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Design for Sustainability: the perspectives of EU residents

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Abstract

Introduction. As the design stage determines over 80% of the environmental impact in a product's lifecycle, the introduction of sustainability dimensions in product design is fundamental. Eco-design is a method that focuses on including environmental aspects of sustainability in product design. However, going beyond eco-design, Design for Sustainability (DfS) integrates all three pillars of sustainability - people, planet, profit.

Research on eco-design and DfS has primarily focused on technocratic perspectives. To advance knowledge on public attitudes towards DfS requirements, the following research question was addressed: *How do EU residents value requirements for Design for Sustainability?* In addition, the alignment of these values with positions of consumer organisations and policy was analysed. From this analysis could be concluded how the preferences of EU residents are embodied in current practices.

Theory. A conceptual framework was developed that shows how residents, consumer organisations, business organisations, and the EU policy landscape on DfS interrelate and can further the adoption of DfS in the EU.

Methods. A literature review was conducted to develop a comprehensive list of DfS requirements. To explore public attitudes towards these requirements, a survey was distributed in nine EU countries (Czechia, France, Germany, Ireland, Italy, the Netherlands, Poland, Spain, and Sweden). Finally, to analyse the alignment of public attitudes with the work of consumer organisations, interviews were conducted with consumer organisations across Europe. To align public attitudes with the current policy landscape on DfS, EU Directives were analysed using content analysis.

Results. From the survey, could be concluded that EU residents particularly value durability, operational safety and efficiency, safe and fair working conditions, and premature replacement of products. On the other hand, requirements valued the least by residents were job creation, reducing the impact of transport and storage, cooperation between actors, waste management, and the use of product-service systems. Overall, it can be concluded that the attitudes towards DfS requirements of the three stakeholders align moderately well.

Discussion and conclusion. The ultimate aim of this research was to provide input for the EU political agenda on DfS. Policy recommendations were formulated for requirements where misalignment between valuation can be found or where additional efforts may be beneficial. Ultimately, this study has provided a foundation for more research into DfS preferences by establishing a comprehensive list of DfS requirements. Subsequently, by adding the previously unexplored perspective of EU residents, a more holistic view of DfS requirements is provided.

1. Introduction

The current take-make-waste model has generated unprecedented levels of growth but is simultaneously exceptionally wasteful. In Europe, 38% of waste is recycled, and a mere 5% of its original raw material value is retained through material recycling and energy recovery (Spangenberg, Fuad-Luke & Blincoe, 2010; EMF, 2015; EC, 2021). While humans continue to create waste, cycles are bound in nature and ensure waste is repurposed (Stahel, 2016). Accordingly, the circular economy (CE) can enforce radically new production and consumption patterns by decoupling economic growth from finite resource consumption (EMF, 2015; Ghisellini, Cialana & Ulgiati, 2016).

At the EU (European Union) level, increasing interest in CE has led to the establishment of the Circular Economy Action Plan (Ghisellini et al., 2016; Polverini & Miretti, 2019). A cornerstone of this plan is the Ecodesign Directive (Mathieux, Ardente & Bobba, 2020). Eco-design is defined as: “a new way for developing products where the environmental aspects are given the same status as functionality, durability, costs, time-to-market, aesthetics, ergonomics and quality” (Pigozzo et al., 2010, p. 23). The introduction of sustainability dimensions in product design is fundamental as the design stage determines over 80% of the environmental impact in a product’s lifecycle (Mendoza et al., 2017). However, it is noted that eco-design methods are limited in scope as they mainly focus on environmental aspects (Park & Tahara, 2008).

Going beyond eco-design, Design for Sustainability (DfS) integrates the three pillars of sustainability - people, planet, profit (Clark et al., 2009; Crul et al., 2009; Spangenberg et al., 2010). While academic literature has largely progressed to prosperity instead of profit, the focus on profit is still common in business and policymaking. Considering that these technocratic institutions are core stakeholders in this research, the choice for profit has been made. Sustainable design allows products to be remanufactured, durable, and repairable (Mathieux et al., 2020), all of which are CE features (Reike, Vermeulen & Witjes, 2018). Consequently, DfS approaches are recognised as essential in implementing CE solutions (Ceschin & Gaziulusoy, 2016).

Considering the role that human behaviour has played in creating environmental problems, it is generally agreed that efforts to resolve these problems and promote sustainability should also include public perceptions of these issues (Ogunbode, 2013). Consequently, understanding the user’s perspective is fundamental for integrating sustainability in design and allow for a more inclusive design process (Wever, van Kuijk & Boks, 2008; Carey et al., 2019). Nevertheless, studies have primarily focused on industry perspectives (Dalhammer, 2016). Also, research into consumers has concentrated mainly on impacts in the use stage of the product (Fletcher & Goggin, 2001; Wever, van Kuijk & Boks, 2008; Evans & Cooper, 2010; Ceschin & Gaziulusoy, 2016; Carey et al., 2019). Furthermore, consumer research has explored perspectives only on specific aspects of eco-design, e.g. ecolabels (Shiu, 2015; Krah, Todorovic & Magnier, 2019) and specific products, e.g. body wash products (Hermann et al., 2007; Lofthouse, Trimmingham & Bhamra, 2017; Vinodh et al., 2017; Chun et al., 2018). However, an assessment of consumer views on various aspects involved in sustainable product design and their relative importance remains unexplored. Parallel to this, an integrated overview of DfS requirements is lacking. DfS requirements represent any requirement concerning a product or the design of a product intended to improve its sustainability performance or any requirement for the supply of information about sustainable aspects of a product (Ecodesign Directive 2009/125/EC, 2009). A variety of DfS requirements are presented in the literature without a clear consensus on their meaning and relative importance. A comprehensive presentation and synthesis of the DfS requirements suggested in the literature would be essential before exploring consumers’ attitudes towards these.

Consumer research is relevant as, in reality, each consumer gives a legitimate reason for the existence of a product or service by deciding how and what to purchase and use (Fletcher & Goggin, 2001; Vezzoli & Manzini, 2008; Shiu, 2015). However, this perspective presumes a limited understanding of how socio-economic systems can change. Additionally, it has to be noted that consumer preferences may not align with the actual impact design choices may have. For example, consumers may prefer requirements with little environmental impact compared to requirements that can have a substantial impact. Nonetheless, consumer research remains

essential in identifying opportunities for sustainable design (Boesen, Bey & Niero, 2019). Business and policy actors can utilise the positive attitudes towards specific requirements and make design choices that have both market potential and sustainable impact.

Simultaneously, people's economic decisions are often regarded separately from their values and commitments as citizens (Soper, 2004). Also, society as a whole, not merely consumers, bear the burden of negative externalities from resource consumption (Sankar, 2006). Considering the different roles that human agents can adopt, it would be relevant to differentiate between consumers and residents. The latter being adopted in this research and understood to include all participants in society (Spaargaren & Oosterveer, 2010). Different roles are connected to different forms of environmental authority, and it is against this background that advancements in research on the perspective of residents on DfS are justified.

Surpassing the commonly explored technocratic perspectives towards design requirements and answering calls for the integration of a wider variety of target groups in the development of CE solutions (Reisch et al., 2016a; Lofthouse et al., 2017), this research aims to contribute to the theoretical field of attitudes towards DfS. Furthermore, following the expected intensification of climate policies, residents' engagement with climate change becomes prominent not only for researchers but also for political agents (Spaargaren & Oosterveer, 2010). Consequently, the ultimate aim of this research is to provide input for the EU political agenda on DfS by showing how residents value DfS requirements, where value is understood as a personal preference.

This research contributes to eco-design developments by expanding the perspective on DfS and broadening the set of design criteria. In addition, by analysing how these values are aligned with positions of consumer organisations and policy, it can be concluded to what extent the preferences of EU residents are embodied in current operations and decision-making processes. Following from the theoretical and practical aspirations of this research, the following research questions are posed:

How do EU residents value requirements for Design for Sustainability?

- A. What Design for Sustainability requirements are most prevalent in academic literature?*
- B. To what extent do the positions towards Design for Sustainability requirements of EU consumer organisations and EU residents align?*
- C. To what extent does the valuation of Design for Sustainability requirements of EU residents align with current Directives?*

By answering these questions, this research contributes to the development of a comprehensive understanding of DfS requirements. More importantly, it aims to stimulate the adoption of DfS across the EU as from both a policy and business perspective, it is relevant to understand what residents value most in sustainable design (Boesen et al., 2019). Integrating environmental, social, and economic considerations in the design phase is crucial in the transition towards CE and preserving the environment (Molenbroek, Cuijpers & Blok, 2012; Michel, 2019). Additionally, surpassing the common structural constraint that "governments negotiate with governments", effective and inclusive policymaking requires empirical evidence of actual residents' interests and needs (Bäckstrand et al., 2006; Reisch et al., 2016a).

2. Theory

This chapter lays down the theoretical foundation of this research by discussing the theoretical concepts and stakeholders involved. In addition, the viewpoints of and work conducted by these stakeholders are explicated as well as the connection between policy and theory. Together this has led to the development of a conceptual framework.

2.1. Concepts

To arrive at a common understanding of the concepts involved, the terms eco-design and DfS are elaborated on as well as their link to the concept of CE.

Since its introduction in the early 1990s, the concept of *eco-design* has developed steadily (Hermann et al., 2007). Eco-design methods are identified as systematic means to deal with environmental issues during product development (Park & Tahara, 2008; Pigosso et al., 2010). Ultimately, eco-design aims to improve products' environmental performance and develop products in line with sustainable development and lifecycle thinking (Pigosso et al., 2010).

Concepts like eco-design were put into practice to address environmental concerns associated with production and consumption. However, over time, *DfS* has evolved to go beyond making a product "green" by including economic and social concerns (Crul et al., 2009; Spangenberg et al., 2010). Similar to eco-design, DfS approaches are based on lifecycle thinking (Clark et al., 2009; Crul et al., 2009). In addition, developments in the field of DfS have shown a progressive expansion from a technical and product-centric focus towards system-level changes in which sustainability is understood as a socio-technical challenge (Ceschin & Gaziulusoy, 2016).

The concept of CE is represented by different schools of thought that acknowledge the current take-make-waste model is inadequate and a new economic system is required to shift to a more sustainable world (Wautelet, 2018). The Ellen MacArthur Foundation defines the CE as an economy that is "restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" (EMF, 2015, p. 2). One note that should be made is that eco-design or DfS rules do not necessarily coincide with CE principles (Michel, 2019). From its most radical incarnation, CE deals with reducing the number of resources consumed while eco-design and DfS operate within a paradigm that does not critique resource consumption. Nevertheless, multiple eco-design and DfS requirements align with CE principles, e.g. durability and recycling (Bakker et al., 2014; Mathieux et al., 2020).

2.2. Stakeholder map

In this section, the interlinkages between central actors will be elaborated on (Figure 1). Three stakeholder types central to this research are: governments, residents and consumer organisations. Additionally, business organisations ultimately do or do not execute DfS methods and hence present an essential link in the chain. Together these actors play an important role in sustainability patterns such as CE since these transitions require innovative concepts as well as innovative actors (Ghisellini et al., 2016).

The aforementioned stakeholders are dependent on the natural environment and responsible for conserving it (Ghisellini et al., 2016). Subsequent to ongoing debates, most stakeholder theories have progressed to consider the natural environment as a stakeholder (Mitchell, Agle & Wood, 1997; Driscoll & Starik, 2004; Haigh & Griffiths, 2009). While most publications have focused on the impacts of organisations on the natural environment, the importance of resources and economic inputs to businesses should not be overlooked (Mitchell et al., 1997; Driscoll & Starik, 2004; Haigh & Griffiths, 2009).

Political actors execute a crucial role in defining and dealing with ecological and social problems (Haigh & Griffiths, 2009; De Groot, Drenthen & de Groot, 2011). These actors encompass all entities in a position to speak for society, and in theory, they can "set the rules of the

game“ (Vezzoli & Manzini, 2008, p. 41). Institutions play a valuable role in green production processes by establishing rules, policies, and structures (De Groot et al., 2011; Yu, Han & Hu, 2016).

As will be elaborated on later in this chapter, groups of individuals within society have their own values and beliefs. For example, while some may need to be forced to adopt eco-friendly lifestyles, others may strive to effectively work with nature (De Groot et al., 2011). Additionally, one axiom that has shaped policy approaches has been that through their market choices, individuals inevitably put pressure on what manufacturers should produce (Fletcher & Goggin, 2001; Li, Wang & Wang, 2020). Nevertheless, the paradox is that while individuals might be central to consumption activities and societal transformations, they are not the most salient agents in the value chain (Akenji, 2014).

The strength of companies combined with the lack of individual power in overarching political structures requires a strong movement for residents to be well-represented in decision-making processes. Consumer organisations are governmental agencies acting as watchdogs that see to it that residents’ rights are well-designed and adequately enforced (BEUC, n.d.; European Commission, n.d.a). The goal of consumer organisations in Europe is to provide independent information on various subjects, represent EU residents among more powerful actors, and influence the development policies that promote and defend their interests (European Commission, n.d.a).

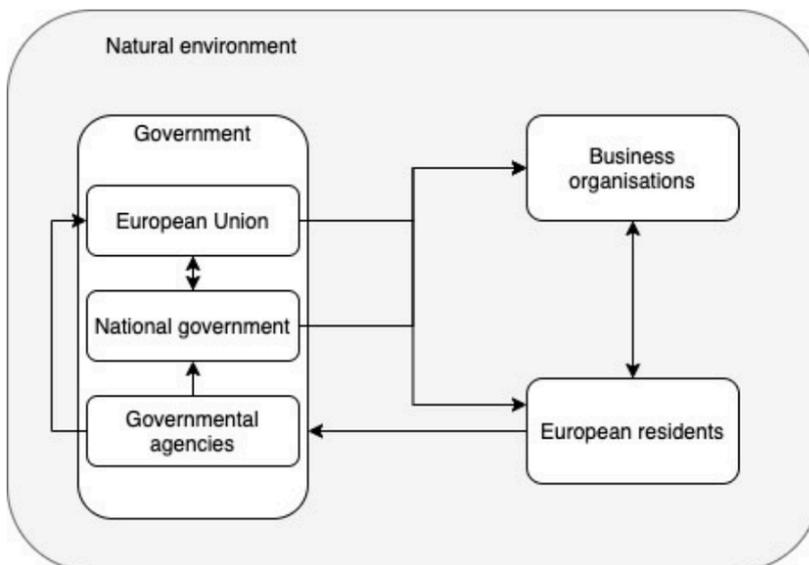


Figure 1. Stakeholder map

2.3. Theory residents

As indicated in the previous section, people hold different beliefs and values about the way society should sustain its quality of life (de Vries & Petersen, 2009). Research findings suggest that attitudes are important determinants of ecological behaviour and understanding attitudes towards issues such as resource efficiency is a crucial step in the successful implementation of CE and DfS concepts (EPRS, 2017).

2.3.1. Measuring attitudes

Environmental attitudes comprise beliefs, affective responses and behavioural intentions that people hold concerning environmental issues. These attitudes are based on complex moral and social values that can not directly be observed but must be inferred from overt responses (Ogunbode, 2013). Over time, a variety of measurement instruments for studying public environmental attitudes have been developed. Ultimately, the New Ecological Paradigm (NEP) scale is recognised as the most widely accepted attitude measure because of its documented validity and reliability (Dunlap et al., 2000; Ogunbode, 2013).

The first version of the NEP scale was published in 1978 when environmental issues obtained a more prominent position on the political agenda. This original NEP scale consisted of

12 items with a 4-point Likert scale response system. Later the scale was revised to update and broaden the scale's content (Dunlap et al., 2000). The revised NEP scale includes 15 items with a 5-point Likert response scale (Dunlap et al., 2000; Anderson, 2012).

Worldviews profoundly inform how environmental issues are perceived, what are considered valuable solutions, and what ought to be the role and responsibility of the individual (Hedlund-de Witt, 2014). The general idea of the NEP scale is that this instrument can measure where a population finds itself in the transition from the Dominant Social Paradigm (DSP) to the NEP. In the NEP scale, eight items reflect the endorsement of the new worldview. The remaining seven items (presented in bold in Table 1) represent an endorsement of the DSP. Additionally, the items of the scale include five facets that focus on beliefs about humanity's ability to upset nature, the existence of limits to human economic growth and development, and humanity's right to rule over the rest of nature (Dunlap et al., 2000; Anderson, 2012; Ogunbode, 2013). The 15 NEP scale items and their allocation to the facets are presented in Table 1.

Table 1. The fifteen NEP items of the NEP scale allocated to the five NEP facets.

NEP facets	NEP items
Reality of limits of growth	N1. We are approaching the limit of the number of people the Earth can support N6. The Earth has plenty of natural resources if we just learn how to develop them N11. The Earth is like a spaceship with very limited room and resources
Anthropocentrism	N2. Humans have the right to modify the natural environment to suit their needs N12. Humans were meant to rule over the rest of nature N7. Plants and animals have as much as rights as humans to exist
Fragility of nature's balance	N3. When humans interfere with nature it often produces disastrous consequences N8. The balance of nature is strong enough to cope the impacts of modern industrial nations N13. The balance of nature is very delicate and easily upset
Rejection of exceptionalism	N4. Human ingenuity will insure that we do not make the Earth unlivable N9. Despite our special abilities, humans are still subject to the laws of nature N14. Humans will eventually learn enough about how nature works to be able to control it
Possibility of an eco-crisis	N5. Humans are seriously abusing the environment N10. The so-called "ecological crisis" facing human kind as been greatly exaggerated N15. If things continue in their present course, we will soon experience a major ecological catastrophe

[Items in bold represent the DSP]

2.3.2. Impact of attitudes

It is generally recognised that positive environmental attitudes are strong antecedents of pro-environmental behaviour (Ogunbode, 2013). However, while people may identify themselves with a particular worldview, this does not imply that this governs their actual behaviour. Historically, psychological models focus on internal factors as determinants for individual behaviour, such as attitudes and beliefs (Di Sorrentino, Woelbert & Sala, 2016). Nevertheless, evidence suggests that environmental attitudes are a poor predictor of environmental behaviour (Gupta & Ogden, 2006; Carey et al., 2019). This connection is commonly referred to as the attitude-behaviour or value-action gap (Gupta & Ogden, 2006). Consequently, doubts exist about the ability of environmental attitudes to predict purchase behaviour. As a result, when evaluating people's claim to value particular DfS requirements, conclusions on actual environmental behaviour should be considered carefully.

In addition to the attitude-behaviour gap, the conception of sustainable behaviour may not always align with actual sustainable impact. Multiple studies have concluded that residents' perceptions of sustainability and LCA results of products can be contrasting (Tobler et al., 2011; Steenis et al., 2017; Boesen et al., 2019). This discrepancy can be explained by the fact that residents rely on misleading and inaccurate beliefs when judging products and are thus susceptible to making ineffective environmental decisions (Steenis et al., 2017). The level of understanding of

sustainability can be linked to the work of consumer organisations and politics who are for a large part responsible for information provision and informative campaigns.

2.4. Current policy landscape

As mentioned in the introduction, a cornerstone of the CE Action Plan is the Ecodesign Directive. Considering the importance of this Directive in the transition to a more sustainable and circular society, this section provides more insight into the content and development of the Directive.

2.4.1. Ecodesign Directive

Noticing that economic actors were hindered by market failures and imperfections to produce and consume eco-designed goods, the EU established the Ecodesign Directive for setting eco-design requirements (Bundgaard et al., 2017; Michel, 2019; Mathieux et al., 2020). The Ecodesign Directive 2005/32/EC applied to energy-using products and was repealed by 2009/125/EC, which applies to all energy-related products (ErPs). In October 2019, the Ecodesign Directive was extended to include more ErPs because of their environmental impact and high impact potential. ErPs encompass goods that impact energy consumption during its use (Michel, 2019). In addition to being energy-related, products are to be covered by the Directive if they (1) sell more than 200.000 units per year throughout the EU, (2) have a significant environmental impact, and (3) present significant potential for improvement in environmental impact without incurring excessive costs (ibid.).

Similar to eco-design and DfS, the Ecodesign Directive is based on lifecycle thinking and pushes the market towards greener products by banning the worst performing ones. The Directive consists of minimum mandatory requirements for energy efficiency, thereby providing thresholds that ErPs have to reach to be placed on the EU market (Michel, 2019; Polverini & Miretti, 2019). Regulations are complemented by harmonised standards, which are technical specifications that indicate compliance with the mandatory requirements (European Commission, n.d.b). Additionally, implementing measures identify advanced benchmarks of environmental performance which are voluntary in nature (European Commission, n.d.c). A summary of the requirements per product group is presented in Appendix I.

2.4.2. Enforcement

As stated by Malcolm (2011): “the enforcement of the Directive [...] is only as good as the enforcement mechanisms accompanying it” (p. 497). However, it has been estimated that 10-25% of products on the European market do not comply with eco-design and energy labelling requirements (European Commission, 2016). When non-compliant products circulate in the European market, penalties can be imposed (Michel, 2019). Member States are responsible for market surveillance, but in the end, manufacturers bear the burden of proof, meaning they have to prove their compliance (European Commission, 2016; Michel, 2019).

2.4.3. Current discussions and prospects

The Ecodesign Directive is considered a key EU policy instrument that addresses the environmental impacts of products (Bauer et al., 2018). It has been estimated that it will deliver energy savings of 175 Mtoe per year (equalling Italy’s primary energy consumption in 2010) (Polverini & Miretti, 2019). In addition, households would save on energy bills and many non-financial benefits prevail, e.g. positive health effects (EPRS, 2017).

Policy has always been a critical driver of eco-design development, but the Directive has received some critical remarks (Mathieux et al., 2020). Most importantly, it is argued that it has not yet fulfilled its potential as a lifecycle-oriented instrument (Bauer et al., 2018). Thus, the challenge remains to construct an integrated policy framework that balances economic, social and environmental aspects (Belz & Peattie, 2012a).

Egenhofer et al. (2018) specified three main obstacles in implementing the Directive from interviews with primary stakeholders across Europe. First, the general opinion prevails that political support for the implementation lacks at the EU level. Second, the regulatory process is viewed as being too slow. Consequently, the Directive seems to fail to keep up with the status quo and fall behind on technological progress. This “need for speed” has also been recognised by experts

(ECEEE, 2018). Third, in addition to inadequate market surveillance, concerns are expressed regarding the risk of double-regulation (i.e. requirements for the complete product and specific parts of the product) (ECEEE, 2018).

Nevertheless, stakeholders generally take a positive stance towards the Ecodesign Directive and propose a broader scope by including non-energy-related products (Egenhofer et al., 2018). Additionally, it has been argued that more effort should be devoted to the systematic inclusion of CE aspects (Egenhofer et al., 2018; Polverini & Miretti, 2019; Mathieux et al., 2020). While it would pose new challenges, the policy does display the potential to include these principles into actual requirements at the product level, e.g. by addressing reparability (ibid.).

The inclusion of CE aspects has been a central issue in the Ecodesign Working Plan, which sets out a list of priority products and measures to be included in the Ecodesign Directive (European Commission, 2016; EPRS, 2017). Subsequently, the draft of the Working Plan was revisited multiple times in light of the CE Action Plan (ibid.). With this most recent plan, besides including new product groups, the Commission has set multiple ambitions. They strive to incorporate more CE aspects in future product requirements, develop more systematic material efficiency requirements, improve the methodological basis for the adoption of requirements, and for global convergence in standards, methods, and minimum requirements (European Commission, 2016; Michel, 2019). As a result of these suggestions, the Ecodesign Directive has been amended in 2019 and is currently being rewritten.

2.5. Science and policy

Important to note is that differences exist in the understanding of eco-design and DfS in science and policy. Overall, literature has focused on identifying and developing methodologies from which a variety of requirements can be derived. The Methodology for Eco-design of Energy-related Products (MEErP) framework largely echoes these requirements and aims to support the implementation of eco-design requirements in policy. According to MEErP, the most applicable requirements would be recyclability benefit rates, recycled content, lifetime and a critical raw material index (Mudgal et al., 2013). While specific requirements for design become evident from the literature, its implementation remains challenging. In response, as part of its environmental management system guidelines, ISO 14006 guides organisations in eco-design integration. However, ISO does not establish specific environmental requirements (Maderna-Fernandez, Pérez-Canto & Rubio-Romero, 2013).

While academics have largely progressed from eco-design to DfS, the former remains dominant in policymaking and business (Michel, 2019). Additionally, although requirements for eco-design and DfS have conclusively been presented in the literature, its adoption in policy has remained limited. As can be seen from Appendix I, the Ecodesign Directive is focused mainly on measures such as impact assessments, while eco-design as a method is wider.

2.6. Conceptual framework

This study has developed a conceptual framework to illustrate the interlinkages between the concepts introduced in this theory section (Figure 2). The framework represents the influences the different stakeholders exert on each other and the expected influence of residents' worldviews on their attitudes towards DfS requirements. Where the four circles overlap, the foundation for sustainably designed products can be found. This foundation can be weak or strong, depending on the favourability and efforts taken towards DfS requirements. While the work of business organisations is not analysed in this research, it is included in this figure due to its integral role in executing DfS methods.

By discussing the concepts and stakeholders involved, worldviews, the current policy landscape, the alignment between policy and academic literature, and the interdependencies presented in the conceptual framework, this theory section provides the basis for empirical research.

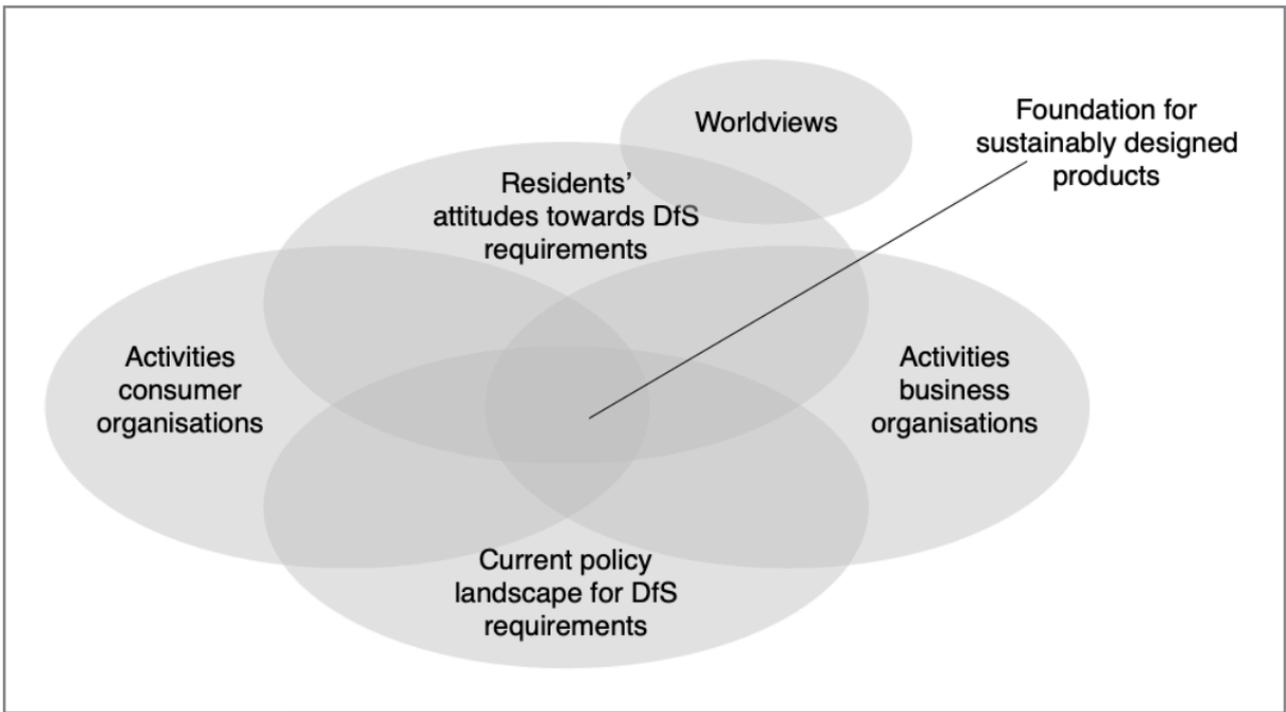


Figure 2. Conceptual framework

3. Methodology

3.1. Research design and process

To reiterate, this research integrates perspectives of residents, consumer organisations and government towards DfS requirements with the ultimate aim of contributing to the political agenda on DfS. The research is based on a mixed-method approach, where first, a comprehensive list of DfS requirements was developed, providing the theoretical basis for empirical research. Then, the research was broken down into five phases and research activities were allocated to different stakeholders included in the research (Figure 3).

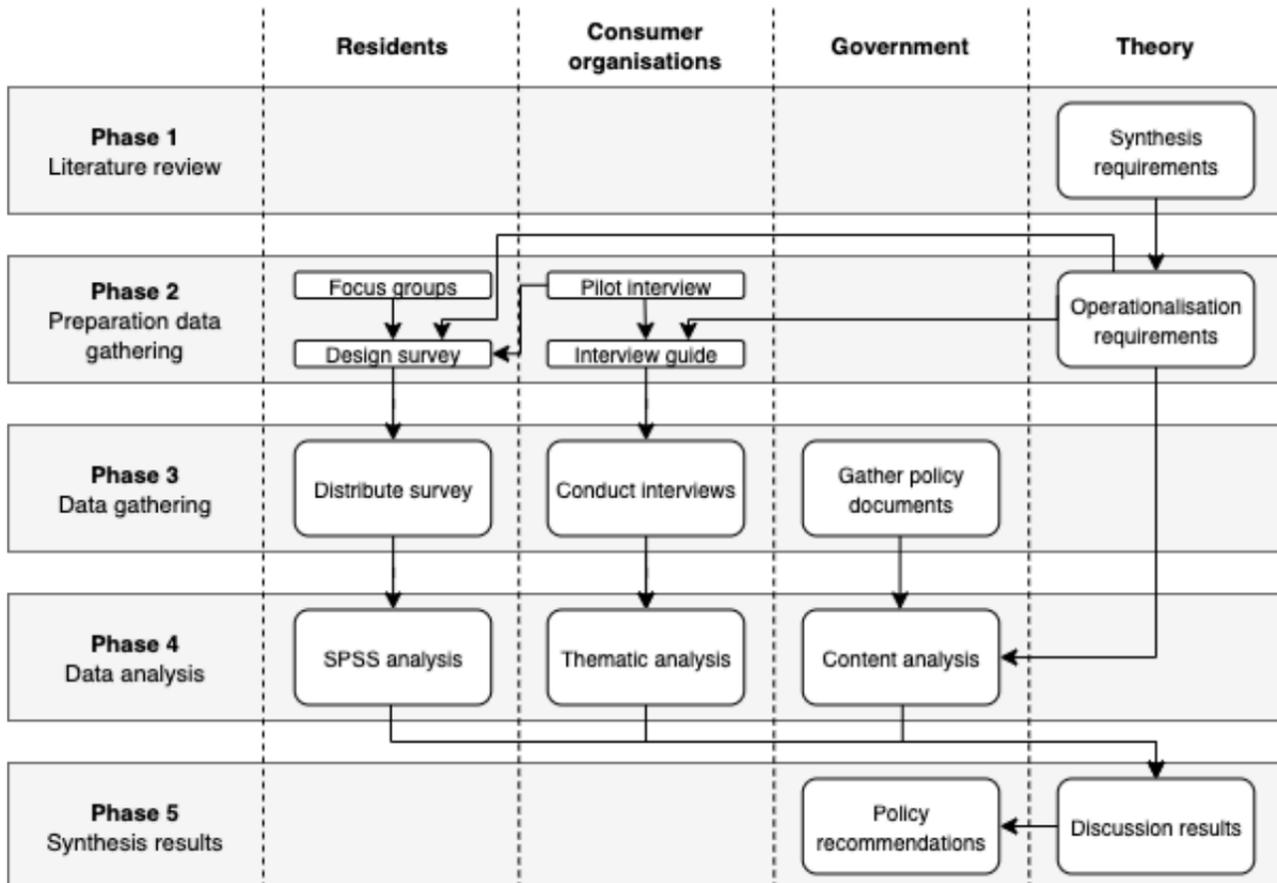


Figure 3. Visualisation of the research process

3.2. Scope of the research

This research was conducted in the EU, consisting of 27 countries. Furthermore, the following stakeholders were included. First, EU residents are considered any national of an EU country (EUR-Lex, n.d.). Second, consumer organisations are federations of national bodies across the EU (BEUC, n.d.; European Commission, n.d.a). Third, the government in this research refers to the EU government and thus to a supranational government.

3.3. Data collection

3.3.1. DfS requirements

From the literature on eco-design and DfS, an extensive list of design requirements emerges. From a theoretical perspective, it was deemed valuable to synthesise these requirements into a comprehensive list (subquestion A). To arrive at this list, literature was obtained from Scopus and Google Scholar using search terms such as *eco-design tools*, *lifecycle optimisation*, and *resource efficiency*. In addition, the search was narrowed down to publications in relevant fields of study, e.g. industrial ecology and cleaner production. Following from the analysis of 34 articles on eco-design and DfS, 62 unique requirements emerged. These were synthesised in three rounds, each round combining the requirements further (Appendix II-A). Reviewing the synthesis in multiple

cycles enhanced the internal reliability of the list. Ultimately a list of 20 DfS requirements resulted. Subsequently, each requirement was allocated to one of the dimensions of sustainability (people, planet, profit). With this, an overview was provided of how the requirements further the incorporation of sustainability in design. Furthermore, the triple bottom line allocation facilitated the development of the ranking questions for the survey (section 3.3.4.).

An operationalisation of the list was called for to allow for requirements to be recognised based on their attributes and provide a clear and complete description of each requirement (Appendix II-B). The operationalisation was used to formulate questions for the interviews and survey and supported the analysis of governmental documents. The operationalisation was derived from the literature detailed in the previous paragraph. The use of an operationalisation enhances the inter-observer consistency of the research by diminishing the level of subjectivity in the allocation of text passages to requirements. Additionally, retrieving the indicators of requirements from theory ensures consistency between the concept and the measure, also known as construct validity.

3.3.2. Interviews

Two types of interviews were conducted, each with different actors and a different purpose. Both interviews were semi-structured, allowing for flexibility regarding the content and order of questions (Bryman, 2012). In addition, interview guides were constructed, providing guidance in asking questions that help answer the research question (Appendix III-A-B). The use of interview guides and semi-structured interviews provides transparency and enhances the replicability of the research (ibid.).

3.3.2.1. Pilot interview

A pilot interview was conducted with the policy officer on sustainable consumption and production (also working as Eco-design project coordinator) at BEUC (*Bureau Européen des Unions de Consommateurs*). BEUC, also known as the European consumer organisation, is the umbrella group for 44 independent consumer organisations across Europe. The organisation represents consumer organisations to EU institutions and ultimately defends the interests of European consumers (Interview with BEUC eco-design project coordinator, 18th of January, 2021; BEUC, n.d.). A pilot interview is proven helpful in refining research instruments and served as a basis for developing the interview guide for consumer organisations and provided input for survey questions (Sampson, 2004).

3.3.2.2. Interviews consumer organisations

To answer subquestion B, pertaining to the alignment of residents' preferences for DfS requirements and those put forward by consumer organisations, interviews were conducted with consumer organisations across Europe. Interviews are deemed a suitable method to answer this research question as interview data (qualitative data) provides more explanatory power than quantitative results and can provide case-specific insights into how consumer organisations approach eco-design or DfS (Bryman, 2012).

A total of eleven consumer organisations, spread across nine countries, participated in the interviews (Figure 4). Before conducting the interviews, the participants were notified of the purpose of the research and interview. Additionally, participants received the interview guide upon request. Furthermore, each interviewee signed an informed consent form, thereby ensuring a detailed understanding of what participation entailed and ensuring a certain level of privacy (Bryman, 2012) (Appendix III-C). Because of the COVID-19 pandemic and the international character of this research, the interviews were held online using MS Teams. Eventually, the interviews lasted 1 hour and 57 seconds on average. All interviews have been recorded and transcribed. Transcripts can be found in Appendix III-D.

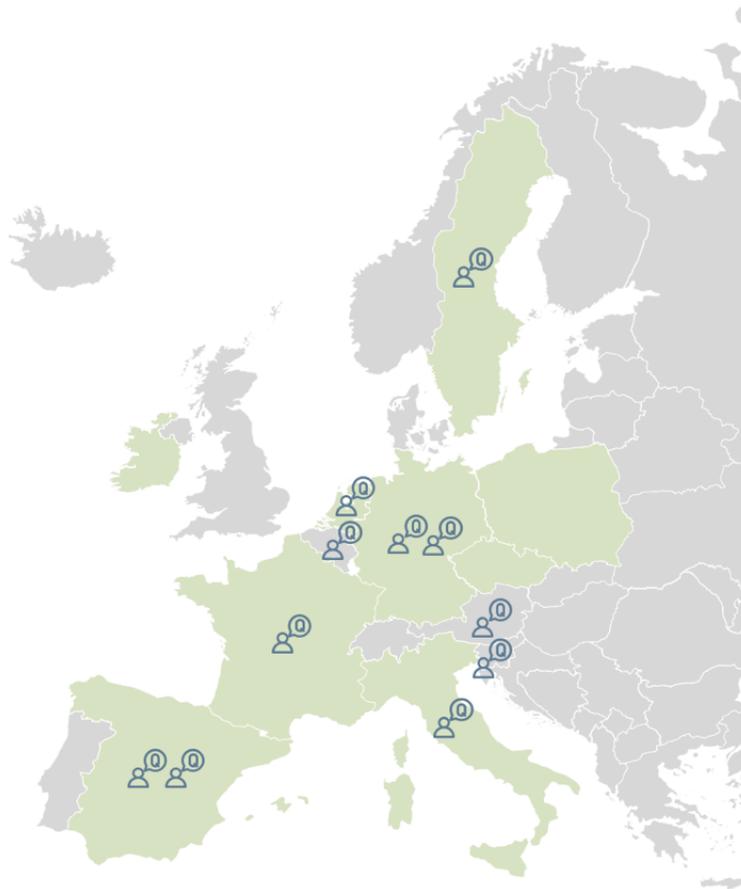


Figure 4. Map of Europe presenting countries where interviews and surveys have been conducted. Each icon represents an interview, green colour represents a country in which the survey was conducted.

3.3.3. Content analysis

In order to answer subquestion C, Directives on, or related to, eco-design or DfS put forward by the EU were evaluated. As defined by the EU, a Directive is a legislative act that sets out a goal that all EU countries must achieve. However, Directives do not dictate the means to achieve these goals, and it is up to the individual countries to devise their laws (European Union, n.d.). 2005 was chosen as a base year for the analysis because the first Ecodesign Directive was put in place this year. Moreover, solely codified documents were included and the most recent versions were analysed, thereby including amendments to the document. The following documents have been analysed:

- Accreditation and Market Surveillance Directive (765/2008/EC)
- Ecodesign Directive (2009/125/EC), including revisions of October 2019:
 - C(2019) 2120
 - C(2019) 2121
 - C(2019) 2122
 - C(2019) 2123
 - C(2019) 2124
 - C(2019) 2125
 - C(2019) 2126
 - C(2019) 2127
 - C(2019) 5380
- EMAS Directive (1221/2009/EC), last revision in 2018
- Energy Labelling Directive (EU 2017/1369)
- EU Ecolabel (66/2010), last revision in 2017
- OHS Directive (89/391/EEC), last revision in 2008
- Packaging and Packaging Waste Directive (94/62/EC), last revision in 2018
- REACH Directive (1907/2006), last revision in 2021

- RoHS Directive (2011/65/EU), last revision in 2020
- Waste Directive (2008/98/EC), last revision in 2018
- Waste Shipment Directive (1013/2006), last revision in 2020
- WEEE Directive (2012/19/EU), last revision in 2018

Content analysis was used to analyse the documents as it seeks to quantify content in terms of predetermined categories (the synthesised list of DfS requirements), thereby making it a deductive approach. Essentially, what is being sought is a categorisation of the phenomenon under interest. The strengths of this approach are its systematic and replicable procedure and its ability to practice objectivity (Bryman, 2012).

3.3.4. Survey

Surveys present a convenient method for gathering large amounts of data (Bryman, 2012) and are a well-established method for collecting empirical data in the field of consumer behaviour (Boesen et al., 2019). Accordingly, this method was employed to arrive at a representation of how EU residents value DfS requirements (main research question). The survey can be characterised as a cross-national survey on public attitudes (and behaviour), and exceptional care was taken in the design and formulation of the questionnaire as this could affect findings. Since no interviewer was present, writing in plain language was essential to avoid misunderstandings (Di Sorrentino et al., 2016). Furthermore, the survey solely included closed questions as this reduces the possibility of respondents abandoning the survey and variability among answers (Bryman, 2012). Additionally, the order of questions was carefully considered to avoid question order bias, where early questions influence how respondents answer questions later in the survey (Bryman, 2012; Alchemer, 2015).

The survey consists of four sections (for the complete survey, see Appendix IV-A):

- *Part 1: demographic questions*
 - Comprised of six multiple-choice questions.
- *Part 2: consumer behaviour*
 - Comprised of two Likert scale questions on shopping preference and taking care of possessions.
 - Comprised of twelve multiple-choice questions on buying behaviour and design preferences. Some questions contained skip logic meaning these questions were displayed if answer conditions had been met. Answer choices have been developed with the help of focus groups (section 3.3.3.2.) and answer choices were randomised.
 - Note: the results of this section are not used in answering the research questions and thus not presented in the results section but can be found in Appendix V-E.
- *Part 3: value allocation of DfS requirements*
 - Comprised of twelve ranking questions. Rankings were presented for the requirements presented in chapter 4. Again, the ranking questions were based on either people, planet, or profit, thus presenting three different rankings. Each of these rankings was then asked for four different product types (section 3.3.3.1.). Answer choices were randomised to avoid answer order bias and to avoid question order bias, the ranking questions themselves were randomised.
- *Part 4: environmental value orientation*
 - Comprised of 15 statements of the New Environmental Paradigm (NEP) Scale (Anderson, 2012; section 2.3.1.).
 - In order to mitigate bias, questions on environmental values were presented last, and no direct mention of environmental attitudes had been presented earlier.

3.3.3.1. Matrix

In the survey, four different product types were used as a basis for the questions to provide respondents with more concrete questions and check variability in answers among product groups. In order to establish product types to be included, a matrix has been developed (Table 2), plotting product complexity against lifetime.

Product complexity. The primary source of product complexity is variety (Orfi, Terpenney & Sahon-Sariisik, 2011). Variations are driven by several factors, e.g. product performance and architecture choices, and are proven to negatively influence product development cost, time, and customer satisfaction (Novak & Eppinger, 2001; Orfi et al., 2011).

As proposed by Novak and Eppinger (2001), and largely supported by Orfi et al. (2011), product complexity generally has three dimensions:

1. The number of components to specify and produce
2. The extent of interactions to manage between these components
3. The degree of product novelty

While these dimensions could have a continuous character, this research merely distinguishes complex from simple products (dichotomous). Additionally, using the vocabulary of the Ecodesign Directive, simple products can also be recognised as non-energy-related products and complex products can be identified as energy-related products.

Product lifetime. Product lifetime is defined as the time from acquisition to discarding the product by the final owner. This period thus includes repairs, refurbishments, and remanufacturing as introduced by the CE concept (Reike et al., 2018), as well as periods of non-usage or storage (Bakker et al., 2014). Furthermore, two product lifetime dimensions are distinguished, short and long. *Short* is defined as a lifetime between 0 and 5 years. *Long* is considered everything longer than five years. More information on how the matrix was developed can be found in Appendix IV-B.

Table 2. Research matrix: specification of product types

Complexity/lifetime	0 - 5 years	> 5 years
Simple Non-energy-related	Clothing	Couch
Complex Energy-related	Mobile phone	Refrigerator

3.3.3.2. Focus groups

In order to develop fixed-choice answers for the questions of part 2 of the survey, two focus groups have been conducted. A diverse set of individuals was recruited to ensure variance in viewpoints. Participants differed in age, educational background, cultural background, and interests.

The survey questions were posed openly to the participants to arrive at fixed-choice answers. This has led to an array of answers as well as discussions on the subjects. Both focus groups were recorded and transcribed (Appendix IV-C). The fixed-choice answers retrieved from the focus group were allocated to themes, specifically to functionality, economic value, aesthetics, sustainability, or circularity (Shiu, 2015). This allocation was performed to determine which answer choices were valued most by respondents (Appendix IV-D).

3.3.3.3. Sample

To capture Europe's diversity, Countries from Northern, Eastern, Southern, and Western Europe have been selected, resulting in a total sample of nine countries. The decision on countries was based on demographic data and data on environmental attitudes (Figure 5, 6, Appendix IV-E). Especially knowledge on environmental issues could substantially influence perceptions on DfS. Therefore, all data was carefully considered to retrieve as close to a representative sample of Europe as possible. A representative sample also enhances the external validity of the research. Eventually, the following countries have been selected for inclusion in the survey:

- Northern Europe: Ireland and Sweden
- Eastern Europe: Czechia and Poland
- Southern Europe: Italy and Spain
- Western Europe: France, Germany, and the Netherlands

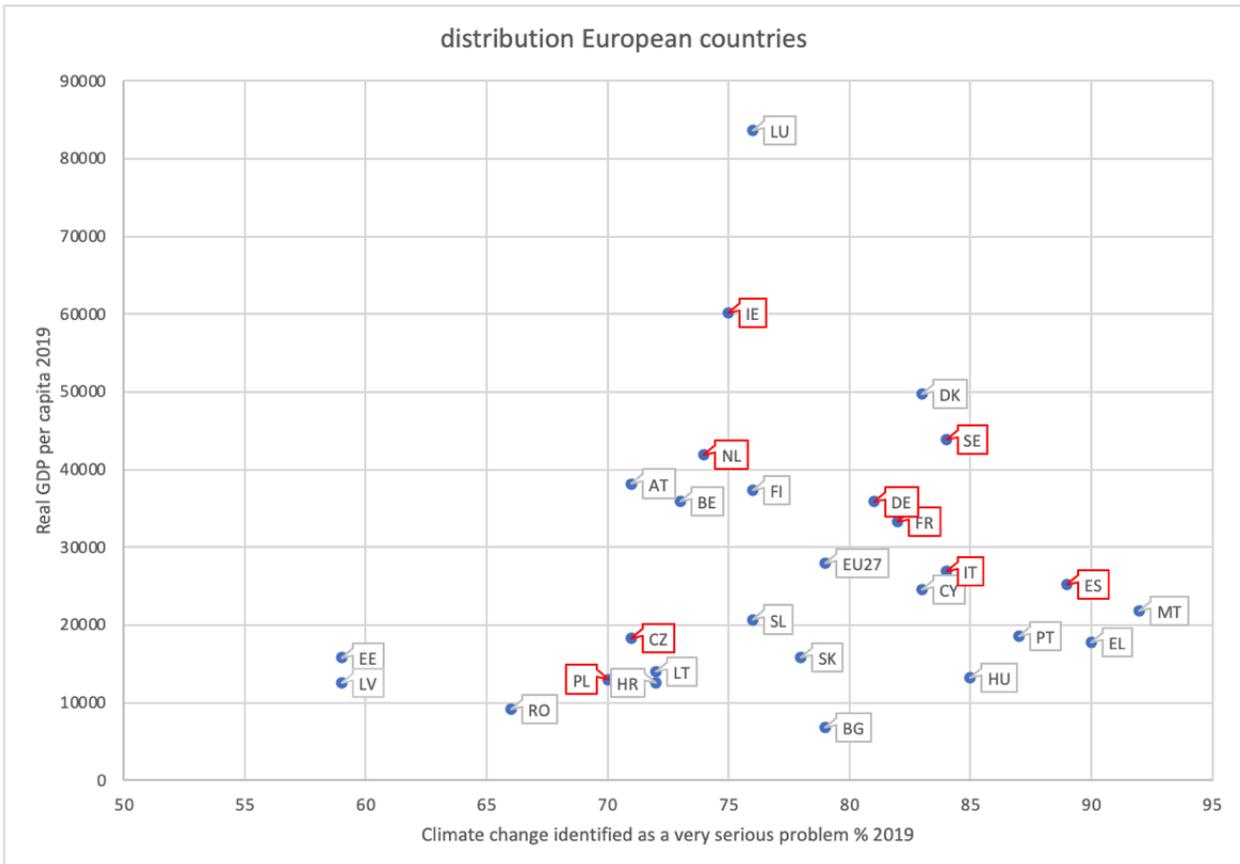


Figure 5. Matrix plotting real GDP per capita in 2019 against “climate change identified as a very serious problem” in % in 2019. Countries selected for the sample have been indicated with red colour. Based on: European Commission (2019); Eurostat (2020c)

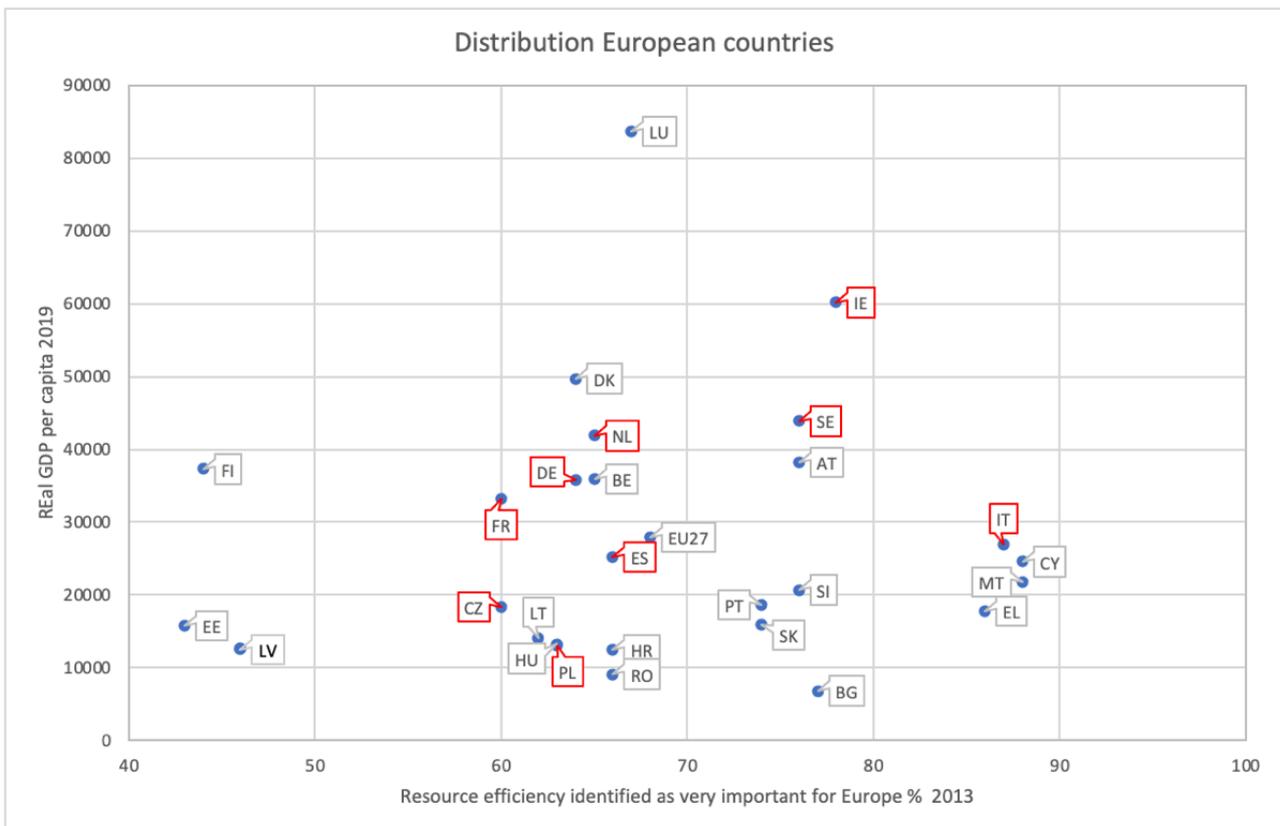


Figure 6. Matrix plotting real GDP per capita in 2019 against “resource efficiency identified as very important for Europe” in % in 2013. Countries selected for the sample have been indicated with red colour. Based on: European Commission (2014); Eurostat (2020c)

Besides choosing countries, the need to sample within countries is a common concern in quantitative research. Since the final aim is to generalise findings, a representative sample is imperative. However, obtaining such a sample is complex and costly, especially in cross-national surveys where samples in each country must do justice to their national specificity while simultaneously being internationally comparative (Bryman, 2012).

Decisions about sample size depend on many considerations and include compromises between factors such as time and cost (Bryman, 2012). In this research, the Cochran formula for sample size was used as it is argued to be especially relevant in large populations (Kotrlík & Higgins, 2001). The formula rests on the level of homogeneity within a population and can be defined as follows:

$$n = \frac{Z^2 pq}{E^2}$$

where:

- Z represents the Z-score (depending on the confidence interval);
- E is the desired level of precision (margin of error);
- p depicts the (estimated) proportion of the population which possesses the attribute in question; and
- q is calculated as 1 - p

The sole prerequisite for participation in the survey was to be 18 years or older. Adopting a 95% confidence interval and a 5% margin of error, n_0 (sample size) per country is presented in Table 3.

Table 3. Number of respondents requested per country based on Cochran's formula. Data retrieved from United Nations Population Fund (2020). The number of responses retrieved is also presented.

	% of adults	Z	e	p	q	n_0	no requested	no retrieved
Czechia	84,2	1,96	0,05	0,842	0,158	204,43	205	207
France	82,3	1,96	0,05	0,823	0,177	223,8	225	227
Germany	86	1,96	0,05	0,86	0,14	185,01	185	287
Ireland	79,2	1,96	0,05	0,792	0,208	253,14	255	257
Italy	87	1,96	0,05	0,87	0,13	173,79	175	177
The Netherlands	84,3	1,96	0,05	0,843	0,157	203,38	205	207
Poland	84,8	1,96	0,05	0,848	0,152	198,07	200	202
Spain	85,6	1,96	0,05	0,856	0,144	189,41	190	192
Sweden	82,4	1,96	0,05	0,824	0,176	222,85	225	227
Total responses							1.865	1.883

3.3.3.4. Survey distribution

The survey was web-based and administered through Qualtrics between the 23rd of March and the 27th of April. In addition to providing survey software, Qualtrics uses cloud-based software and allows researchers to create and distribute surveys among the desired sample while using probability sampling. Probability sampling is commonly used in high-quality surveys to be able to draw inferences about the specific population. Furthermore, Qualtrics works with ESOMAR (European Society of Opinion and Marketing Research) to retrieve respondents. In turn, ESOMAR works to ensure adherence to professional and ethical standards (Qualtrics XM, n.d.). The cooperation with Qualtrics is visualised in Appendix IV-F.

Web-based surveys provide a convenient way to generate large amounts of data. In addition, data is easily exported into programs such as SPSS, and it is cheaper than most other forms of data collection. Nevertheless, online surveys typically generate lower response rates than other forms of data gathering. Moreover, most importantly, internet users could represent a biased sample of the population because they tend to be better educated, wealthier, younger, and not ethnically representative (Bryman, 2012).

3.3.3.5. Practical concerns

To avoid biased responses, the survey was provided in all national languages of the countries of interest: Czech, English, French, German, Italian, Spanish, Swedish, and Dutch. The translation was arranged in two rounds. First, the survey was translated by the principal researcher using Deepl and Google Translate. Second, the translated document was checked and adjusted by natives in the respective languages (Appendix IV-G). All translators were informed on the purpose of the survey and concerns such as pronouns and gender discrimination. All translations were copied into the Qualtrics software, and based on the respondents' IP addresses and location, the software automatically presented the survey in the language of the residing country. Nevertheless, the language could manually be adjusted since residents of a country are not necessarily fluent in the respective language.

The IP addresses were also used to detect discrepancies between respondents' location and country of residence. If discrepancies emerged, the survey was terminated at once.

Qualtrics uses a Double-Opt-In process to ensure respondents are engaged and consenting to participate in the survey to ensure high-quality data. Additionally, RelevantID Digital Fingerprinting is leveraged to safeguard that multiple responses do not come from the same respondent. In addition, the resulting data is inspected on quality, checking for the following indicators:

- Straight- and flatliners: respondents that answer grid questions in the same manner or create patterns.
- Bad verbatims: answering open-ended questions by way of keyboard banging or typing illogical answers.
- Speeders: respondents that speed through the survey by simply clicking through the questions.
- Bots: software created to take surveys multiple times for incentives (Qualtrics, 2021).

To advance the robustness and reliability of the survey data, and to check for speeders, a minimum time spent on the survey was established. This time was set at 4.30 minutes and was calculated as half of the average time spent on the survey in the second soft launch (9.01 minutes)(Appendix IV-F). This minimum time limit advances the confidence that respondents have taken their time to read and answer the questions adequately.

3.4. Data analysis

3.4.1. Interviews

All interviews were analysed using thematic analysis. This method focuses on identifiable themes, which are abstract constructs that arise from the data and theoretical understanding of the subject (Aronson, 1995; Ryan & Bernard, 2003). Guidelines for the recognition of themes are presented in Table 4.

The interview transcripts were analysed using NVivo, software commonly used for the qualitative analysis of textual information. Following an inductive procedure, a so-called "node" was created for each theme that arose from the interview data. Consequently, relevant passages were coded into sub-themes or "child nodes". Coding was performed in two iterations. First, all data was coded into themes and sub-themes. Second, sub-themes with similar meanings were harmonised (e.g. *link to durability* and *link to repairability* were merged into *interconnections*).

To strengthen the internal reliability of the thematic analysis, all nodes and child nodes were reviewed by two independent coders. Hereby intercoder reliability was established. Confusion over nodes or uncertainties were discussed and resolved (e.g. adjusting the level of detail of child

nodes). Ultimately, the thematic analysis resulted in 43 nodes and 263 child nodes (Appendix III-E).

Table 4. Guidelines for theme identification. Based on: Aronson (1995); Ryan & Bernard (2003); Bryman (2012).

What to look for	Definition	Value
Repetitions	Topics that occur and reoccur	Appearance of important themes
Indigenous typologies or categories	Local expressions that are unfamiliar or used in an unfamiliar way	Identification of subthemes
Metaphors and analogies	Particular representation of thoughts	Meaningfulness of statements
Transitions	How topics shift	May be markers for themes
Similarities and differences	Discussing similar topics in different ways	Researcher remains focused on data instead of theory Can generate themes
Linguistic connectors	Examining use of words such as since or because	Signals relations (e.g. dependency or causal)
Missing data	Reflecting what is not in the data	Signals important themes for further exploration
Theory-related material	Using scientific concepts as springboards for themes	How data illuminates questions Contribution to science

3.4.2. Content analysis

Generally, content analysis uses a so-called coding manual that comprises instructions for all possible categories for each dimension being coded (Bryman, 2012). Here, the operationalisation of requirements was used as the coding manual. Each requirement represented a node. Subsequently, child nodes were created to understand which aspects of the requirement are included in the Directives. In total, 22 nodes and 165 child nodes were created. All nodes and their allocated text fragments can be found in Appendix VI.

3.4.3. Survey

The output data of the survey was analysed using SPSS (version 26). Because of its objective nature, using SPSS software enhances inter-observer consistency. In the analysis, the data from all countries was accumulated to assess the preferences across the EU. New variables were created, and various tests were performed, e.g. correlations were performed to check for differences across countries, demographic profiles, and environmental attitudes. These correlations were performed in the interest of uncovering factors influencing residents' preferences towards DfS. Which tests were conducted for each question of the survey can be found in the coding manual in Appendix IV-H.

The representativeness of the sample was reviewed by comparing demographic distributions of the sample and the actual population. While generally representative, some observations can be made on the sample. First, marginally more females responded to the survey than males. Second, survey respondents were generally younger than the population (section 3.3.3.4.). Third, an important observation that was also touched upon in section 3.3.3.4. is that (except for Czechia and Sweden) respondents were educated to a higher level than the population in general.

3.5. Ethical concerns

As delineated by Bryman (2012), ethical principles in social research can be covered by four main areas:

1. Whether there is harm to participants;

2. Whether there is a lack of informed consent;
3. Whether there is an invasion of privacy;
4. Whether deception is involved.

Criteria 1 and 3 are typically involved in methods such as participant observation and are therefore not applicable in this research. Concerning the remaining criteria, all interview participants were asked to sign an informed consent form and were notified about the purposes of the research. Similarly, the introduction to the survey notified respondents on the purpose of the research (without explicitly naming sustainability to prevent answer bias) and how their data was processed.

Additionally, concerns regarding data protection were taken into account. Adhering to the European Code of Conduct for Research Integrity, all data was processed by research personnel of Utrecht University only and was disclosed only for the specified purposes. Moreover, following the Safeguards Principle, data was stored on a secured private device (ALLEA, 2017).

Specifically for the survey, by working with Qualtrics and ESOMAR, compliance with all ethical procedures was ensured (Qualtrics XM, 2021). In the analysis, all responses were processed anonymously, thereby protecting individuals' privacy. Furthermore, Utrecht University authorised the principal researcher to track the IP addresses of respondents. Therefore, subsequent to attaining the survey data, the function "Anonymize Response" was enabled in Qualtrics. By enabling this function, data could not be traced back to individual responses.

4. Synthesis of DfS requirements

The previously discussed methods have laid down the foundation for academic and empirical research. As a result of this research, this chapter presents the results of the literature review. Chapter 5, 6, and 7 present the results of the interviews with consumer organisations, the content analysis of EU Directives and the survey among EU residents. Subsequently, the results are integrated, and policy recommendations are provided.

As seen from the research process (Figure 3), the first step in this research was developing a comprehensive list of DfS requirements. From the review of literature on eco-design and DfS, a list of 20 DfS requirements has resulted. In this section, all 20 requirements are shortly explained to indicate what each requirement entails (Table 5). The complete operationalisation of the requirements can be found in Appendix II-B.

Each requirement is allocated to one aspect of the triple bottom line: either people, planet or profit. Since respondents choose within each P and not between Ps, equal value is attributed to people, planet and profit, as envisioned by the concept of sustainability (Alhaddi, 2015).

Table 5. Allocation to triple P and description of DfS requirements. Parts of requirements written in *italics* are the names of the requirements henceforth.

Triple P	Requirement	Description
People	<i>Information provision on product characteristics</i>	Quality information should be provided on the following elements: production methods, product usage, life span of the product, how to discard the product
	<i>Operational safety and efficiency</i>	Products should comply with health and safety regulations and not provide any risk to human health and users should be supported to lower their energy and material demand
	<i>Job creation</i>	Production processes or repair and maintenance of the product should create job opportunities and employee development should be stimulated by providing training
	<i>Ethical responsibility for residents</i>	The design of a product should not cause harm to its users and should empower users
	<i>Cooperation between different actors</i>	Product design should be created using an interdisciplinary approach and involve public participation
	<i>Safe and fair working conditions</i>	Products should be created in a safe and healthy environment using no child or forced labour and all actors involved in the production of a product should receive fair wages
	<i>Consider differences and impact on communities</i>	Local and global communities should not be affected by the design and production of a product and cultural effects should be considered in the design of a product
Planet	<i>Durability</i>	Product and material lifetime should be extended accompanied by longer guarantee rights
	<i>Limited use of hazardous and/or unsustainable materials</i>	Policy guidelines with regard to toxic materials and chemicals should be followed and using materials with sensitive origins or materials that cause inordinate amounts of pollution should be avoided
	<i>Reusability, recyclability, recoverability</i>	Use materials that are easy to recycle or recover and encourage reuse through product design
	<i>Ease of repair and maintenance</i>	Products should be designed that they can easily be cleaned and disassembled and spare parts should be available. Also, products involving software should be upgradeable for a considerable amount of time
	<i>Use of sustainable and/or reused/recycled materials</i>	Use of renewable, biodegradable materials with low energy content
	<i>Reduce the environmental impact of transport and storage</i>	Optimise and reduce distribution while design more energy efficient transport options and reduce weight and volume of products
	<i>Reduction of (virgin) resource use during production</i>	Design products with less materials (dematerialisation) and optimise and reduce production processes
	<i>Waste management</i>	Consider the design of packaging and design products that create a minimal amount of waste
	<i>Optimise the end-of-life system</i>	Design products in such a way that the retention value is maximised and stimulate users of the product to dispose of the product in an environmentally sound manner
	<i>Conservation/ biocompatibility</i>	Design products in such a way that pollution and emissions are minimised and product design should not cause a loss of biodiversity
Profit	<i>Optimise usage by PSS</i>	Establish financially attractive take-back programmes, initiate affordable leasing and renting services for products, and design products taking into account shared use to reduce costs of use
	<i>Availability of financial and/or regulatory arrangements</i>	Design products taking into account shared use to reduce costs of use, provide a good price-quality ratio, and support the possibility for self-regulatory measures and financial incentives
	<i>Reduce replacement because of fashion or technology</i>	Develop an appealing design that is less susceptible to fast changing fashion or technology cycles and avoid the use of subjective or temporary aspects

This research provides a theoretical contribution to the research field on DfS by synthesising the requirements available in the literature. Besides providing a comprehensive understanding of DfS requirements, this list has served as a foundation for empirical research. Specifically, the list was used in the development of the survey, the interview guide with consumer organisations, and the analysis of EU Directives. The results of this empirical research are presented in the subsequent chapters.

5. General pursuits of consumer organisations

This chapter presents the results of the first part of interviews with consumer organisations across Europe. This part focuses on the general activities that consumer organisations perform and thereby provides more insight into their daily work. Additionally, the theoretical concepts involved in this research have been discussed with consumer organisations (section 2.1.).

5.1. Organisational goals

In its essence, consumer organisations exist to help people. Because of substantial knowledge gaps between residents and producers, residents often need help in making purchase decisions. Additionally, residents by themselves may not have the power to influence the status quo in industry or politics. Depending on the consumer organisation, support is offered by providing independent information to aid decision-making processes, representing consumer interests in national and international policymaking, lobbying, and pushing the industry to improve markets. In short, they defend, support and advise consumer interests. Consumer organisations do this by performing product tests, processing complaints, monitoring market developments, answering questions, and offering protection through law. Ultimately, consumer organisations perform these activities to build fairer markets where consumers are treated properly. Some consumer organisations take on all these activities as one organisation (e.g. Consumentenbond in the Netherlands). Other countries have established different organisations, each with its area of expertise. For example, in Spain, ASUFIN focuses exclusively on financial issues and OCU also executes lobbying activities and performs product tests.

“We can’t be experts in everythings as a consumer. We really need support and independent support would be better because advertising from companies is not always so reliable”¹

“There are certain things that are obvious for consumers but the most important bit is probably where the asymmetry of information between traders and consumers is too big. If you are a trader you always know what you sell, the technical details, you have a contractual relationship with the manufacturer. Whereas being a consumer is not a fulltime job right? It just happened, I just happen to be a consumer in a market economy. So the really important things are those things that consumers cannot do by themselves in terms of purchasing power or decision power. So it’s really to deal the background noise and make sure that there are legal boundaries in place that actually enable consumers to safely and securely consume. To not be manipulated or extorted, to be treated fairly, to have access to courts. So these are the kind of market conditions that we are trying to establish and this requires political work”²

“So the problem basically with consumer decisions is most consumers just trust. They trust that whatever is in the shop is safe, and is good. I mean you don’t go with your chemistry kit to the supermarket and test whether the food is safe, whether it’s poisonous. You just trust that it’s okay.”²

Consumer organisations can provide information on what products or services may be more responsible or sustainable. However, ultimately the consumer decides. Organisations do use surveys, complaint databases and market information to review which subjects residents are interested in, and over time, sustainability has become a more important topic to residents. Hence it has become an essential part of the work of consumer organisations.

“We really don’t want to educate them a lot in the way we are strict teachers. We just want to give them better alternatives or show them better alternatives.”³

¹ Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

² Interview with German consumer organisation on the 26th of February 2021

³ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

5.2. Understanding of theoretical concepts

Sustainability has thus become a widely discussed subject in the work of consumer organisations. Diving deeper into theoretical concepts, the CE is viewed as a challenging concept because of the different interpretations. Nevertheless, it appears the CE is considered a valuable concept in an innovation context where “new ways forward” have to be identified.

“But it is more the concept that I think it’s quite tough to discuss. There are issues even among colleagues in the consumer movement because you have different perceptions and it is used in so many different ways.”⁴

Discussing eco-design and DfS more specifically, different interpretations can be found between consumer organisations. As for the definition of eco-design, many interviewees consider eco-design as a concept to be equal to the content of the political framework, the Ecodesign Directive. Eco-design is primarily approached in product testing, where tests are performed for eco-design requirements such as energy efficiency, ease of disassembly and the type of materials used. Interviewees anticipate that using eco-design principles could lead to banning the worst performing products from the market and subsequently push producers to design even better products. Ultimately, it can be concluded that consumer organisations maintain a general understanding of the eco-design concept and feel a more holistic approach to design would be the next step.

“When we talk about ecodesign it is mostly this political view regarding the Ecodesign Directive and what it means to people, how is it organised, how is it implemented.”⁵

That next step would be DfS, a concept much less familiar to interviewees. While few interviewees are aware of DfS, after a short explanation (when needed), all consider DfS extremely important. Some organisations have already taken steps in areas of social sustainability as they feel this inherent to their mission as consumer organisations: protecting people. However, as in policy, eco-design principles prevail. This is also reflected in the pilot interview with BEUC, the international consumer organisation working in Brussels. As indicated by the interviewee, an essential consideration for BEUC is to balance environmental and consumer interests.

“We’re very unhappy, especially with the European Commission sometimes, when it uses the word sustainability in all it’s political documents and it only means the green parts of it and that is not sustainability.”⁴

5.3. Theoretical concepts in practice

While a more theoretical understanding of the discussed concepts might be relevant, consumer organisations find themselves in a much more executive role. Following a practical approach, eco-design is considered to contribute to product innovation in general and more specifically to the durability, performance and efficiency of products. Consequently, the implementation of eco-design requirements such as energy efficiency forces consumers to save resources.

“And we try to have something that works for everyone and so we really have to make sure that what ends up in the shops is safe, is good, and take certain choices from consumers, actually that is ecodesign or design for sustainability ultimately does, you don’t leave it in the hands of consumers whether it’s sustainable.”⁶

⁴ Interview with Sveriges Konsumenter, Sweden on the 19th of February 2021

⁵ Interview with AK Wien, Austria on the 11th of February 2021

⁶ Interview with German consumer organisation on the 26th of February 2021

“Yes, from the view of consumer protection we think it’s very important from the one point of resource protection because if you produce more and more and sell more and more products it has a negative effect on the ecology. And on the other hand it’s has also an effect on society,”⁷

Eco-design is also considered a method to reach a circular economy where both schools of thought embrace a life cycle perspective. In the execution of this method, multiple components of the R-framework are considered relevant, e.g. repair, reuse, and recycling. In addition, eco-design can go hand in hand with cost reductions due to the use of fewer resources.

“We think that only through ecodesign or design for sustainability we can actually go from a flat or line economy to a circular one. It’s something like it’s the only way we can actually do it.”⁸

“...also think about every step in life of such a product. [...] Usually the manufacturers are just focusing on buying this product and then it should do it’s job and I think this ecodesign is really that you also think about the end of life and how to integrate it again and so on.”⁹

“It’s very important that we really consider circular economy as the real circle and many times circle economy, not only once which was in the near past. [...] But really don’t throw it away because we have recyclability which is great but we have to be make sure there’s another circle, be it reuse, be it refurbishing, remanufacturing. So all of this starts with circling around as much as possible until we are going to recycle and then.”¹⁰

While consumer organisations deem the concepts involved in this research relevant for the transition to a circular and more sustainable society, residents may bear very different attitudes towards the concepts. Sustainability has become a much more common subject in different societal groups, but consumer organisations observe an attitude-behaviour gap where the price and appearance of products seem to play a considerable role. Additionally, the understanding of the circular economy can be identified as limited where circularity is primarily linked to the recycling of waste.

Similarly, from research by consumer organisations, it resulted that residents do not directly understand the concept of eco-design. Nevertheless, indirectly consumers are getting more used to making informed decisions and are aware of specific aspects of eco-design such as energy consumption, hazardous substances, durability and reparability.

“But the people, the members we have they are already very aware of the fact that they don’t want to make blind choices. They really want to, to get right information at the moment they need to really be active and make a difference.”¹¹

In the end, residents or consumer organisations do not implement eco-design or DfS principles. This is in the hands of policymakers and industry that are pushed by consumer organisations’ lobbies. Here, interviewees consider the role of industry to be producing more eco-designed or DfS products to either meet or stimulate consumer needs. Across consumer organisations, it is generally believed that industry complies with the Ecodesign Directive and strengthening the Directive could have much potential.

⁷ Interview with AK Wien, Austria on the 11th of February 2021

⁸ Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

⁹ Interview with projectmanager at Stiftung Warentest, Germany on the 17th of February 2021

¹⁰ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

¹¹ Interview with project officer energy & building at Test-Achats, Belgium on the 11th of March 2021

“Because it was important also in certain way to push institutions in Europe. Because consumers can not access the product if the product doesn’t exist.”¹²

“You know not all the businesses are doing a bad job, most businesses actually are complying with the legal requirements. So if you strengthen the legal requirements they may not be happy about it but they will follow which has an important effect on the market.”¹³

Overall, interviewees are reasonably optimistic about the Ecodesign Directive and what it has accomplished. Many feel an excellent next step is the inclusion of new product groups, such as mobile phones and clothing, and new requirements, e.g. lifespan obligations. These points are also touched upon in the pilot interview. Three concerns remain: the risk of double-regulation, the lack of market surveillance, and overregulation. Regarding the latter two points, the interviewee at BEUC indicated that although eco-design is an instrument that has been working well, it is hard to decide which types of requirements to include. Including too many requirements could make the Ecodesign Directive overwhelming and complicated not only for companies but also for market surveillance.

“I don’t think the consumers are the ones who are the only ones who should change these markets. On the free market, the consumer has not got enough information, consumers don’t have enough information to really choose sustainable, to really choose the right quality products. It’s very important to have the legislation, to have some directives to put the threshold and lift it up and to make sure that also the producers are innovating and they’re putting better and better products on the market. And there are a lot of examples how such directives or campaigns, make better products and make consumers choose better products.”¹⁴

“It has been successful and we achieved things with the energy design which we wouldn’t have achieved without it.”¹⁵

5.4. Methodologies and strategies

In order to measure the effectiveness of the theoretical concepts in practice, solid methodologies are needed as making wrong claims about a product can have legal consequences for the businesses involved and the trust among consumers. Within the field of testing, consumer organisations often work together internationally within the ICRT (International Consumer Research and Testing) to save costs and efforts. Cooperation is essential within testing as most consumer organisations can not use LCAs because of resource constraints or a lack of expertise. Consequently, not all consumer organisations make use of LCA methodology. Often simplified methods are used and products are not tested on all their features but solely on the aspects that make a difference within the product group (e.g. some products are produced similarly). In addition to self-employed tests, many consumer organisations have also started using consumer reviews and experiences as a reliable source of product performance. Ultimately, the majority of tests are performed for environmental aspects. Few consumer organisations conduct tests for social requirements (e.g. factory visits), and if so, these tests are not executed regularly. The main arguments here are again resource constraints as well as the difficulty of arranging such tests.

¹² Interview with president of ASUFIN, Spain on the 6th of April 2021

¹³ Interview with German consumer organisation on the 26th of February 2021

¹⁴ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

¹⁵ Interview with Sveriges Konsumenter, Sweden on the 19th of February 2021

“Yes for that we have another organisation, called the ICRT. Within that we do producttests togethewith a few consumer organisations we decide we want to test a hedge trimmer, and then we ask: who would like that too? Because we look at products that are the same in a lot of countries otherwise it doesn't make sense. When we have a good overlap, then you have to test only once and then the ICRT arranges a laboratory and agrees on a good price for that. So they organise and facilitate that and make sure the data is available in a central place where we can all use it.”¹⁶

“Yeah we use it as a method which is really important because that let us make an assessment in which part of the life cycle there could be more impact with different changes. So that helps us when we are making the research or the analysis we also focus on the parts that have more impact on the environment. Because we have that whole cycle and that allow us to make a better analysis and focus on this kind of parts of the project.”¹⁷

To translate the results of tests into practice and stimulate the adoption of eco-design and DfS, consumer organisations pursue different strategies. Informing consumers through a variety of channels is one strategy to increase awareness on the subject. Secondly, consumer organisations cooperate on many different levels to permeate into different areas. They work together on an EU level within the BEUC but also work together on other subjects. Some organisations also cooperate with manufacturers, market surveillance authorities, and environmental agencies.

“...we are also working with producers and manufacturers. As I mentioned in some of the projects we try not only to point out what manufacturers are not doing right in our point of view or in the European level kind of view but we also provide a methodology for them to be able to implement when they are developing new products.”¹⁷

“...what we found, we present that to the environmental agencies in the different regions so they could see if they could take that into account in the different activities they would like to run within the climate change strategy they had.”¹⁸

¹⁶ Interview with Dutch consumer organisation on the 26th of February 2021

¹⁷ Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

¹⁸ Interview with project officer energy & building at Test-Achats, Belgium on the 11th of March 2021

6. Technocratic perspective towards DfS requirements

As discussed in the introduction, eco-design and DfS is often approached from a business or policy perspective. This view is essential for the implementation of eco-design and DfS requirements as policy imposes obligations for product design and business is required to execute these obligations. Additionally, since consumer organisations present a link between residents and business and between residents and policy, their view on DfS requirements is also considered relevant. To explore this technocratic perspective on DfS requirements, the results of the second part of the interview with consumer organisations which concerns their work on DfS requirements, are discussed in this chapter. Additionally, the current policy landscape for each requirement is presented. These results are derived from the content analysis on Directives that involve topics included in the DfS requirement (section 3.3.3.). As discussed earlier, Directives are legislative acts that set out goals that EU countries must individually achieve (European Union, n.d.).

The results of the interviews and content analysis are discussed for each DfS requirement. The requirements are presented according to their allocation to people, planet or profit in the order of their mean ranking across the product groups (i.e. the highest-ranked requirement on average is presented first).

6.1. People

Operational safety and efficiency

To reiterate, the requirement *operational safety and efficiency* encompasses compliance with health and safety regulations and the efficient use of products. This requirement appears to be an essential part of the work of consumer organisations. Protecting residents' health is a core responsibility. Specifically, the main focus areas are safety, risk factors and substances, usability features, and energy efficiency.

Part of *operational safety and efficiency* is stimulating users to operate their appliances in a more energy-efficient manner. Testing and reporting on energy efficiency have become a standard procedure, and education on understanding energy labels and renewable energy has become part of this information stream. However, while energy efficiency is vital in sustainability, the quality of the product needs to be addressed simultaneously, which can lead to trade-offs.

“Yes but of course we are also very strict on the quality. So we don't want washing machines that don't use any water because we still want the washing machine to clean your clothes and this is the first thing they have to do. Some producers already saw this and realised that we punished them more if the clothes were still dirty than award them for not using too much water or energy.”¹⁹

Similar to energy efficiency, operational safety is imperative in the testing and reporting on products. However, this is not necessarily related to sustainability. Operational safety is essential for electrical products and products that can emit particles, e.g. stoves.

“Well first there is sort of non-negotiable operational safety, I mean there should not be unsafe products on the market, whether sustainable or not basically. So we deal with it separately because that's sort of a precondition for every product no matter what comes then. So that's a big topic for consumer organisations but that's always been the sort of separate workstream.”²⁰

In current Directives, human and environmental health are the main focus areas within *operational safety and efficiency*. For example, the REACH Directive focuses on the health of the population regarding hazardous substances and states that “the purpose of this regulation is to ensure a high

¹⁹ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

²⁰ Interview with German consumer organisation on the 26th of February 2021

level of protection of human health and the environment". Additionally, the RoHS and Waste Directives address human health concerning electronic equipment and reducing waste streams.

Several obligations exist for human health hazard assessments. However, these are not required for all product groups and end uses, e.g. as stated in the REACH Directive, cosmetic products and food contact materials do not need to be included in a chemical safety report. Risk characterisation shall consider all human populations and environmental spheres for which exposure to the substance is known or reasonably foreseeable. Exposure scenarios need to consider different population groups (e.g. workers, consumers indirectly exposed to the material) and specific vulnerable sub-populations (e.g. children, pregnant women). When any special precautions need to be taken by any of these groups, instructions need to be communicated.

In the Directives, efficiency is generally understood as energy efficiency. Energy efficiency is believed to contribute significantly to greenhouse gas emissions and is linked to cost-efficiency. The Ecodesign Directive includes energy efficiency requirements for all products included in the Directive (including refrigerators), which is limited to ErPs. Energy efficiency requirements push producers to manufacture more energy-efficient products. Simultaneously, energy labels encourage manufacturers to use more energy-efficient technologies, and these labels are a key driver in helping residents choose energy-efficient products. However, the Energy Labelling Directive stipulates that energy labelling requirements shall not have negative impacts on the functionality of products. This concern is similar to the trade-offs mentioned in the interviews. In addition to energy efficiency requirements, the Ecodesign Directive has set minimum requirements for water use in products such as washing machines and washer-dryers.

Safe and fair working conditions

The subject of *safe and fair working conditions* is concerned with working conditions free from harm and is generally recognised as a critical problem in the production of textiles. However, research on this topic is rarely conducted because testing is a complex and resource-intensive process. Many difficulties can arise such, as the cooperation of producers, distance to the site, and legitimacy of the provided information. Additionally, compared to environmental aspects, it can not be measured and setting clear objectives is a challenge.

The problem of *safe and fair working conditions* is connected to the globalisation of supply chains. Here, two aspects are highlighted by the interviewees. First, the extent to which products are produced locally is something consumer organisations would like to inform consumers on, especially in relation to food products. Additionally, the COVID-19 pandemic is recognised as a stimulator for local production and less dependence on global supply chains. Second, from a more political view, it is believed due diligence obligations could add to the sustainability of production and furthering safe and fair working conditions. However, this is not necessarily linked to eco-design or design for sustainability.

"...we look at it from the angle that we assume that most consumers don't want to support human right breaches or environmental damages with whatever they purchase. So in this sense, we're supportive and we work a lot on those due diligence obligations and on making manufacturers liable for their value chain. So in that sense we do work on this but not strictly speaking linked to sustainable product design."²¹

Safe and fair working conditions are addressed in current Directives in two ways. First, minimum requirements for encouraging improvements to guarantee a higher level of protection of workers' health and safety requirements are established. These requirements specify safety instructions, hygiene, appropriate training, and exposure to chemicals and hazardous materials. The OHS Directive states that encouraging these improvements is the responsibility of Member States but ultimately, the employer is responsible for ensuring workers' safety and health in every aspect related to their work. Second, workers' rights are addressed where it is distinctly mentioned that workers should have the right to access information on the substances they are working with. In addition, national governments should establish rules to assure workers' rights. It is worth

²¹ Interview with German consumer organisation on the 26th of February 2021

mentioning is that the Directives are effective within the EU only, and no obligations exist for workplaces outside the EU where materials may be sourced from. Simultaneously, from both the literature and interviews, it can be concluded that problems with *safe and fair working conditions* mainly arise within the global supply chain.

Ethical responsibility

Ethical responsibility focuses on empowering users and not causing harm to users. This requirement is not something consumer organisations generally consider in their assessment of products or communication to the public. Similar to the assessment of *safe and fair working conditions*, the requirement is not easily evaluated and consequently, residents have few tools and little information they can use in their decision-making process (e.g. labels). Ultimately, some consumer organisations communicate on the issue in ways they deem appropriate but do not initiate tests or field research.

“Yeah so this is something we propose in a positive way saying that there are several problems in the industry but choosing this kind of certified product, you can have a guarantee it's better than others.”²²

The central aspect considered part of *ethical responsibility* in Directives is the use of animal testing. In the REACH and EU Ecolabel Directives, it is indicated that animal testing (on vertebrate animals) should only be conducted when necessary and should never be repeated. Simultaneously research on alternative methods is a paramount concern. This can be recognised as a different approach to *ethical responsibility* compared to the definitions discussed in the interviews and the survey, where *ethical responsibility* was directed more at how the design of products influences the usage behaviour of its users.

Furthermore, social-ethical aspects are discussed in the Directives with reference to ILO (International Labour Organisation) conventions. These aspects are thus more of an international character than the requirements for *safe and fair working conditions* set at the EU level. Additionally, it is indicated that advice on ethical issues may be collected from experts to ensure the reliability of the advice given and included in the Directives. Both the use of ILO standards and code of conduct and advice by experts are not obligated in the Directives but can be used when considered appropriate by e.g. Committees.

Information provision

Information provision is concerned with the quality and amount of information provided on the product and is considered one of the main objectives of consumer organisations (section 5.1.). Nevertheless, this requirement is not necessarily related to sustainable product design. One subject that is related to sustainable product design is certification. Consumer organisations are wary of greenwashing as this does not provide consumers with correct information. Checking the reliability of certifications presents itself as an important research area for consumer organisations. Related to this, consumer organisations need to be critical of the content of each label.

“If there's some trust certificate we of course award these products that have them, but we always see the broader picture. So let's say we were just testing some food products and they have these UTZ certificates but there was palm oil in it. So I mean you have to be quite careful not only trust one certificate, one point of view... and this is something we are quite aware of.”²³

Similar to the mission of consumer organisations, Directives are very focused on the provision of information and establish both rules and guidelines on how to convey information to guide consumers. Information on environmental performance (e.g. labels) allows consumers to compare

²² Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

²³ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

products on these aspects and advise them on using products to maximise environmental benefits (e.g. energy savings).

Information can be conveyed through educational campaigns, instructions on the product, labels and certifications. Instructions are often obligated and primarily concern safe use, information related to hazardous substances, first aid instructions, and special precautions. Labels and certifications present the conformity of the product with a certain standard, and Directives present a variety of rules related to the presentation of a label on a product. Concerning the label's content, the quality can differ. Consequently, some labels can be misleading to consumers, which is prohibited by many Directives. As stipulated in the interviews, misleading consumers and greenwashing presents a challenge where the label's reliability, credibility, and correctness is questioned. To avoid greenwashing, compliance of products with, e.g. the Ecolabel, is checked by a competent body using assessment requirements set in the Directive.

Directives do not merely focus on informing residents on sustainability issues. Information should also be provided to businesses. Here, manufacturers, sellers, treatment facilities, and in particular, SMEs should be encouraged to implement eco-design requirements. For this purpose, the REACH Directive proposes the establishment of helpdesks.

The following aspects are mentioned in the Directives to increase the correctness and understandability of information: clarity of information, digitalisation, reporting, and transparency. First, the clarity of information includes obligatory requirements such as that information is visibly displayed on products and includes suggestions for improving the clarity of information, e.g. using graphs instead of text. The clarity of information is essential to increase the effectiveness of eco-design methods. Clarity can be accommodated by using clear and coherent wording, provision of details, availability in multiple languages, and adjustment of the text to the anticipated type of user. Second, it is suggested that information should be easily accessible. The digitalisation of information is a focus area in Directives to enhance the accessibility and exchange of information. Third, reporting is crucial in determining compliance to labels and is therefore obligated. Fourth, transparency is vital in the exchange and availability of information and keeping information up to date. Nevertheless, some Directives also specify the need for confidentiality in protecting commercial and industrial information. A clear distinction between confidential and non-confidential information should be made to enhance transparency while protecting commercial secrets.

Consider differences and impact on communities

The cultural and social impacts that production processes can have on global and local communities are not something that consumer organisations generally consider. Theoretically, *consider differences and impact on communities* can be regarded as an overarching concept with connections to *safe and fair working conditions*. Nevertheless, from the interviews, it can be concluded that this requirement is dealt with as being a part of *safe and fair working conditions*. One point that overlaps between these two requirements is the shift from global to local production to gain more insight into production processes. Furthermore, no specific attention is awarded to the harm production processes can exert on communities.

Directives stipulate that requirements for environmental protection or other sustainability issues should have no negative impacts on businesses' competitiveness or on consumers regarding affordability or life cycle costs of the product.

Furthermore, local issues such as odour, dust, noise, and visual appearance are addressed for production processes and waste management. These issues are to be addressed by the Member States. Additionally, specific climatic regions or regions of special interest that are considered fragile are specifically dealt with by developing separate criteria for assessing the significance of the product's environmental impacts.

Ultimately it is suggested that approaches to protect communities should be preventive and opportunities should be identified to achieve high levels of environmental protection (e.g. by reducing the potential environmental impact). Protective approaches ultimately benefit consumers and other end-users.

Job creation

Sustainable product design should offer new job opportunities together with appropriate training. In the interviews, consumer organisations indicated they are not focused on labour issues. One connection is that *job creation* is an integral part of the circular or social economy. This association is largely connected to the environmental requirements *repair and maintenance* and *reusability* which can produce local jobs.

“...the social economy is important to I think or we think. If you reuse things more often and you have a marketplace where you can buy those things or get them repaired and we think this will create jobs.”²⁴

In Directives, job creation is addressed primarily by providing requirements on training to ensure that personnel is capable and knowledgeable on protecting the environment. Additionally, employees should be involved in the process of continual improvement of environmental performance. Here, employees can be involved by either direct participation or by providing them with information. The possibilities of job creation in a circular economy are not directly mentioned in current Directives.

Cooperation between actors

To reiterate, *cooperation between actors* is focused on creating interdisciplinary partnerships and including the public in product design. Cooperation is considered necessary for consumer organisations mainly because they can share knowledge and research efforts among consumer organisations (as discussed in section 5.4.). Furthermore, consumer organisations work together on an international level for testing and lobbying. Additionally, they work together with industry actors, environmental agencies, and different authorities and share their market knowledge.

Cooperation between actors is approached in Directives as a means for proper implementation and enforcement of the Directives. Cooperation is strongly encouraged and aims to support networks between EU bodies, international organisations, and the EU and developing countries. The ultimate goal of this cooperation is to exchange information, share best practices, and create business opportunities. Stimulating cooperation between industry actors could lead to product innovation and more sustainable product design. Besides industry and government, cooperation is also of particular importance for market surveillance authorities. Here cooperation aims at sharing all available market intelligence when establishing, implementing, and updating surveillance programmes. Finally, all interested parties in a product group are consulted to ensure balanced participation when preparing measures. Public participation is stimulated by establishing an open dialogue with the public and present the ability to provide input to draft versions of implementing measures. Cooperation in developing measures could stimulate the inclusion of various sustainability aspects since different actors experience different consequences of unsustainable design.

6.2. Planet

Durability

Durability is about extending the lifetime of products and was named as the primary focus for BEUC. Also national consumer organisations name *durability* as a central element to sustainable product design. However, consumer organisations observe a discrepancy between products becoming less durable and a growing awareness for this requirement among residents. They indicate the importance of this awareness as durable design does not mean that products are used longer and premature obsolescence poses a challenge.

“So you have to raise awareness in society on what it is about to keep things. If you only raise durability but people throw things away before the durability ends it will not happen. This must go together because otherwise it doesn't help.”²⁴

²⁴ Interview with AK Wien, Austria on the 11th of February 2021

Durability is thus very much connected to the idea of obsolescence, but also repair and maintenance are often connected to durability. Maintenance, in this case, refers to the upgradeability of devices. If the software of devices is not updated, this presents problems for data protection and the functionality of a product. The connection between durability and repairability can be viewed in different ways. On the one hand, repairability can assure that products last longer. On the other hand, durability can impede repairability.

“Because sometimes durability is not linked to repairability. For example if you glue the pieces together you might have a better resistance to water, it's waterproof, while when you don't glue it, it's easier to repair. So you even have some contradiction between the two.”²⁵

As indicated in the pilot interview and discussed later in this chapter, repair is recognised as a priority in sustainable product design and a repairability index is being developed. In the longer term, consumer organisations are also working together with national governments and the EU to create a durability index that will inform consumers how long a product will last. Related to this is the ability to test for durability for which a methodology is needed. This is indicated to be challenging as durability can present itself as an abstract concept. Currently, many consumer organisations work with databases where users can share their experiences with the product lifetime of products. Additionally, the PROMPT (Premature Obsolescence Multi-stakeholder Product Testing programme) project aims to develop a comprehensive method to extend the useful lifetime of products and contribute to the circular economy. The project is focused on electronic devices such as smartphones, vacuum cleaners, televisions, and laundry machines. Ultimately, consumer organisations aim to provide residents with more information on the lifetime of their purchases and would also like to oblige producers to give this indication.

Providing the product lifetime is related to an extended warranty on products, which was a common theme in the interviews. Consumer organisations believe the length of the mandatory warranty is directly related to the durability of the product since a more extended warranty will stimulate producers to develop more durable products. Consequently, extending the length of mandatory warranties is a large part of the lobbying efforts of consumer organisations. Specifically, providing information on the product's lifetime to consumers and aligning the length of the warranty with the expected lifetime of the product are commonly discussed subjects.

“...it is something we really try to put in the legislation that companies would also tell the consumer how durable the product is: how long, what is the expected lifetime and to also stand behind this. So in this case with some warranties or guarantees that the consumer can really trust these numbers. So this is something that will change in a lot of markets.”²⁶

Generally, durability tests are conducted for electrical household products such as washing machines, fridges, dishwashers, kitchen appliances, heating and cooling appliances, vacuum cleaners, and more expensive electrical appliances in general. Mobile phones and laptops are usually also tested for durability. However, indications on the lifetime can be given for non-electrical products as well. For example, some organisations run tests for bikes, and more recently, many consumer organisations are also focusing on the durability of t-shirts and textiles.

In current Directives, it has been recognised that *durability*, understood as lifespan extension, reduces the environmental impact of products because of its impact on resource efficiency. Consequently, durability is discussed extensively in the Waste Directive as a means to reduce waste. Additionally, the Ecodesign Directive mentions the need for a minimum guaranteed lifetime (an aspect also favoured by interviewees) to further the durability of products. Nevertheless, while the benefits of *durability* are recognised and discussed, no obligations are set for durability

²⁵ Interview with Environment and Transportation project manager at UFC - Que Choisir, France on the 16th of March 2021

²⁶ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

requirements with one exception: LED and OLED light sources need to undergo endurance tests to verify lumen maintenance and survival factors.

Durable product design also means technical durability is needed and, similar to the interviews, durability is connected to both repairability and upgradeability. Regarding the latter, the revisions of the Ecodesign Directive of 2019 state that “a software update shall never have the effect of changing the product’s performance in a way that makes it non-compliant with the eco-design requirements applicable for the declaration of conformity”. Software updates are not to change the performance of a product which could lead to the earlier replacement of products and thereby decrease its durability.

Limited use of hazardous and/or unsustainable materials

The *limited use of hazardous and/or unsustainable materials* is concerned with not using materials with a significant environmental impact or a sensitive origin. With some exceptions, testing for hazardous materials is indicated to be a standard procedure for consumer organisations. However, one interviewee stated that in essence, hazardous materials should not be part of any product. Products commonly tested are tools, household chemicals, food, cosmetics, clothes, smartphones, solar panels, and those used and touched by children, such as toys. The use of hazardous materials is thus important for consumer organisations to address with regard to sustainable product design and circularity.

“If you want to recycle there might not be a big health issue with the product in itself but if you want to put that in a circular flow it has to be lower in terms of these pollutant because otherwise it will not work for a circular economy.”²⁷

Internationally, differences exist in the importance allocated to testing for hazardous materials. As one interviewee indicates, German, Danish, and Swiss organisations test many of these substances while, e.g. in the United Kingdom, they value these tests much less. From the interviews with consumer organisations in Germany, it can be found that they run tests for hazardous substances for many different products and also investigate these products in-depth.

“For example in the past with car seats for children: Germans investigated also the seat belts and found that there are toxic substances in the black plastics and we did not think to include this.”²⁸

In principle, several hazardous substances are prohibited (in specific amounts) by EU law. This is also why BEUC indicates not to focus on these substances in extending the Directive to prevent double-regulation. Another consequence of already existing regulation on substances is that some consumer organisations indicate not to test for these substances. Opinions on the level of strictness of these laws differ across consumer organisations, where some indicate it is rather strict, other interviewees indicate that these limits should be much stricter. This is also where consumer organisations have the opportunity to inform consumers on measures going further than EU law.

“So I think the regulations are quite strong but we do find some stuff and I think the big advantage is that we can go further than the regulation. So if we have the opinion that some substances are more harmful or shouldn’t be inside of a product, we can test for it and say: okay in our opinion this is not good for you.”²⁹

While testing and communicating on hazardous substances is standard for a wide range of product groups, this is different for unsustainable materials. The interviewees generally agree that

²⁷ Interview with Sveriges Konsumenter, Sweden on the 19th of February 2021

²⁸ Interview with Dutch consumer organisation on the 26th of February 2021

²⁹ Interview with projectmanager at Stiftung Warentest, Germany on the 17th of February 2021

they address the issue and communicate to residents about this but do not assess it. However, this is named to be on the agenda of some consumer organisations, e.g. microplastics in products.

“So it’s more like information that you, that people are aware: okay there are some materials that are not easy to get and think about what you buy.”³⁰

In Directives, the use of hazardous materials is considered to be one of the most critical issues. *Hazardous materials* are materials for which any grounds exist to think that a substance might constitute a risk to human health or the environment. Directives present lists of hazardous materials and lay down measures to restrict the use of these materials. The precautionary principle underpins these provisions. The producer must ensure that the exposure to such hazardous materials is reduced to as low a level as is technically and economically possible. When feasible, hazardous materials must be substituted by materials with a lower environmental impact. However, certain substances may still be used if there are no better alternatives or if alternatives have a higher impact. Only then, specific hazardous materials may be used, but only to a limited extent.

While the use of hazardous materials is widely discussed (evidently in the REACH Directive), the use of unsustainable materials or a definition thereof lacks in Directives. Similarly, the impact of materials is only considered as an environmental issue and not a problem for social sustainability.

Conservation/biocompatibility

While ranked generally high, the requirement of *conservation and biocompatibility* is not part of the work of consumer organisations in a direct sense. Naturally, subjects such as energy efficiency and reduction in resource use lead to conservation of resources and environments. However, no direct efforts are made for this requirement.

Directives focus extensively on the issues of *conservation and biocompatibility*. In fact, environmental protection is the primary goal of most Directives included in this research. Directives identify vital areas to indicate how the environment can be conserved. These areas include biodiversity, emissions, pollution, land use and contamination of land. These areas then serve as core indicators in determining the environmental performance of products.

Ease of repair and maintenance

From interviews with European and national consumer organisations, it resulted that repairability is extremely important to consumer organisations. However, while some interviewees indicate it to be most important, most interviewees agree that the first step in sustainable product design would be to develop products that do not fail and consequently would not need repair. Nevertheless, *repair and maintenance* presents itself as a requirement that is becoming more important in the future work of consumer organisations because of their contribution to the durability of a product. Repair and maintenance is a subject discussed mainly for electrical appliances and products that last long, which aligns with the lower placement of this requirement on the ranking for a t-shirt (section 7.3.2.).

While this requirement is recognised as essential to DfS, multiple barriers arise from the experience of consumers (e.g. spare parts). From the perspective of consumer organisations, a problem with the *ease of repair and maintenance* is the methodology to determine this. Again, the PROMPT project focuses on developing better assessment methods for repairability. These methods involve how many steps need to be taken to repair the product, what tools are needed, and what parts are critical. Some consumer organisations are also working independently on developing a standard procedure for measuring the *ease of repair and maintenance*.

“I don’t know in other countries but in Italy many times you ask for repair and the answer is: no spare parts, the cost is too high and it’s more convenient to get a new one.”³¹

³⁰ Interview with projectmanager at Stiftung Warentest, Germany on the 17th of February 2021

³¹ Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

Since the 1st of January 2021, France has implemented a repairability score on products such as washing machines and mowers, which displays the ease with which a product can be repaired on a scale from 1 to 10. Because of its recent introduction, the repairability score is frequently discussed and the effectiveness of the score is debated. In the end, most countries are looking to introduce a similar score or develop an EU-wide score. It is generally believed the score could contribute to consumers' awareness but concerns exist about how consumers would use such a score in their purchase. Additionally, the repairability score is an integrated score and at the point of purchase, it is not clear to the buyer which aspects of repairability apply to the product. Another problem is that manufacturers calculate the score themselves, which can lead to biased results. While the first results of the implementation are not yet impressive, it is argued that the score pushes producers to design repairable products and it can become a sales argument on which residents can base their purchase choices.

"So for now, the results are not striking to be honest. For example the grade that the smartphones got, it not so different from one smartphone to another. Like the Apple iPhone got a 6 while the Fairphone got a 7 or 8."³²

Regarding the maintenance of products, consumer organisations are pushing for rights to let products get repaired by third parties, which is not always feasible. The ability to choose where to get a product repaired adds to consumer freedom and competitive pricing.

"So now you can bring your car to a third party workshop but the more it's connected, the more there's software integrated, the more the manufacturers want to keep a hold of what is there. They don't want to have anyone accessing it and we're lobbying quite a lot against that because it's better for consumer choice and also to pick a proper price if you don't want to go to the manufacturer."³³

"...also for the consumer because if you own the product, you should have the right to open it and to put in parts, to exchange parts and something like that it is often not possible."³⁴

Part of the *ease of repair and maintenance* is how products can be disassembled, which is identified as a critical part of the Ecodesign Directive or subsequent works. It is recognised that measuring the ease of disassembly may be difficult in terms of methodology and trade-offs. Ease of disassembly can contribute positively to durability in that it can prolong the lifetime of a product. However, it can also inhibit durability. Furthermore, easy disassembly may have consequences for the safety of products and consumer organisations indicate that designs that are easy to disassemble are usually more expensive. Ultimately, a problem also lies with the demands of consumers, where they require all different functional and aesthetic requirements that not easily coincide with the possibility to disassemble a product.

"Sometimes it's always said that well: "I can't change the battery of my mobile phone", no you can't do that personally but if you want a waterproof phone, which most people want, then I am not sure if it is feasible to do that at a low price both waterproof and easy opening. [...] You look at your old Nokia Ericsson phone where it was so simple but you don't want to go that way again. You want to have waterproof products and then it would be very tricky to make it very functional."³⁵

"I think it should be very clear to the manufacturers that you expect ease of disassembly but then product safety and also a long lasting durable product must be overarching goals. So the risk then is that industry says: it's not possible because then the product would not be safe."³⁵

³² Interview with Environment and Transportation project manager at UFC - Que Choisir, France on the 16th of March 2021

³³ Interview with German consumer organisation on the 26th of February 2021

³⁴ Interview with AK Wien, Austria on the 11th of February 2021

³⁵ Interview with Sveriges Konsumenter, Sweden on the 19th of February 2021

As indicated earlier, in Directives, repair is approached as a means of extending product lifetime. While multiple aspects of design for repair are addressed in Directives, the revisions of the Ecodesign Directive go further than suggesting design for repair. In the Directive, obligations are set for the availability of specific spare parts, the maximum delivery time of spare parts, the minimum period of availability of specific spare parts, the ease of disassembly, and the ability for professional repairers to repair products. In addition to these obligatory requirements, Member States are invited to set up systems for repair and take measures to promote repair among residents.

Maintenance is also considered to enhance the durability of a product. Directives measure the ease of maintenance by calculating how many consumables are needed for proper maintenance. However, no obligatory requirements are established for ease of maintenance.

Reduction in (virgin) resource use during production

Reducing the amount of (virgin) resources used in production deals with optimising and reducing production. For consumer organisations, the first step in *reducing (virgin) resource use during production* is reducing production in general. While most interviewees indicate that this is out of the scope of their work, one interviewee indicates this to be the most critical step towards a more sustainable society. In the end, it can be found that consumer organisations focus on informing the consumer of their needs and thereby try to avoid overproduction.

“We are talking about clarifying the situation, clarifying the real needs so we can avoid services and products which are not needed because the situation was not clear.”³⁶

Another way to reduce the *(virgin) resource consumption in production* is by using fewer materials, known as dematerialisation. Consumer organisations do not commonly employ this method and they pointed out that dematerialisation does not add to the value of a product from a consumer point of view. Additionally, products are getting more complex and, as a result, often require more materials. Interviewees argue that dematerialisation is a requirement automatically considered by producers to reduce production costs, especially in light of rising resource prices. Finally, they acknowledged that dematerialisation could be a valuable design requirement, however, not at the cost of durability.

“...we see products get more and more complex, especially if they are getting more and more smarter. So you have products where you really have to think about why do you need a smart thing here but it's a trend.”³⁷

“From a consumer point of view there's a lot of scepticism. When you look at the kind of products you use, they're getting thinner in terms of the materials, but not very durable physically because it's thinner and thinner and I think that has happened for a lot of products.”³⁸

While consumer organisations focus on reducing production in general, Directives focus more on changing energy consumption patterns and promoting more sustainable production methods. To identify the impact of production, organisational data should be used and accurate, reproducible methods should be developed. Overall, the sustainability of production processes is based on the use of raw materials, water, energy, and resource efficiency. Additionally, a reduction of waste from manufacturing would be desirable. However, all these measures are focused on encouragement and no specific requirements are set to reduce the impact of production.

³⁶ Interview with project officer energy & building at Test-Achats, Belgium on the 11th of March 2021

³⁷ Interview with AK Wien, Austria on the 11th of February 2021

³⁸ Interview with Sveriges Konsumenter, Sweden on the 19th of February 2021

Regarding dematerialisation, material efficiency is named in Directives as a means to reduce the impact of production processes while simultaneously being cost-efficient, yet no obligations are set for this.

Use of sustainable and/or reused/recycled products

Overall, using sustainable, reused or recycled materials would lead to a lower environmental impact of products. However, whether these types of materials are used in products is not an aspect consumer organisations include in the evaluation of products for several reasons. First, testing if materials are recycled can be a complicated process requiring much information. The latter also presents a second difficulty as information provided by manufacturers may not always be correct. Third, using *sustainable and/or reused/recycled materials* is not always more environmentally friendly as it can require more energy input. However, consumer organisations communicate to residents on different types of plastics and their appearances and look at the reliability of certificates for recycled content.

While using so-called sustainable materials is not a topic addressed in Directives, using secondary materials is identified as a valuable requirement. The use of these materials is addressed mainly in Waste Directives and the Ecodesign Directive. Expressly, Directives state that used components should not be regarded as waste and could be incorporated in new products. Additionally, the use of recycled content should be encouraged by e.g. improving market conditions for such materials. Also, the promotion of setting EU standards for minimum amounts of recycled content in packaging is discussed in the Packaging and Packaging Waste Directive. Finally, information on the material composition of products should be publicly available and limited values of pollutants are required to ensure safe waste management. Concluding, while Directives discuss some of the issues involved in the *use of sustainable and/or reused/recycled materials*, no specific requirements are introduced yet.

Reusability, recyclability, recoverability

Within the three Rs, *reusability, recyclability, and recoverability*, consumer organisations perceive reusability as the most crucial requirement, which coincides with the 10R framework of the CE (Reike et al., 2018). *Reusability* includes promoting reuse through product design and establishing a system for reuse. Consumer organisations have initiated a variety of campaigns on the reuse of certain products, e.g. plastic bags. However, reusability is not an aspect that is used when comparing products. Consumer organisations do experience a change in mentality on the use and purchase of second-hand products. Nevertheless, from the point of consumer protection, problems arise regarding the warranty, especially for electronic products, as warranties usually expire soon or do not apply when a product is re-sold. Ultimately, reusability appears to be especially important for electronic devices, clothing, and batteries.

“In our web file on certain products we tell people what they can do with the product second hand and what kind of sharing initiatives exist for the product but it is not something that we use to compare products on.”³⁹

“Because in Italy only poor people buy secondary products so we’re trying also to educate that it’s not bad to choose these kinds of products. There are also some new apps that are appearing that make it so easy to exchange and to sell.”⁴⁰

Recyclability is an objective in itself but also includes the use of compatible materials and few contaminants. The subject is researched to a limited extent by consumer organisations, but while recyclability assumes there is waste in the first place, it is nevertheless vital. Consumer organisations initiate various campaigns to inform residents on how, what, and where to recycle, primarily for clothing, batteries, and packaging. One example is the creation of databases on where

³⁹ Interview with Dutch consumer organisation on the 26th of February 2021

⁴⁰ Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

to recycle what types of products. As a consequence, most interviewees recognise that their residents are doing well in recycling their waste. Two problems remain that are however outside the scope of residents. First, the export of waste, and second, the industry also creates much waste that is not recycled.

“...there is a bit of a danger because if you have this recycle road to fulfill, this means you have to put things away more often.”⁴¹

“And now we see what happened is that a lot of plastic was not recycled, it was just pushed away from Europe which is really dirty and it's something we should be ashamed of.”⁴²

Recoverability includes design for remanufacturing and refurbishing and is considered especially important for metals. However, it is much less focused on by consumer organisations. While its importance is recognised, it is generally not included in product tests or campaigns.

The Directives consider reuse to have significant potential in reducing the environmental impact of products due to, among other things, resource efficiency. *Reusability* is considered the second step in the waste hierarchy (after prevention) and is thought to further the adoption of the CE. It is stated that design for reuse should be strongly encouraged by determining the possibility for reuse in every phase of development, avoiding technical solutions that impede reuse, and avoid the use of hazardous substances. Subsequently, reuse should be encouraged by establishing reuse networks, promote cooperation between producers and recyclers, and establish a solid market for reused products. In the Directives, reusability is discussed primarily for packaging and electronic equipment, and while reuse is considered necessary, no obligations on reuse are established yet.

After reuse, recycling is the third step in the waste hierarchy. Similar to reusability, it is generally believed that recycling furthers the transition to a CE. The idea of design for recycling is similar to that of reuse but coding is added to identify easily recyclable materials. Another important aspect of recycling is the availability of recycling processes. Directives specifically refer to the development of new recycling facilities and recycling targets for material groups. Similar to reusability, recycling is considered especially important for packaging materials and electronic equipment, and specific materials (e.g. paper and glass). Again similar to discussions on reuse, while recycling itself and improving recycling processes are strongly encouraged, no binding requirements are presented.

Recoverability is defined as any operation where waste serves a valuable purpose by replacing other materials which would otherwise have been used to fulfil that function. Directives identify *recoverability* as the fourth step in the waste hierarchy. Similar to both reusability and recyclability, possibilities for recovery should be determined in every step of the design process. Recoverability can be subject to different processes such as composting, energy recovery, and material recovery. Regarding the latter, Directives have set targets for different types of materials and encourage Member States to enhance the development of recovering facilities and cooperation between producers and recyclers. However, these suggestions are not translated into binding requirements. Next to material recoverability, energy recoverability is also discussed in Waste Directives. Energy recovery is defined as combusting waste as a means to generate energy through direct incineration with the recovery of the heat. For energy recovery, specific requirements are set. Namely, waste destined for energy recovery should have a minimum calorific value and the recovery of energy should take place with a high level of energy efficiency. Ultimately, recoverability is executed to retain the value of materials and specific product groups addressed in Directives are again packaging and WEEE.

Optimise the end-of-life system

The *optimisation of the end-of-life systems* includes achieving higher collection ratios by increasing the convenience of collection and maximising the retention value. However, consumer

⁴¹ Interview with AK Wien, Austria on the 11th of February 2021

⁴² Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

organisations do not focus on this requirement in their work. Only one example was named in the interviews, which is an initiative in France. Here, an obligation to pay a “tax” will be introduced and these earnings will be directed to the disposal of these products, e.g. for a washing machine.

“So when you produce a washing machine for example you have to pay a tax, but it is not tax, but a contribution to an organisation. The organisation will assemble the contribution that will help then to tackle the end of life of products. [...] One of the aims of this eco-contribution is to found a fund for repairability and reuse.”⁴³

Similar to the viewpoints of consumer organisations, the end-of-life system is not widely discussed in Directives. Besides developing improved recycling/recovering facilities as discussed in the previous paragraph, final disposal is discussed in terms of information provision. Specifically, sufficient information is required on treating and disposing of the product at the end of its life. While none of these discussions include binding requirements, the revision of the Ecodesign Directive includes obligatory requirements on the provision of end-of-life information. This information should be available until at least 15 years after the placing on the market of the last unit of a product model.

Waste management

The management of waste concerns reducing the amount of waste or otherwise increase the value of waste. It is an important subject to consumer organisations. Particularly, avoiding waste is presented as a focal point. Moreover, recycling waste is a subject of many information campaigns. Consumer organisations indicate that residents are especially interested in these subjects, more than they expected. This has led to more campaigns and initiatives, such as cooperation with distributors and packaging institutions.

Packaging is one of the main commitments of consumer organisations within *waste management* because of the growth in unnecessary packaging materials. Specifically, the packaging of online purchases and food are areas of focus. Other product groups included in the work on *waste management* are food waste and household waste in general.

“We have this topic of packaging where we check if the packaging is suitable for the product and if it’s not too much. And also you have the problem that the package is much bigger than the content.”⁴⁴

Similar to the work of consumer organisation, the Directives discuss *waste management* extensively (evidently waste Directives). Environmentally sound management is defined as “taking all practicable steps to ensure that waste is managed in a manner that will protect human health and the environment against adverse effects which may result from such waste”. Waste management involves multiple steps where first, waste should be prevented or transformed into valuable products to further the adoption of the CE. For this purpose, Member States are expected to establish waste prevention programmes and thus, no binding requirements are established at the EU level. Second, in the design of a product, an indication should be given on the amount of (hazardous) waste generated. This is non-obligatory. Information on the composition of hazardous materials in products and consequently in waste is obligatory to assure the health and safety of waste processors. Third, for the disposal of waste, required information should be provided again by the manufacturer in a safety data sheet. The same applies to the fourth step, waste collection. Here the Member States are also responsible for the insurance of deposit systems but no obligations exist on how these deposit systems are to be set up. Fifth, for the collection, transportation, and storage of waste, waste treatment should be safe for all those involved and again, information provision obligations exist. Furthermore, waste treatment methods should be specified and properties or special precautions that may affect the treatment should be noted. The

⁴³ Interview with Environment and Transportation project manager at UFC - Que Choisir, France on the 16th of March 2021

⁴⁴ Interview with projectmanager at Stiftung Warentest, Germany on the 17th of February 2021

Directives discuss laws on waste import and export (a problem recognised by interviewees in recycling) elaborately. Different laws exist for waste shipped between the Member States or between the Member and non-Member States.

Reduce the impact of transport and storage

Reducing the *impact of transport and storage* includes optimising distribution processes as well as reducing the weight and volume of the product. The interest in the impact of transport has gained more attention with the growth of online purchases but differs between consumer organisations. Consumer organisations that use LCA methodologies in their product tests feel the *impact of transport and storage* is implied in every article they publish. Others recognise the importance but place it lower down the list as they feel many other aspects can have more significant impacts.

More specifically, regarding the storage of products, little effort is taken except in Italy, where a producer has initiated to produce products merely when products are ordered, thereby achieving a zero storage production process.

The *impact of transport and storage* is not an extensively discussed subject in Directives. For example, the Energy Labelling Directive states that the impact of transport of both goods and residents is exempted from its scope. The EMAS Directive recognises the impact of transport and identifies business travel and transportation issues as the main impact areas. However, no obligations are set for limitations on or means of travel and transport.

Regarding the impact of storage, this subject is exclusively discussed in terms of safe storage of hazardous substances. Here obligations are set for the provision of sufficient information for transport and storage as well as for the sites for storage (e.g. impermeable surfaces or weatherproof coverage). Besides obligations for hazardous materials for safety, no requirements are set for other impacts or materials.

6.3. Profit

Reduce replacement because of fashion or technology

Reducing the replacement because of fashion or technology is concerned with fashion cycles and temporary aspects of design. Consumer organisations perform different research types to evaluate why residents replace products and how often they indicate to replace certain products (e.g. for a mobile phone). Consequently, these results are compared to market data to assess an attitude-behaviour gap (section 2.3.2.).

It is recognised that residents often replace products because of commercial reasons and new features, while some of these features might not be useful to the consumer. Here consumer organisations can inform consumers on the impact of their choices on both the environment and their expenses. Providing the consumer with knowledge on the impacts of changing products for fashion reasons is essential. However, ultimately it is the consumer who has the freedom to choose.

Linked to the replacement of fashion and technology is the turn that the discussion has made from planned obsolescence to premature obsolescence. Premature obsolescence is a common subject among consumer organisations and alongside independent research of consumer organisations, many work together in the previously mentioned PROMPT project. Overall, it is recognised that premature obsolescence is less of a problem for functional products such as fridges compared to multimedia products, where many psychological aspects play a role. Additionally, fashion is a common subject in campaigns on premature obsolescence.

“A very good example is a 3D television. When it came out it was a big story for a year or two, it was everywhere “perhaps you should buy this TV with 3D features”. No one is using them and we immediately knew. I mean this is nothing, it’s nothing really useful for consumers”⁴⁵

Another problem related to the replacement of products is the software compatibility of devices which is becoming increasingly important. Additionally, a large part of the problem with

⁴⁵ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

mobile phones is the contracts consumers have with providers to replace their phones, for example, every two years.

While consumer organisations recognise the *replacement because of fashion or technology* as important, some admit the environmental viewpoint on this subject is lacking still.

The Directives discuss *the reduced replacement because of fashion and technology* to a limited extent. In fact, replacement because of fashion is omitted from Directives. Technological progress is discussed merely in terms of labelling. Here, Directives state that e.g. energy labels should be adjusted based on the technological progress in the product group. However, no reference is made to premature replacement.

Availability of financial and/or regulatory arrangements

The *availability of financial and/or regulatory arrangements* includes possibilities for self-regulatory measures and financial incentives. The interviews show that the introduction of *financial or regulatory arrangements* is a requirement that is mainly in the hands of the government. Here tax reductions, subsidies, loans, and grants are named as standard instruments. Consumer organisations themselves are also initiating several projects to stimulate the uptake of certain sustainable products as they recognise that these incentives make products more attractive for consumers. One example is the initiative of Italy, together with other European consumer organisations, to stimulate the purchase of solar panels.

“I mean it was together with other European organisation and we made this buying group of people. So we had a block of 200.000 people buying solar panels for a cheaper price because we had this agreement with the producer saying okay we have 200.000 people buying your products, I can make a big discount.”⁴⁶

Other examples of initiatives are a repair bonus in Austria and a comparison of the sustainability of energy providers and special offers for the most sustainable ones in Belgium. However, not all consumer organisations indicate to work on such initiatives due to certain circumstances. For example, in Germany, a high share of tenants exists, making it more complicated to invest in e.g. solar panels. Consequently, new legislative frameworks will need to be developed in such cases for tenants to invest in solar panels together.

As can be concluded from the previous passage, solar panels are common products for financial or regulatory benefits. Other products that consumer organisations focus on within this requirement are electric cars, sustainable housing, heating and cooling systems, and washing machines.

Directives in themselves are indeed regulatory arrangements. However, different parts of this legislation can be detailed and different types of regulatory measures are used. One type of measure discussed primarily in the field of waste is extended producer responsibility as a preventive measure where minimum collection rates are determined for specific materials or product groups. Suggestions are made on preventive measures, but ultimately, Member States are individually responsible for establishing extended producer responsibility schemes.

Another topic addressed in Directives is market surveillance. Market surveillance exists to ensure compliance to Directives and thereby protect the public interest. Market surveillance authorities carry out audits to monitor compliance and such audits are specified in Directives. This content is specified to ensure equivalent and consistent enforcement of EU legislation. In addition to providing the content of surveillance activities, a Market Surveillance Framework is established and it is noted that national accreditation bodies should be independent to safeguard objectivity and impartiality.

The remaining regulatory issues discussed in the Directives are the development of the Directives (e.g. scheduling of reviews, amendments, assessments and working plans), legislative coherence on both a Community level and with national legislation, and special attention is given to SMEs because of their resource limits.

⁴⁶ Interview with sustainability expert at Altroconsumo, Italy on the 5th of March 2021

Financial arrangements present themselves in several forms in the Directives: namely as incentives, insurances, loans, grants, funds, investments, and financing programmes (e.g. deposit-refund schemes). All these economic initiatives are presented as means to promote the uptake of requirements or sustainable products. Additionally, the polluter-pays principle is introduced in the Waste Directive as a means to allocate the costs of waste management to those responsible for it. In the Directives, economic benefits can go hand in hand with environmental benefits (e.g. energy efficiency) and sustainability should have no negative impacts on affordability.

Optimise usage by PSS

PSS (Product-Service Systems) can include take-back programmes, sharing initiatives, or lease or rent services to achieve more intensive product use. The interviews with consumer organisations revealed that many barriers in the use of PSS still exist. First, and most importantly, it is indicated that the price of these services is usually very high compared to buying the product, especially if it is used often. Consumer organisations' primary purpose is to inform consumers what is best for them on multiple aspects and from an economic perspective, these services are usually not preferable. Second, the contractual terms of product-service systems can be very constraining for residents. Here it is indicated that providers' business is to make money and consequently make it difficult for consumers to, for example, switch services. Third, one barrier in using PSS is the time that needs to be invested in it. Users need to rent the product, pick it up, and return it and consequently would be more comfortable buying it. The final problem in leasing or renting products is the consumer mindset and, as a consequence, the commonality of using PSS. Here, the main argument is that people would like to own products themselves. Whether this paradigm is changing is not agreed upon by interviewees. Additionally, consumer organisations indicate these conclusions may not be entirely correct as their members are usually not representative of the population (they are generally older and wealthier).

“The sad story is that not yet and in many more years to come consumers are not very fond of collective use. Certain aware consumer groups are very much so but it is still a little percentage.”⁴⁷

“And what we also did is we looked at those pay-per-use services, or lease and then you usually conclude that... well if you want to have a good circular economy then these things have to be attractive for people and if you start calculating, they are usually not.”⁴⁸

While many barriers are indicated, there are also drivers for the rent or lease of products. Here, price and convenience are mentioned again. In some cases, leasing or renting a product can be cheaper depending on the frequency of use. Also, since the market for PSS is growing, competitive prices make its use more attractive. Especially in cities renting a bike or car can present a convenient option because of space limitations.

The use of PSS is often linked to CE principles as it is recognised to reduce consumption. Nevertheless, the effectiveness of these principles is questioned for multiple reasons. First, although the potential in reducing the amount of products used, PSS does not seem to have this effect yet. Second, when residents do not use the communal products and purchase them themselves, it again adds up to the number of products. Third, when contracts offer the renewal of products because of e.g. new technologies, it is unsure what happens to the old versions of the product and constantly replacing products is not recognised as sustainable or circular.

“The problem is that the ownership of product is not reducing at the same speed as the collective use or rental or sharing. It is more or less if you say like all the bikes and cars and muppets you can rent here in Stockholm hasn't tremendously reduced the amount of cars that people have. In theory it sounds like such a good environmental thing but often it adds too. And it is the same even with a lot of products.”⁴⁷

⁴⁷ Interview with Sveriges Konsumenter, Sweden on the 19th of February 2021

⁴⁸ Interview with Dutch consumer organisation on the 26th of February 2021

“It’s also from the part of durability or sustainability point of view when I am using a service that, I don’t know, gives me the possibility to use all the time the new products it’s also... what is done with the products I used before?”⁴⁹

It can thus be concluded that most interviewees view the implementation of PSS as one with many challenges. However, it is also recognised that certain groups of residents are more akin to PSS use. Especially students and young people are named as leading actors in the upsurge of PSS because of new ways of living and new mindsets. Also, residents of urbanised areas are mentioned as leading actors because of space limitations.

“I think that with younger generations this would be easier to acquire because I mean you’re used to a lot of different services that are used but never really owned by you. Where I grew up, everything was bought, whatever the things, it was bought.”⁴⁹

The use of PSS is not mentioned in any of the Directives analysed.

6.4. Concluding remarks

In this chapter, the approach to each of the DfS requirements by consumer organisations and policymakers has been discussed. The table below (Table 6) presents the work consumer organisations and policymakers execute on each of the requirements next to the average ranking of the requirements. How well the valuation of the requirements aligns between the stakeholders is discussed in section 8.2. and 8.3.

Table 6. Average ranking of DfS requirements according to European residents and the value attributed to these requirements by consumer organisations and policymakers.

Average ranking European residents	Valuation consumer organisations	Discussed in policy
People		
1. Operational safety and efficiency	★★★	★★★
2. Safe and fair working conditions	★★	★★
3. Ethical responsibility	★	★
4. Information provision	★★★	★★★
5. Consider differences and impact on communities	★	★★
6. Job creation	★	★
7. Cooperation between actors	★★	★★
Planet		
1. Durability	★★★	★★
2. Limited use of hazardous/unsustainable materials	★★	★★
3. Conservation/biocompatibility	★	★★★
4. Ease of repair and maintenance	★★★	★★
5. Reduction of (virgin) resource use during production	★★	★
6. Use of sustainable, reused/recycled materials	★	★
7. Reusability, recyclability, recoverability	★★	★★★
8. Optimise the end-of-life system	★	★★
9. Waste management	★★★	★★★
10. Impact of transport and storage	★	★★
Profit		
1. Reduce replacement because of fashion/technology	★★★	★
2. Financial and/or regulatory arrangements	★★	★★★
3. Optimise usage by PSS	★★	X
Valuation consumer organisations:	Discussed in policy:	
★ = recognise requirement, do not work on it	★ = recognised, suggestions are given	
★★ = work on requirement to a limited extent	★★ = some obligations but mostly suggestions	
★★★ = work on requirement a lot	★★★ = multiple obligations	

⁴⁹ Interview with product testing manager at ZPS, Slovenia on the 16th of March 2021

Perspectives of consumer organisations and policymakers on ecodesign and DfS requirements have been researched. However, this research has discussed the perspectives of the two stakeholders for all 20 DfS requirements derived from the literature review (Chapter 4). Having discussed these perspectives, the next step in this research is evaluating an unknown perspective: the perspective of EU residents.

7. Descriptive results EU residents

In the previous chapters, the DfS requirements that are most apparent in academic literature, the general work of consumer organisations, and the perspective of consumer organisations and policy towards DfS requirements have been discussed. Nevertheless, the perspective of residents has remained largely unexplored in academic literature but is relevant in identifying opportunities for sustainable design (Boesen, Bey & Niero, 2019). The perspective of EU residents was researched with the use of a survey. This chapter presents the descriptive results for each section of the survey. Information on statistical tests performed is incorporated in the text and can be found in Appendix IV-H.

7.1. Demographic distributions

Table 7 presents the demographic distributions of the complete sample. Distributions of the demographic categories per targeted country can be found in Appendix V-A.

Table 7. Distributions within demographic categories of the sample. Expressed in frequency and percentage. N = 1883.

Variable	Category	Sample frequency	Sample percent
Gender	Male	843	44,8
	Female	1021	54,2
	Other	7	0,4
	Do not want to disclose	12	0,6
Age	18 - 30	748	39,7
	31 - 40	452	24
	41 - 50	306	16,3
	51 - 60	243	12,9
	61+	134	7,1
Country of residence	Czech Republic	207	11
	Germany	187	9,9
	France	227	12,1
	Ireland	257	13,6
	Italy	177	9,4
	The Netherlands	207	11
	Poland	202	10,7
	Spain	192	10,2
	Sweden	227	12,1
Education attainment	Primary education	94	5
	Secondary education	683	36,3
	Post-secondary, non-tertiary education	144	7,6
	Short cycle tertiary education	244	13
	Bachelor's or equivalent level	418	22,2
	Master's or equivalent level	237	12,6
	Other	63	3,3
Employment	Working fulltime	860	45,7
	Working parttime	249	13,2
	Self employed	105	5,6
	Military service	9	0,5
	Retired	117	6,2
	Homemaker	94	5
	Student	239	12,7
	Unemployed	146	7,8
	Disabled	23	1,2
Other	41	2,2	
Income (all)	Less than X	301	16
	Between X - X (lower end)	725	38,5
	Between X - X (higher end)	529	28,1
	More than X	121	6,4
	Do not want to disclose	207	11

7.2. NEP scale

The final section of the survey consisted of 15 statements on environmental attitude answered using a 5-point Likert scale. The statements presented in bold represent the dominant social paradigm (DSP). The remaining statements reflect the new environmental paradigm (NEP) (Table 8). Statements in bold are reverse coded to arrive at a mean for each of the statements. It is generally accepted that a mean NEP score of 3 presents the boundary between the DSP and the NEP (Ogunbode, 2013). Here, the overall mean was established at 2,42 indicating that the respondents' ecological attitude was akin to DSP. The overall distribution of NEP scores is presented in Figure 7.

Table 8. Presentation of the agreement with each of the statements in % of responses, the mean, and the standard deviation. N = 1883.

NEP facets	NEP items	% of responses					Mean	SD
		Strongly agree	Agree	Unsure	Disagree	Strongly disagree		
Reality of limits of growth	N1. We are approaching the limit of the number of people the Earth can support	25,2	36,2	27,5	8,5	2,7	2,27	1,018
	N6. The Earth has plenty of natural resources if we just learn how to develop them	31,7	41	18	7,1	2,3	2,07	0,99
	N11. The Earth is like a spaceship with very limited room and resources	23,7	38	24,3	10,8	3,2	2,32	1,05
Anthropocentrism	N2. Humans have the right to modify the natural environment to suit their needs	11,4	20,6	23,9	30,3	13,9	3,15	1,223
	N12. Humans were meant to rule over the rest of nature	7,5	17,6	26,8	28,8	19,2	3,35	1,19
	N7. Plants and animals have as much as rights as humans to exist	53	31,9	10,3	3,6	1,2	1,68	0,884
Fragility of nature's balance	N3. When humans interfere with nature it often produces disastrous consequences	40,9	40,9	12,2	4,7	1,2	1,84	0,895
	N8. The balance of nature is strong enough to cope the impacts of modern industrial nations	11,2	17,8	27,9	29,5	13,6	3,17	1,199
	N13. The balance of nature is very delicate and easily upset	32,9	44,1	16,3	4,8	1,9	1,99	0,924
Rejection of exceptionalism	N4. Human ingenuity will insure that we do not make the Earth unlivable	14,2	27,6	40,1	13,6	4,4	2,66	1,023
	N9. Despite our special abilities, humans are still subject to the laws of nature	33,9	42,3	17,9	4,1	1,8	1,97	0,916
	N14. Humans will eventually learn enough about how nature works to be able to control it	11,9	26,9	36	18,5	6,7	2,81	1,079
Possibility of an eco-crisis	N5. Humans are seriously abusing the environment	46,5	38,3	10,2	3,8	1,3	1,75	0,878
	N10. The so-called "ecological crisis" facing human kind as been greatly exaggerated	9,5	17	24,7	29	19,8	3,33	1,235
	N15. If things continue in their present course, we will soon experience a major ecological catastrophe	37,9	37,4	17,8	5,5	1,4	1,95	0,95
						2,42	1,07	

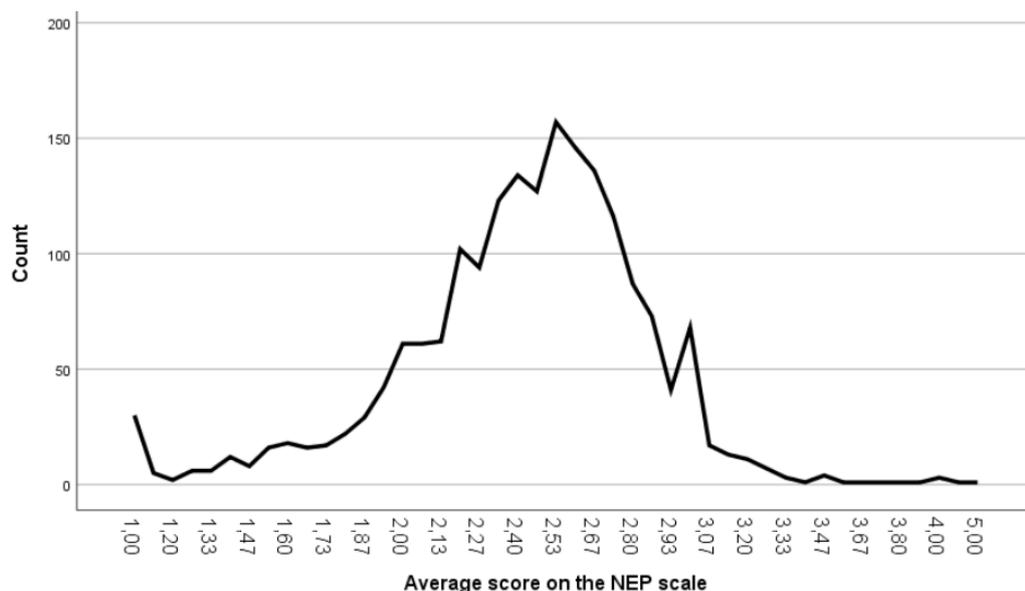


Figure 7. Distribution of the NEP scores across the sample. N = 1883.

The average NEP scores were tested for correlations within demographic categories again using a One-Way ANOVA with post hoc test Tukey and Games-Howell. The average NEP scores for each demographic category can be found in Appendix V-A-B.

Statistical tests were conducted to determine the representativeness of the NEP scale. First, a test of reliability was performed to measure the internal consistency of the NEP scale. A Cronbach's alpha of 0,662 was obtained, indicating an acceptable level of internal consistency/reliability. Second, a principal component analysis (PCA) with varimax rotation was conducted on all 15 scale items to investigate the extent to which the pattern of responses was consistent with the hypothesised structure of the NEP. Finally, the Kaiser-Meyer-Olkin verified the adequacy of the sample size (KMO = 0,857, 0,8 - 1,0 can be considered an adequate sample size). Further results of the PCA can be found in Appendix V-B.

7.3. Rankings of the requirements

Ranking the requirements provided an answer to the main research question of how respondents value DfS requirements and therefore, these questions formed the core of the survey. Respondents were asked to rank the economic, social and environmental requirements identified in the literature for each product group. The table below presents the rankings per product group as well as the overall ranking (Tables 9, 10, 11). More descriptive results are presented in Appendix V-C. Since these are independent rankings, scores need to be considered independently. Notably, no conclusions can be made on the relative importance respondents allocate to either social, environmental or economic requirements. Consequently, people, planet and profit are considered equally important, which is in line with the notion of sustainability.

The rankings were analysed using a Friedman's ANOVA. This is a non-parametric test used to detect differences in treatment across responses and commonly used in analysing rankings. Concerning the rankings' statistics: all rankings have an asymptotic significance of $p = 0,000$ and were thus significant. Effect sizes were calculated using Kendall's W. These ranged from a medium for the economic rankings (between 0,1 - 0,3) to a very small effect size for the social and environmental rankings ($< 0,1$).

Table 9. Average ranking of social requirements per product group as well as overall.

Ranking	T-shirt	Couch	Mobile phone	Refrigerator	Overall
1	Safe and fair working conditions (3,36)	Operational safety and efficiency (3,44)	Operational safety and efficiency (3,30)	Operational safety and efficiency (3,25)	Operational safety and efficiency (3,39)
2	Operational safety and efficiency (3,62)	Safe and fair working conditions (3,61)	Safe and fair working conditions (3,77)	Ethical responsibility (3,77)	Safe and fair working conditions (3,64)
3	Ethical responsibility (3,75)	Ethical responsibility (3,80)	Ethical responsibility (3,85)	Safe and fair working conditions (3,78)	Ethical responsibility (3,79)
4	Consider differences and impact on communities (4,02)	Consider differences and impact on communities (4,02)	Information provision (4,02)	Information provision (4,04)	Information provision (4,09)
5	Information provision (4,15)	Information provision (4,19)	Consider differences and impact on communities (4,11)	Consider differences and impact on communities (4,15)	Consider differences and impact on communities (4,09)
6	Job creation (4,41)	Cooperation between actors (4,45)	Job creation (4,45)	Cooperation between actors (4,50)	Job creation (4,45)
7	Cooperation between actors (4,69)	Job creation (4,48)	Cooperation between actors (4,50)	Job creation (4,51)	Cooperation between actors (4,54)

[values in bold present the numerical value of the average ranking. Each colour represents one requirement.]

Table 10. Average ranking of environmental requirements per product group as well as overall.

Ranking	T-shirt	Couch	Mobile phone	Refrigerator	Overall
1	Limited use hazardous and/or unsustainable materials (4,54)	Durability (4,48)	Durability (4,48)	Durability (4,30)	Durability (4,45)
2	Durability (4,66)	Limited use hazardous and/or unsustainable materials (4,93)	Limited use hazardous and/or unsustainable materials (4,95)	Limited use hazardous and/or unsustainable materials (4,98)	Limited use hazardous and/or unsustainable materials (4,84)
3	Conservation/ biocompatibility (5,19)	Ease of repair and maintenance (5,27)	Ease of repair and maintenance (5,18)	Ease of repair and maintenance (5,13)	Conservation/ biocompatibility (5,33)
4	Use sustainable and/or reused/recycled materials (5,47)	Conservation/ biocompatibility (5,32)	Conservation/ biocompatibility (5,28)	Conservation/ biocompatibility (5,45)	Ease of repair and maintenance (5,35)
5	Reduction in (virgin) resource use during production (5,64)	Use sustainable and/or reused/recycled materials (5,66)	Reduction in (virgin) resource use during production (5,62)	Reduction in (virgin) resource use during production (5,56)	Reduction in (virgin) resource use during production (5,65)
6	Optimise the end-of-life system (5,80)	Reduction in (virgin) resource use during production (5,75)	Optimise the end-of-life system (5,70)	Reusability, recyclability, recoverability (5,73)	Use sustainable and/or reused/recycled materials (5,66)
7	Reusability, recyclability, recoverability (5,81)	Reusability, recyclability, recoverability (5,80)	Use sustainable and/or reused/recycled materials (5,77)	Use sustainable and/or reused/recycled materials (5,75)	Reusability, recyclability, recoverability (5,77)
8	Ease of repair and maintenance (5,86)	Optimise the end-of-life system (5,87)	Reusability, recyclability, recoverability (5,81)	Optimise the end-of-life system (5,94)	Optimise the end-of-life system (5,85)
9	Waste management (5,91)	Reduce impact of transport and storage (5,93)	Waste management (6,04)	Waste management (5,98)	Waste management (5,99)
10	Reduce impact of transport and storage (6,10)	Waste management (5,98)	Reduce impact of transport and storage (6,17)	Reduce impact of transport and storage (6,19)	Reduce impact of transport and storage (6,10)

[values in bold present the numerical value of the average ranking. Each colour represents one requirement.]

Table 11. Average ranking of economic requirements per product group as well as overall.

Ranking	T-shirt	Couch	Mobile phone	Refrigerator	Overall
1	Reduce replacement because of fashion or technology (1,71)	Financial and/or regulatory arrangements (1,75)	Reduce replacement because of fashion or technology (1,75)	Financial and/or regulatory arrangements (1,79)	Reduce replacement because of fashion or technology (1,77)
2	Financial and/or regulatory arrangements (1,76)	Reduce replacement because of fashion or technology (1,80)	Financial and/or regulatory arrangements (1,84)	Reduce replacement because of fashion or technology (1,81)	Financial and/or regulatory arrangements (1,78)
3	Optimise usage by PSS (2,53)	Optimise usage by PSS (2,46)	Optimise usage by PSS (2,42)	Optimise usage by PSS (2,41)	Optimise usage by PSS (2,45)

[values in bold present the numerical value of the average ranking. Each colour represents one requirement.]

Friedman’s ANOVA is an omnibus test that displays whether there are overall differences in the rankings but does not indicate which groups differ from each other. Consequently, post hoc tests were used. More specific, a Dunnett test with Bonferroni was used to test for significant pairs. As a result, the majority of the pairs proved to be significant.

In order to determine which demographic categories significantly differed from each other in the importance they allocated to each of the requirements, a One-Way ANOVA with post hoc tests Games-Howell and Tukey was conducted. These tests were conducted for all demographic categories as well as the NEP score. The correlations are discussed below for each people, planet and profit and are summarised in tables 12, 13, and 14. The implications of these correlations are discussed in chapter 8.

7.3.1. People

Table 12. Correlations between demographic categories and the NEP scale and social requirements presented in order of their average ranking.

	Age				Gender				Country				Education				Employment				Income				NEP							
	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge				
Operational safety and efficiency		X		X					X	X	X				X																	X
Safe and fair working conditions					X			X													X	X	X	X	X	X	X	X	X	X	X	X
Ethical responsibility					X	X	X												X		X											
Information provision					X				X	X	X																					
Impact communities						X			X	X	X	X																X				
Job creation					X	X			X	X	X	X	X	X	X										X	X			X	X	X	
Cooperation	X				X	X	X	X		X						X					X	X			X	X			X	X	X	

[Green or empty boxes indicate no correlations were found between groups, blue or boxes marked with a X represent correlations.]

Operational safety and efficiency

Within the ranking of *operational safety and efficiency* of the t-shirt, France presents itself as an outlier in that it values this requirement significantly more than Czechia, Ireland, Poland, and Spain.

French residents also value *operational safety and efficiency* significantly more than Czech respondents in the ranking of the design requirements of the couch. Another significant difference was found between age categories where the oldest age category (61+) valued this requirement significantly more than the youngest age category (18-30).

The value attributed to the requirement in the ranking for the mobile phone shows significant differences between countries. However, this difference can not be attributed to specific countries. Between the education categories ‘post-secondary, non-tertiary’ and ‘master level’ a significant difference can be found where respondents educated to a master level rank this requirement significantly higher.

Similar to the correlations of the couch, significant differences between age groups are found in the ranking of the design changes desired for a refrigerator. Here, the age group ‘18-30’ ranks *operational safety and efficiency* significantly lower than the age groups ‘41-50’, ‘51-60’, and ‘61+’. Additionally, the average NEP scores of those who ranked *operational safety and efficiency* first and those who rated it last (seventh) differed significantly, where respondents with a higher NEP score valued this requirement most.

Safe and fair working conditions

In the preference for this requirement in the case of a t-shirt, it was revealed that females value this requirement significantly more than males. In addition, following from the correlation with the NEP scale, people who think *safe and fair working conditions* is the most important social requirement have a significantly higher NEP score than respondents who rank it fifth or seventh.

Again, significant differences were found between rankings and average NEP scores in the ranking of a couch. Here, a significant difference is revealed between respondents who rank *safe and fair working conditions* first and those who rank it sixth. Similar to the differences in NEP scores in the ranking of a t-shirt, respondents that rank this requirement first generally possess a higher NEP score. Additionally, income categories differ in their valuation of this requirement. Precisely, respondents in the income categories ‘between X-X (higher end)’ value this requirement significantly more than respondents in the category ‘more than X’.

Similarly, differences in the ranking of a mobile phone differ between income categories. Specifically, the highest income category ‘more than X’ differs significantly from all other income categories. Moreover, respondents that ranked *safe and fair working conditions* higher (in this case first or third) carry a higher NEP score than those who ranked it sixth.

As in the ranking of the t-shirt, females value *safe and fair working conditions* more than males for a refrigerator. Once more, differences between income categories show that respondents earning 'more than X' valued this requirement less than respondents in the income categories 'between X-X (lower end)' and 'between X-X (higher end)'. Finally, similar to all three product categories, significant differences occurred between the average NEP scores where respondents who rated this requirement first possessed a significantly higher NEP score than respondents who ranked it fifth.

Ethical responsibility

Similar to the ranking of *safe and fair working conditions* for a t-shirt, females value *ethical responsibility* higher than males. Between different income groups, it appeared that respondents in the category 'between X-X (lower end)' value this requirement significantly less than respondents who did not want to disclose their income.

In the ranking of the mobile phone, females again attribute more value to *ethical responsibility* than males.

The same difference is observed in the ranking of design changes to the refrigerator, where females rank the requirement significantly higher than males. Additionally, within the employment categories, self-employed respondents generally ranked *ethical responsibility* higher than retired respondents.

Information provision

In the ranking of *information provision* on a t-shirt, significant differences are manifested between males and females, where males attribute a higher value to the requirement. In the distribution among countries, Czechia is presented as an outlier in that it valued the provision of information significantly more than Ireland, Italy, the Netherlands, Poland, Spain and Sweden.

The availability of information on a couch is also valued significantly more by Czech respondents than Irish, Dutch, and Spanish respondents.

Again, in the ranking of the requirement for a mobile phone, Czech respondents place this requirement significantly higher in the ranking than Polish or Swedish respondents.

Consider differences and impact on communities

The importance assigned to this requirement in the ranking of a t-shirt reveals significant differences between countries. Specifically, in Czechia and France, this requirement is valued significantly less than in Italy, the Netherlands, Poland, Spain and Sweden.

In the ranking of a couch, Czech respondents again rank this requirement significantly lower than Italian, Dutch and Swedish respondents. In addition, German and French residents rank it significantly lower than Dutch residents. Also, significant differences exist between NEP categories. However, these differences can not be assigned to specific categories.

Significant differences exist between countries for the ranking of *differences and impact on communities* of the mobile phone. Nevertheless, these could not be attributed to specific countries. Additionally, males and females show a significant difference in their ranking, where females attribute more value to this requirement.

Differences between countries can again be observed in the ranking of the refrigerator, where Swedish respondents rank the requirement significantly higher than their Czech, German and French counterparts.

Job creation

For a t-shirt, the requirement *job creation* was valued significantly less by respondents who identified themselves with the gender category 'other' compared to other gender categories. Respondents from Sweden also ranked the requirement as less important than Germany, France, Ireland, Italy, Poland and Spain.

In the ranking of a couch, similar differences can be observed. The gender category 'other' again ranks *job creation* significantly lower and than all other gender categories. Also, Sweden presents itself as an outlier and differs significantly from Germany and Spain, ranking the requirement higher. In addition, 'secondary' educated respondents rank *job creation* higher than

respondents with a 'bachelor degree'. Finally, significant differences occur between the NEP scores of responses, however not between specific rankings.

Again in the ranking for the mobile phone, Swedish respondents rank the requirement significantly lower compared to Italy. Also, respondents educated to the 'post-secondary, non-tertiary level' attribute more value to *job creation* than respondents educated to a 'bachelor level'. Moreover, respondents who rated *job creation* second hold a significantly lower NEP score than respondents who rated the requirement sixth or seventh.

Also, for the ranking of design changes to the refrigerator, the average NEP differed significantly. Precisely, respondents who rated *job creation* first possessed a significantly lower NEP score than respondents who rated the requirement fifth, sixth, or seventh. Respondents who ranked it second also had a significantly lower NEP score than respondents who ranked it sixth or seventh. Furthermore, as in the mobile phone ranking, 'post-secondary, non-tertiary' educated respondents ranked this requirement significantly higher than respondents who have obtained a 'bachelor degree'. Finally, Spanish residents found the requirement more important than Irish and Swedish residents.

Cooperation between actors

In the case of a t-shirt, males ascribed significantly higher values to *cooperation* than females. Additionally, significant differences were detected between the ranking of the requirement and the NEP score. However, these differences could not be allocated to specific groups.

Also, males displayed to attach significantly higher values to the requirement for the ranking of a couch than females and respondents that identify as 'other'. Again, significant differences were observed between average NEP scores. Specifically, respondents who ranked *cooperation* fourth carried lower NEP scores than those who ranked the requirement sixth or seventh. Differences also appear between age categories where '51-60' rank the requirement significantly lower than '18-30' and '31-40'. Finally, the highest income category ranks the *cooperation between actors* significantly higher than lower-income categories.

From the mobile phone ranking, it can once again be concluded that males rank *cooperation* significantly higher than females. Also, respondents from the highest income category allocated more value to this requirement than respondents from the lowest income category or those who do not want to disclose their income. Between countries, there also appear to be significant differences. However, these differences do not occur between specific countries.

Finally, also for the ranking of the refrigerator, males allocated a higher value to this requirement than females. A difference in the ranking was also revealed between the education level 'secondary' and 'bachelor', where the former considers *cooperation* more important. The average NEP scores showed a significant difference where those who rated cooperation sixth possessed a higher NEP score than those who rated the requirement third.

7.3.2. Planet

Table 13. Correlations between demographic categories and the NEP scale and environmental requirements presented in order of their average ranking.

	Age				Gender				Country				Education				Employment				Income				NEP			
	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge
Durability				X					X	X	X	X					X			X								X
Limited use hazardous/unsustainable materials		X	X	X	X			X	X	X	X	X								X				X	X	X		X
Conservation/biocompatibility					X			X																				
Ease of repair and maintenance									X	X		X		X											X			
Reduction virgin resource use production																												
Use sustainable, reused/recycled materials																									X			
Reusability, recyclability, recoverability																		X						X	X			
Optimise end-of-life system					X				X																			X
Waste management		X		X												X		X								X		
Impact of transport and storage			X	X								X				X				X					X		X	X

[Green or empty boxes indicate no correlations were found between groups, blue or boxes marked with a X represent correlations.]

Durability

In the ranking of the *durability* for a t-shirt, significant differences between countries arose. Specifically, France ranked it significantly higher than Ireland and Spain. In turn, Spain ranked *durability* significantly lower than the Netherlands. Additionally, students appeared to have significantly less interest in durability than disabled respondents.

In the case of a couch, French respondents again ranked *durability* significantly higher than Spanish respondents.

Finally, in the ranking for the refrigerator, multiple significant differences were found. First, again, France allocated more value to *durability* than Spain. Second, the age group '41-50' rank this requirement significantly higher than the age group '18-30'. Third, 'full-time' working respondents value *durability* significantly more than 'unemployed' respondents. Fourth and final, the income category 'more than X' ranked this requirement significantly lower than respondents from the income categories 'between X-X (lower end)' and 'between X-X (higher end)'.

Limited use of hazardous and/or unsustainable materials

Correlations between demographic categories and the ranking for a t-shirt reveal that females rank this requirement significantly higher than males. In addition, respondents who ranked this requirement first carried a significantly higher NEP score than respondents who ranked it fifth.

In the ranking of the couch, significant differences were found between age groups and countries. On average, the *use of hazardous and/or unsustainable materials* was valued significantly more by the age group '51-60' than by the age category '18-30'. Italian residents also ranked this requirement significantly higher than their Czech counterparts. Finally, significant differences were found between the placement of the requirement and the average NEP score, however not between specific groups.

In the design of a mobile phone, age groups again showed significant differences in their rankings. Higher values were attributed to the requirement by older generations. Specifically, '61+' showed significant differences with '18-30', '31-40', and '41-50' and '51-60' showed significant differences with '18-30'. Also similar to the ranking of the couch, Italy attributed significantly more value to the *use of hazardous and/or unsustainable materials* in comparison to Poland.

In the ranking of the refrigerator, multiple significant differences were revealed. First, again older generations valued this requirement significantly more. The age categories '51-60' and '61+' showed significant differences with all younger age categories. Second, the gender category 'other' ranked this requirement exceptionally high. Third, French respondents rated the *use of hazardous/unsustainable materials* significantly lower than Italian and Swedish respondents. Fourth, 'retired' respondents ranked the requirement higher than 'full-time' working respondents or 'students'. Here it could be argued that this correlation aligns with the correlations found between the age groups. Fifth, respondents who did not want to disclose their income cared more for the *use of hazardous/unsustainable materials* than respondents in the category 'between X-X (higher end)'. Ultimately, respondents who ranked this requirement as most important identified themselves with a significantly higher NEP score than respondents who placed the requirement fifth or sixth.

Conservation/biocompatibility

Both for the ranking for a t-shirt and a refrigerator, slight variances exist among demographic categories. Significant differences for both rankings did solely arise between gender groups, but these could not be ascribed to specific groups.

Ease of repair and maintenance

The ranking of *ease of repair and maintenance* for a t-shirt differed significantly between countries. In particular, Czechia and France were more akin to this requirement. Czechia differed significantly from Germany, Ireland, Spain and Sweden. France revealed significant differences with Ireland, Italy, the Netherlands, Poland, Spain, and Sweden. Also, in the correlation with the average NEP score, significant differences were found between respondents who ranked it first and those who ranked this requirement second, fourth, ninth, or tenth. Here the latter groups maintain a higher NEP score.

In the case of a couch, significant differences were found between Czech and Swedish respondents. Specifically, Czech respondents generally rank *ease of repair and maintenance* higher, as seen in the ranking for a t-shirt.

In ranking this requirement for a mobile phone, significant differences existed between subsets of educational categories but not between educational categories themselves.

For the *ease of repair and maintenance* of a refrigerator, again significant differences between countries arose. However, this time it were Irish, not Czech, respondents who ranked the requirement significantly higher than Swedish and Polish respondents.

Reduction in (virgin) resource use during production

For none of the products groups, significant differences appeared between demographic categories or average NEP scores.

Use of sustainable and/or reused/recycled materials

In the ranking of a t-shirt, a significant difference in NEP scores among the respondents can be detected. However, this difference can not be ascribed to specific groups.

Reusability, recyclability, recoverability

In the placement of this requirement for a couch, significant differences were found between employment groups and NEP scores. However, to both significant differences, it applies that these differences occur generally and not between specific groups.

For the ranking of a refrigerator, significant differences emerged between income categories. Precisely, the lowest income category significantly differed from the second-lowest income category, where the former generally ranked the requirement higher.

Optimise end-of-life system

The optimisation of the end-of-life system is ranked significantly higher for t-shirts and mobile phones. More specifically, within the ranking of this requirement for a t-shirt, a significant difference arises between France and Ireland, where Irish respondents value this requirement more than French respondents.

In the ranking of a couch, males value the *optimisation of the end-of-life system* significantly more than females.

For the ranking of a refrigerator, significant differences between the NEP scores arose. However, these NEP scores differed overall and not between specific categories.

Waste management

Concerning a couch, there was a significant difference between the oldest and the youngest age groups where '18-30' ranked the requirement significantly higher than '61+'. Additionally, there appeared to be a significant difference between the average NEP scores of respondents that ranked it second and those that ranked it in the eighth, where the latter carries a higher NEP score.

In the case of a mobile phone, unemployed residents ranked *waste management* significantly higher than retired residents.

As in the ranking of a couch, '18-30' ranked *waste management* significantly higher than '61+' for a refrigerator. In addition, looking at educational attainment categories, those having received 'other' education rank the requirement significantly higher than those having obtained short-cycle tertiary education.

Impact of transport and storage

Within the ranking for a t-shirt, a significant difference was found between NEP scores where those who ranked the *impact of transport and storage* second carried a significantly lower NEP score than those who ranked it third.

The requirement was ranked significantly higher by the age category '18-30' than by the category '61+'. Also, significant differences could be detected between the average NEP scores. Specifically, respondents who ranked this requirement third possessed a significantly lower NEP score than respondents who placed it fifth, eighth, ninth, or tenth.

Within the ranking of the *impact of transport and storage* for a refrigerator, various significant differences occurred. First, the age category '18-30' ranks this requirement significantly higher than the age category '61+'. Second, Dutch respondents value this requirement more than French respondents. Third, respondents having received 'short-cycle tertiary education' value the *impact of transport and storage* less than respondents who have received 'other' education. Fourth, significant differences occurred between employment categories, however, not between specific categories but between subsets of categories. Fifth, average NEP scores differ between respondents who ranked this requirement first and those who rank it seventh or ninth, where the former group carries a lower NEP score.

7.3.3. Profit

Table 14. Correlations between demographic categories and the NEP scale and economic requirements presented in order of their average ranking.

	Age				Gender				Country				Education				Employment				Income				NEP			
	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge	T-shirt	Couch	Phone	Fridge
Replacement fashion/technology											X			X					X									
Financial/regulatory arrangements			X	X		X	X		X	X	X	X							X	X	X					X		X
Optimise usage by PSS				X		X			X	X	X	X		X								X			X	X		X

[Green or empty boxes indicate no correlations were found between groups, blue or boxes marked with a X represent correlations.]

Replacement because of fashion or technology

Within the ranking of a couch, no significant differences did arise with one exception: there does appear to be a significant difference between education attainment levels, however not between specific levels.

In the ranking of a mobile phone, significant differences can be found between countries and employment categories. Here, respondents from the Netherlands rank this requirement

significantly lower than respondents from Poland. Additionally, 'homemakers' value this requirement significantly less than 'self-employed' and 'unemployed' respondents.

Financial and/or regulatory arrangements

In the ranking for a t-shirt, Ireland placed *financial/regulatory arrangements* significantly lower than France and Sweden. Additionally, respondents with lower incomes value this requirement more than respondents with higher incomes.

In the design of a couch, males and females differ significantly in their value attribution to this requirement, where females ranked it higher. Additionally, a significant difference did occur between countries, however not between specific countries. Also, the answers showed significant differences with the average NEP scores, where respondents who rated this requirement first carry a significantly higher NEP score than respondents who rated this requirement last (third).

The mobile phone ranking showed a difference between '18-30' and '41-50', where the latter ranks *financial/regulatory arrangements* significantly higher. As with the design of a couch, females cared more for this requirement than males.

In the case of a refrigerator, this requirement was especially valued by the age category '41-50' compared to the age group '18-30'. In France, this requirement was valued significantly more than in Czechia. Within the employment categories, 'homemakers' ranked this requirement significantly higher than respondents in the 'other' category. Finally, when comparing the average NEP scores of the rankings, respondents who rank *financial and/or regulatory benefits* first possess a higher NEP score than respondents who rank the requirement last (third).

Optimise usage by PSS

The ranking of the t-shirt reveals that German respondents value this requirement significantly less than Dutch, Polish, and Irish respondents. In turn, Ireland ranked the requirement significantly higher than France. Additionally, respondents that rated this requirement first possessed a significantly lower NEP score than respondents who rated this second or third.

In the ranking for the couch, significant differences between males and females were revealed, where males valued the requirement more. Like the ranking of a t-shirt, Irish respondents valued the *optimisation of usage by PSS* exceptionally high, compared to German and French respondents. Correlations with the average NEP scores show that respondents who ranked this requirement first carried a significantly lower NEP score than those who ranked it third.

Correlations between the country of residence and the ranking of a mobile phone again show that Irish residents value leasing or renting products more than Spanish residents. Furthermore, Dutch respondents ranked the requirement significantly higher than French, Italian, Polish, and Spanish respondents. Another significant difference was found between educational categories where respondents who have obtained 'other' education ascribed more value to the requirement than respondents education to a 'secondary' level. Finally, between income groups, there appeared to exist a significant difference between subsets of categories.

Within the ranking of the refrigerator, it was revealed that respondents aged '18-30' valued this requirement significantly higher than respondents aged '41-50'. Between countries, multiple significant differences were found. Again Irish respondents valued the availability of leasing or renting a refrigerator exceptionally high in comparison to Polish, French, and Italian residents. Italy showed a lower average ranking than Czechia, Germany, and the Netherlands. Moreover, the Netherlands ranked the requirement significantly higher than France. Finally, the average NEP score of respondents who rated *optimise usage by PSS* third was significantly higher from respondents who rated the requirement first or third.

7.4. Concluding remarks

This research has established a comprehensive list of DfS requirements from academic literature. Consequently, besides the more common approach of analysing perspectives of policymakers and civil society organisations towards DfS requirements, this research has included the perspective of residents and has thus surpassed the common technocratic approach to eco-design and DfS. Having discussed the viewpoints of the three stakeholders towards each requirement, the foundation is established for a comparison between these viewpoints. The analysis of the

similarities and differences in the valuation of the requirements is the final step in answering the research questions and is the subject of the next chapter. Additionally, from the results of this chapter, it can be concluded that DfS requirements are valued differently across the four product types and demographic categories. Possible explanations for these differences in valuation are also discussed in the next chapter.

8. Interpretation and comparison of results

This chapter integrates the results of the survey, interview, and content analysis. This integration is performed to determine how the values towards the DfS requirements of residents, consumer organisations, and policymakers align. The first aim of this section is thus to answer the core question: *How do EU residents value requirements for Design for Sustainability?* Hereafter an answer is provided to question B: *To what extent do the positions towards Design for Sustainability requirements of EU consumer organisations and EU residents align?* Lastly, the answer to question C is provided: *To what extent does the valuation of Design for Sustainability requirements of EU residents align with current Directives?*

The chapter is structured as follows: the value EU residents attribute to the DfS requirements is presented and the difference in valuation between demographic categories is evaluated first (core question). Consequently, the most apparent similarities and discrepancies between the valuation of DfS requirements by residents and consumer organisations and between residents and EU policy are discussed (questions B and C).

8.1. Valuation of DfS requirements by EU residents

The main aim of this study was to answer the following research question: *How do EU residents value requirements for Design for Sustainability?* To provide an answer to this question, first, a review of academic literature was conducted to arrive at a common understanding of DfS requirements (Chapter 4). The resulting list of DfS requirements served as input for the survey's ranking questions, which in turn served to provide an answer to the core research question. According to their allocation to the people, planet or profit aspect of sustainability, the most interesting observations are presented below. The correlations that are discussed in this section can be found in more detail in section 5.4.1. to 5.4.3.

People

Within the ranking of the social requirements, it was found that *operational safety and efficiency* or *safe and fair working conditions* were ranked highest depending on the product group. Overall, *operational safety and efficiency* was valued more by older generations (> 41 years old). This finding can be related to research on the adverse effects of long-term, low-level exposure to environmental substances of older residents. These studies show that older people are not as resistant to certain substances as younger generations, and as a consequence, older generations could pay more attention to the safety of products (Risher et al., 2010).

The current study found that the requirement *safe and fair working conditions* was generally placed higher in the ranking by people with a higher NEP score, meaning those who are more environmentally aware. Additionally, females care more for *safe and fair working conditions* and *ethical responsibility* (which was placed high in the ranking as well) than males. These findings align with previous studies that indicate that females are generally more environmentally aware, also termed the "eco gender gap" (Mintel, 2018; Swim et al., 2018). However, while the results of this study show that females generally possess a higher NEP score, this score was not significantly higher than the score of other gender categories. Another reason why females may score *safe and fair working conditions* and *ethical responsibility* higher than other gender categories could be that women have a greater tendency to be prosocial, altruistic, and empathetic. Research suggests that women feel more socially responsible, leading them to care more about environmental problems and consequently adopt environmental behaviours (Swim et al., 2018).

This study shows that *job creation* and *cooperation between actors* are placed at the lower end of the ranking. Here two observations can be made. First, *job creation* is considered less important for residents with a bachelor degree than residents belonging to other educational attainment categories. This finding could be a consequence of the confidence in obtaining a job more easily when possessing a higher educational degree. Second, males value *cooperation between actors* significantly more than females. This result is in agreement with the gender discussion in the previous paragraph. Research suggests that while females care more for ethical and environmental justice, males have a more positive attitude towards business and science

arguments of climate change (Swim et al., 2018). Here, *job creation* and *cooperation between actors* are social requirements related to enhancing business processes.

Planet

The ranking of the environmental requirements revealed that EU residents highly valued *durability* and *the use of hazardous and/or unsustainable materials*. Furthermore, similar to *operational safety and efficiency*, *the use of hazardous and/or unsustainable materials* was valued more by older generations. Again, this could be explained by a lower resistance to such substances and, therefore, more attentiveness to this requirement (Risher et al., 2010).

The results of this study show that French residents particularly value *durability*. Similarly, French residents also value *ease of repair and maintenance* higher than other EU residents. A potential explanation for these correlations could be the implementation of a reparability score on certain products in France since the 1st of January 2021. Furthermore, from the interview with a French consumer organisation (16th of March 2021), it was found that the possibility of implementing a durability score is also being discussed in the country. As a result of the familiarity with these assessments, French residents may see more value in easier repair and maintenance and consequently better durability of products. With regard to *ease of repair and maintenance*, it should be noted that this requirement was ranked significantly lower for a t-shirt (8th) than for the other product groups (3rd). This could potentially be a consequence of the financial investment made for a couch, mobile phone, and refrigerator, as well as the lifetime of such products. Another explanation could be that clothing is generally easily repairable, and as a result, this not recognised as essential to consider for designers.

The requirements *waste management* and *impact of transport and storage* were ranked lowest in the environmental ranking. Specifically, across product groups, it was found that the youngest age category (18-30) valued these requirements higher than the oldest age category (61+). This could possibly be due to the increase in packaging, and consequently waste, over time where younger generations are much more accustomed to recycling and treating their waste. The positive attitude of younger generations towards waste management is supported by previous research and can be explained by more awareness of waste separation (Stępień, Wadowski & Żurkowski, 2013). Additionally, the positive attitude of younger generations towards practices such as waste management can be explained by the upsurge of education on environmental problems (Corcoran & Osano, 2009).

The interest in the *impact of transport and storage* could be a consequence of global developments where production and consumption have increasingly become separated in space. As a result, international transport is one of the main consequences of globalisation processes and it has a significant environmental impact (Köhler, 2014). Additionally, it has been found that younger generations generally identify themselves as more supranational (Jung, 2008) and consequently, they could also be more aware of the origin of their purchases. Hence, younger generations may realise that the origin of a product influences the distance of transport and thereby the environmental impact of the product sooner than older generations who are less accustomed to global supply chains.

Profit

Depending on the product group, *the replacement because of fashion or technology* and *financial and/or regulatory arrangements* were the highest valued economic requirements. *The replacement because of fashion or technology* was ranked first for t-shirts and mobile phones, which could be explained by a larger dependence on appearance. This means that buying new t-shirts can primarily be motivated by fashion trends and buying a new mobile phone can be driven by technological advancements. Research suggests that the emergence and rapid dissemination of the fast replacement of products are frequently attributed to socio-cultural changes and that consumers feel the need to adapt to this reality. Consequently, the adaptation to fast-changing trends becomes a part of a person's personality and residents might feel "left out" when not in possession of the newest products (Barnes et al., 2013). This feeling of being "left out" was also discussed in the interviews as part of premature obsolescence. As seen from the ranking, this

phenomenon is less of an issue with a couch and a refrigerator, where the image could play much less of a role.

This argumentation is also reflected in the ranking of a couch and refrigerator, where *financial and/or regulatory arrangements* are considered more important than fashion and technology. Instinctively, *financial and/or regulatory arrangements* are placed exceptionally high by residents belonging to lower-income categories. The fact that the requirement *financial and/or regulatory arrangements* is placed higher for a couch and refrigerator can also be explained by the higher investments that these products require. Additionally, a couch and refrigerator are products that last long and consequently, residents could feel an investment in these products could lead to higher durability of the product.

Across all product groups, it was found that the possibility to *optimise usage by PSS* was valued least. This could be because PSS is a relatively new concept and it is often recognised that many barriers exist. For example, renting or leasing products often requires more time and money. Additionally, it requires a different mindset from its users, one that up until recently is mostly focused on possession instead of sharing.

Concluding remarks

Overall, EU residents value the following requirements the most: durability, the limited use of hazardous/unsustainable materials, operational safety and efficiency, safe and fair working conditions, replacement because of fashion and technology, and the availability of financial or regulatory arrangements.

Requirements that were valued the least by residents are the impact of transport and storage, waste management, job creation, cooperation between actors, and the optimisation of usage by PSS.

Between product groups, differences can be observed in the valuation of the requirements. These differences often align with the characteristics of the product group, e.g. durability is ranked higher for products that require higher investments and are supposed to last long. Additionally, differences in ranking between demographic categories have been found that can be connected to previous research and characteristics of these categories.

8.2. Alignment with consumer organisations

As discussed in the theory section (2.2.), residents are not the most powerful agents in the value chain of products. Hence, they require representation of their interests in national and international decision-making processes. Accordingly, it is deemed relevant to compare public attitudes with the work put forward by consumer organisations and thereby provide an answer to subquestion B: *To what extent do the positions towards Design for Sustainability requirements of EU consumer organisations and EU residents align?* The most important observations will be discussed again for each people, planet, and profit.

People

Operational safety and efficiency is considered an essential social requirement according to residents and is similarly found to be at the core of the work of consumer organisations. Consumer organisations exist to protect residents and hence, in their opinion, the safety of products is imperative for products to be placed on the market. The (energy) efficiency of products is also commonly included, which can be traced back to the early conceptions of eco-design and the existence of energy labels.

While attitudes towards *operational safety and efficiency* align well, the same can not be concluded for the requirements *safe and fair working conditions* and *ethical responsibility*, which EU residents highly value. While consumer organisations are aware of the problems related to working conditions within value chains of products, not much effort is taken in researching these problems due to resource constraints. According to consumer organisations, these requirements are critical in the value chains of clothing pieces, as reflected in the rankings for a t-shirt. Here consumer organisations and residents thus seem to identify similar problems in these value chains.

The efforts taken towards *ethical responsibility* are not in line with the value allocated to this requirement by residents. Residents rank *ethical responsibility* reasonably high, while consumer organisations do not pay much attention to this requirement.

Job creation and *cooperation between actors* are found at the lower end of the rankings. Comparing these rankings with the positions of consumer organisations, the following observations can be made. In line with public attitudes towards the requirement, *job creation* is not included in the work of consumer organisations. It is considered a part of a circular or service-oriented economy but no concrete actions are taken to stimulate more jobs.

While *cooperation between actors* is generally considered not to be important to EU residents, it is deemed to be very valuable to consumer organisations. However, a disparity in conceptions of the requirements could be the cause of this discrepancy. In literature, and as communicated to residents, *cooperation between actors* is understood to further the collaboration between different types of actors to stimulate the exchange of information and expertise and use this in developing a product. While consumer organisations acknowledge these aspects of the requirement, cooperation is a tool to carry out their work and save resources. Nevertheless, most consumer organisations stipulate the importance of sharing their market information for product development. Thus, while the perceptions of the concept largely overlap, consumer organisations perceive *cooperation* as a more limited concept that is essential in their direct work and less critical in product development.

Planet

This study shows that both residents and consumer organisations consider *durability* the most critical requirement in sustainable product design. *Durability* encourages resource efficiency as fewer products would need to be replaced. Nevertheless, *durability* could have little impact when not decoupled from premature obsolescence (discussed in more detail later).

The *use of hazardous and/or unsustainable materials* contains two parts that are treated differently by consumer organisations. The use of *hazardous materials* is a common concern in product testing, although differences in their importance can be found between countries. It is also noted that while regulations exist on the safety of materials, consumer organisations have the advantage to go beyond regulation and include more materials that pose a risk to human health or the environment. While the *use of hazardous materials* is believed to be detrimental to sustainable design and human health, the *use of unsustainable materials* is rarely addressed in product assessments. Naturally, some materials can be both hazardous and unsustainable, but consumer organisations focus on human health hazards of the materials and therefore not the sustainability aspects. Since the use of both hazardous and unsustainable materials are combined in one requirement, no conclusions can be drawn on whether residents value hazardous and unsustainable materials equally or, similar to consumer organisations, attach more value to either hazardous or unsustainable material use. Nevertheless, considering the importance that residents attribute to the requirement and the importance consumer organisations attribute to the use of hazardous materials, valuations towards the requirement broadly align.

Overall, *ease of repair and maintenance* was ranked relatively high (except in the design of a t-shirt) and also consumer organisations have significant commitments to this subject. Nevertheless, consumer organisations differ significantly in the value they attribute to this requirement as some recognise it can be complicated for residents. Consumer organisations agree that repairability could contribute to the durability of a product but that durability should always be most important in the design of products. The priority given to durability is also reflected in the ranking by residents.

Similar to the ranking by residents, *waste management* and *impact of transport and storage* are subjects consumer organisations do not focus their attention on. Here it can thus be concluded that public attitudes align well with the positions of consumer organisations. Regarding the *impact of transport and storage*, one note should be made. Namely that multiple consumer organisations make use of LCAs in their environmental assessments of products. Depending on the scope of the LCA, the impact of transport and storage is commonly taken into account in this method (Finnveden et al., 2009). Hence, it could be argued that consumer organisations who use LCAs as

a methodology take into account the *impact of transport and storage* even though they do not directly inform consumers of this impact.

Profit

In line with the value residents allocate to *replacement because of fashion and technology*, consumer organisations consider this an important design requirement. They address the topic primarily in the form of premature obsolescence. More specifically, consumer organisations work together on an EU level to combat premature obsolescence by developing methodologies to assess the lifetime of products (PROMPT project). Also, in their direct communication to residents, consumer organisations address the need for the replacement of products (especially for electronic products). From the ranking, it can be observed that this requirement is essential for products connected to reputation, such as clothing and mobile phones. This aligns well with the product groups consumer organisations focus on.

Consumer organisations consider *financial and regulatory arrangements* as appropriate methods to stimulate the uptake of sustainably designed products. However, regulatory and financial arrangements are for a large part considered to be the responsibility of national or supranational governments. Consequently, the value attributed to this requirement does not entirely align with the efforts of consumer organisations.

A discrepancy can be found between the attention given to *optimising usage by PSS* by consumer organisations and the valuation of this requirement by residents. PSS is a common subject within consumer organisations and is recognised as an essential step in the transition to a CE. Simultaneously, as can be concluded from the public attitudes towards PSS, consumer organisations admit that many barriers are yet to be overcome to adopt PSS successfully. Nevertheless, PSS remains a commonly discussed subject within consumer organisations while residents indicate not being ready for this transition yet.

Alignment

Across sustainability facets, it can be concluded that the work of consumer organisations aligns well with the attitudes of residents towards DfS requirements. This could result from frequent interaction between consumer organisations and residents as well as the market research conducted by consumer organisations. Nevertheless, looking at the interest of EU residents in requirements such as *safe and fair working conditions* and *ethical responsibility*, consumer organisations could commit more resources to these subjects to provide residents with more information on social aspects. The limited amount of attention given to these social requirements could also be attributed to the difference between ecodesign and DfS. As resulted from the understanding of consumer organisations of theoretical concepts (section 5.2.), many organisations are unfamiliar with DfS and have a better understanding of eco-design. Eco-design is generally understood as the political framework, which is based on eco-design principles and thus more on environmental aspects. Moving from eco-design to DfS, social requirements such as *safe and fair working conditions* would attain equal value as environmental requirements and would thus become more important.

Another aspect where significant discrepancies between the two stakeholders can be found is in the valuation of PSS. While consumer organisations consider this a relevant requirement, the rankings show that EU residents do not value this. Nevertheless, it should also be noted that it could be relevant to prepare residents for changes in business models in light of political developments towards CE (such as the CE Action Plan).

A summary of the alignment between the valuation of DfS requirements by residents and by consumer organisations is presented in table 15.

Table 15. Summary of the average ranking of DfS requirements by EU residents, the valuation of these requirements by consumer organisations and the alignment of viewpoints between the two stakeholders.

Average ranking European residents	Valuation consumer organisations	Alignment consumer organisations
People		
1. Operational safety and efficiency	★★★	★★★★
2. Safe and fair working conditions	★★	★★
3. Ethical responsibility	★	★
4. Information provision	★★★	★★
5. Consider differences and impact on communities	★	★★
6. Job creation	★	★★★★
7. Cooperation between actors	★★	★
Planet		
1. Durability	★★★	★★★★
2. Limited use of hazardous/unsustainable materials	★★	★★
3. Conservation/biocompatibility	★	★
4. Ease of repair and maintenance	★★★	★★
5. Reduction of (virgin) resource use during production	★★	★★★★
6. Use of sustainable, reused/recycled materials	★	★★
7. Reusability, recyclability, recoverability	★★	★★★★
8. Optimise the end-of-life system	★	★★★★
9. Waste management	★★★	★
10. Impact of transport and storage	★	★★★★
Profit		
1. Reduce replacement because of fashion/technology	★★★	★★★★
2. Financial and/or regulatory arrangements	★★	★★★★
3. Optimise usage by PSS	★★	★
★ = recognise requirement, do not work on it	★ = does not align well	
★★ = work on requirement to a limited extent	★★ = aligns fairly well	
★★★ = work on requirement a lot	★★★★ = aligns well	

8.3. Alignment with EU policy

As presented in the introduction, this study aimed not just to provide an overview of which DfS requirements are valued most by EU residents but ultimately to provide input to the EU political agenda on DfS. In order to formulate such recommendations, an analysis of current Directives in relation to public attitudes is required. Subquestion C is intended to provide this analysis: *To what extent does the valuation of Design for Sustainability requirements of EU residents align with current Directives?* Observations are again structured according to the allocation of people, planet or profit.

People

The study found that *operational safety and efficiency* is a core subject of multiple Directives. In these Directives, operational safety is understood primarily as human health. Particularly the REACH and RoHS Directive focus on the use of hazardous substances and their consequences to human (and environmental) health. Legislation on *operational safety* has developed considerably and has included more materials over time in light of precaution. Nevertheless, materials that can impede operational safety might still be present in products if no suitable substitutes are found. The efficiency of products is addressed in the Ecodesign Directive and the Energy Labelling Directive. Energy efficiency is approached by setting energy efficiency targets and it is not about empowering residents to use their appliances in a more energy-efficient manner (see operationalisation of the requirements in Appendix II-B). The Ecodesign Directive also includes the efficient use of other resources such as water. However, since these requirements are relatively new (2019), they are applied only to a limited number of products.

Safe and fair working conditions are valued high by residents across product groups but are addressed only to a limited extent in Directives. *Safe and fair working conditions* form the core of

the OHS Directive and are shortly discussed in other Directives. However, from the literature and interviews, it can be derived that problems with regard to working conditions occur mainly in countries outside the EU. Directives address workers' rights but solely within their jurisdiction. While this can be considered only natural, no obligations are set for e.g. the working conditions from which materials are sourced.

Contrary to definitions in the literature and the understanding of interviewees, Directives address *ethical responsibility* primarily in terms of animal testing, wherefore multiple restrictions are set. Related to this narrow focus on *ethical responsibility*, Directives do not include limitations on levels of harm that a product can cause to its users.

Information provision is an essential part of EU legislation on sustainably designed products which aligns with the attention given to this by consumer organisations. *Information provision* is addressed mainly in the context of labels and certifications for which strict communication guidelines exist. Nevertheless, residents do not value this requirement particularly high, which can be a consequence of an already adequate amount of information. A slight discrepancy can thus be found in the value allocated to this requirement.

On the lower end of the ranking are the requirements *job creation* and *cooperation between actors*. Apart from providing adequate training to workers in for example the OHS Directive, the former is not specifically mentioned in legislation. In literature, *job creation* is linked to the transition to a CE which is not yet part of Directives. Hence, the limited discussion of *job creation* could be explained by the absence of service economy principles in Directives.

Similar to the approach of consumer organisations, *cooperation between actors* is stimulated primarily to reach objectives set in the Directives, e.g. sharing knowledge on market surveillance. However, the establishment of networks across the value chain is stimulated and promotes the cooperation between different types of actors such as researchers and producers. However, no precise or obligated requirements are set for these initiatives. Nonetheless, the value attributed to *cooperation between actors* in Directives broadly aligns with the valuation of residents.

Planet

Durability is regulated in Directives and perceived as a means to reduce waste and enhance resource efficiency. As in the interviews, *durability* is often linked to repairability (discussed later in this section) and upgradeability and Directives state that a minimum guaranteed lifetime would advance the durability of products. However, no requirements are set for the *durability* of products, except that LED and OLED lamps need to undergo endurance tests. Furthermore, it is stated that upgrades should not affect the performance of the product. While *durability* is discussed in Directives, it can not be regarded as the most important subject, while to residents and consumer organisations, it is the most crucial requirement in the sustainable design of a product. Also, since almost no obligations exist for the durability of a product, a misalignment can be observed between efforts in Directives and values of EU residents.

The *use of hazardous materials* is a commonly discussed subject in Directives (primarily the REACH and RoHS Directives) which is in accordance with residents' value allocation. The *use of unsustainable materials* is, however, not mentioned in Directives. This is similar to the attention given to this subject by consumer organisations. However, as indicated earlier, while this could be considered a misalignment, it could also be a consequence of synthesising these two types of materials in one requirement.

The ultimate aim of most Directives is to reduce emissions and pollution as well as conserve the level of biodiversity. *Conservation and biocompatibility* can thus be considered a core subject in policy. When comparing this to the relative importance residents allocate to this requirement, alignment can be found between the values of political and public actors.

From the analysis of *ease of repair and maintenance* can be concluded that the requirement is relatively important to both residents and policymakers. As previously mentioned, repair and maintenance is linked to durability because of its effect on product lifetime. In the Directives, *ease of repair and maintenance* involves many sub-requirements, such as the availability of spare parts and maximum disassembly time. The revisions of the Ecodesign Directive have included obligations for these sub-requirements for multiple product groups, among

which are refrigerators. *The ease of repair and maintenance* is considered to be reasonably important to residents (and especially important for products such as refrigerators). Consequently, the increase in attention given to the subject in Directives aligns well with the valuation of the requirement by residents.

Contrary to the valuation of residents, *reusability, recyclability, and recoverability* are widely discussed in (waste) Directives to significantly affect products' environmental impact. Misalignment between the valuation of this requirement by policymakers and residents can thus be found.

Linked to the facilitation of reusing, recycling, and recovering processes, the *optimisation of end-of-life systems* is not valued high by residents. The optimisation of these systems is discussed in policy, but not in detail. Instead, extended producer responsibility is discussed and additional discussions are primarily connected to *reusability, recyclability, and recoverability*. Thus, while the valuation of *optimisation of end-of-life systems* aligns between residents and Directives, the latter approaches the subject primarily in the context of reusing, recycling and recovering materials.

Waste management is a common concern in (waste) Directives and is connected to the two requirements discussed above. However, in the valuation of residents, *waste management* was considered one of the least important requirements. Hence, a discrepancy between public and political opinions can be found.

The impact of transport and storage is not highly valued by residents and is discussed to a minimal extent in the Directives analysed. Misalignment can thus be observed.

Profit

The *replacement because of fashion and technology* is important to EU residents, especially for t-shirts and mobile phones. However, this requirement is discussed only to a limited extent in policy. In Directives no notions on subjects such as premature obsolescence can be found. The only suggestion that is made is that labels should move at the same pace as technological progress. Here it can thus be concluded that the interests of residents and policymakers do not align.

The interest in *financial and/or regulatory arrangements* is aligned with the content of Directives. This is coherent with the role of policy in that *financial and/or regulatory arrangements* often need to be executed by policymakers. A variety of financial and regulatory instruments are used to stimulate residents to buy more sustainably produced products. Many arrangements are also addressed to business actors to improve market conditions for sustainably designed products.

The *optimisation of usage by PSS* was valued extremely low by EU residents and in policy, no notion on the subject was found. Hence, the opinions of residents and policymakers align.

Alignment

Based on the results, it can be concluded that the attitudes of EU residents generally align with the subjects of the Directives analysed in this study. This could be explained by the inclusion of public attitudes in policy development. However, when distinguishing between obligated requirements and suggestions made in Directives, it can be seen that this alignment becomes less robust. Multiple discrepancies can be found between the attitudes of EU residents and the content of Directives. First, requirements related to waste management, recycling, and the treatment of products at the end of life are widely discussed in Directives but not valued highly by residents. Second, similar to the misalignment between opinions of residents and consumer organisations, the requirement *safe and fair working conditions* is valued exceptionally high by EU residents. Nevertheless, a limited number of obligations are set for this requirement. As previously mentioned, this could also be a consequence of the more narrow focus of policy which is focused mainly on eco-design, and thus more on environmental requirements, instead of on DfS which includes social and economic requirements. A summary of the alignment of valuation of the requirements by EU residents and Directives is presented in table 16. Recommendations on how to improve alignment in the valuation of requirements are presented in the next chapter on policy recommendations.

Table 16. Summary of the average ranking of DfS requirements by EU residents, the valuation of these requirements in European Directives and the alignment of viewpoints between the two stakeholders.

Average ranking European residents	Discussed in policy	Alignment with Directives
People		
1. Operational safety and efficiency	★★★	★★★★
2. Safe and fair working conditions	★★	★★
3. Ethical responsibility	★	★★
4. Information provision	★★★	★★
5. Consider differences and impact on communities	★★	★★★★
6. Job creation	★	★★★★
7. Cooperation between actors	★★	★★
Planet		
1. Durability	★★	★★
2. Limited use of hazardous/unsustainable materials	★★	★★
3. Conservation/biocompatibility	★★★	★★★★
4. Ease of repair and maintenance	★★	★★★★
5. Reduction of (virgin) resource use during production	★	★★
6. Use of sustainable, reused/recycled materials	★	★★
7. Reusability, recyclability, recoverability	★★★	★★
8. Optimise the end-of-life system	★★	★★
9. Waste management	★★★	★
10. Impact of transport and storage	★★	★★
Profit		
1. Reduce replacement because of fashion/technology	★	★
2. Financial and/or regulatory arrangements	★★★	★★
3. Optimise usage by PSS	X	★★★★

★ = recognised, suggestions are given ★ = does not align well
★★ = some obligations but mostly suggestions ★★ = aligns fairly well
★★★ = multiple obligations ★★★ = aligns well

8.4. Theoretical implications

Now that an answer has been provided to the research questions, the relevance of these findings for science is evaluated. This relevance has become evident by developing a comprehensive list of DfS requirements and exploring their relative importance for different product groups according to EU residents, consumer organisations, and policymakers. First, by creating a comprehensive list of DfS requirements, this study contributes to eco-design developments by expanding the perspective through DfS and broadening the set of design criteria. Second, contrary to previous research that has focused on a limited number of requirements, this research establishes the relative importance of each requirement by developing a ranking. Here it can be observed that requirements that are frequently named in literature can also be found to be more important to residents than requirements not mentioned often. For example, durability is a commonly named requirement and essential to residents. Similarly, job creation is named less often and ranked low. Third, previous studies on eco-design or DfS requirements have commonly focused on one product type. This study has included four different product types by developing a matrix based on product complexity and product lifetime. Hence, this research provides an analysis of the relative importance of DfS requirements for different product groups and here, differences can be observed. For example, repair and maintenance is less important for t-shirts and durability is more important for products that require a large investment. Fourth, this research takes into account the perspective of multiple stakeholders but most importantly, where previous research has focused on the perspective of industry or governments, this research has broadened its scope to include the perspective of residents. This extension of scope is relevant as not merely consumers experience the negative externalities from resource consumption but society as whole. Consequently, the perspective of all residents on DfS requirements are considered relevant and add to the knowledge and perspectives on DfS in theory.

In this section, the contribution of this research to the theoretical field of DfS has been presented. However, the implications of this research reach further than theory and as previously stated, the ultimate goal of this research is to provide input for the political agenda on DfS. To provide this input, the policy recommendations that follow from the evaluation of the alignment of perspectives are presented in the next chapter.

9. Policy recommendations

As stated in the introduction, this research aims to provide input for the EU political agenda on DfS. A comparison of the valuation of DfS requirements of the three stakeholders included in the research is presented in table 17. Using this comparison, recommendations to stimulate the uptake of DfS within policy and consequently within society are formulated. Policy recommendations are discussed for requirements where misalignment between valuation can be found or where additional efforts may be beneficial. Additionally, considering the role consumer organisations have in society (section 5.1.), the part they can play in these recommendations is addressed. The chapter is again structured according to the sustainability aspects: people, planet and profit.

Table 17. Alignment of valuation of DfS requirements between residents and consumer organisations and between residents and the content of EU Directives.

Average ranking European residents	Alignment consumer organisations	Alignment with Directives
People		
1. Operational safety and efficiency	★★★	★★★
2. Safe and fair working conditions	★★	★★
3. Ethical responsibility	★	★★
4. Information provision	★★	★★
5. Consider differences and impact on communities	★★	★★★
6. Job creation	★★★	★★★
7. Cooperation between actors	★	★★
Planet		
1. Durability	★★★	★★
2. Limited use of hazardous/unsustainable materials	★★	★★
3. Conservation/biocompatibility	★	★★★
4. Ease of repair and maintenance	★★	★★★
5. Reduction of (virgin) resource use during production	★★★	★★
6. Use of sustainable, reused/recycled materials	★★	★★
7. Reusability, recyclability, recoverability	★★★	★★
8. Optimise the end-of-life system	★★★	★★
9. Waste management	★	★
10. Impact of transport and storage	★★★	★★
Profit		
1. Reduce replacement because of fashion/technology	★★★	★
2. Financial and/or regulatory arrangements	★★★	★★
3. Optimise usage by PSS	★	★★★

★ = does not align well

★★ = aligns fairly well

★★★ = aligns well

9.1. People

EU residents highly value *operational safety and efficiency* and both aspects are addressed in Directives. While alignment between the two stakeholders exists, opportunities for improvement are also identified. Currently, progressions in *operational safety* are included by regularly updating the list of substances that can cause harm to users. Simultaneously, consumer organisations can notify residents of substances that are not yet restricted by policy but could potentially cause harm to human health. Directives also state that efficiency requirements should be adjusted in line with technological progress to maintain a high level of energy efficiency. However, instead of following technological progress, future EU Directives could serve as a technological push by setting stricter resource efficiency requirements and thereby stimulating innovation. This strategy was proven effective in the implementation of the Ecodesign Directive, where designers were forced to implement minimum requirements. Considering the importance residents allocate to *operational safety and efficiency*, stimulating producers to enhance the resource efficiency of products could be a valuable step in future EU Directives.

A misalignment can be observed between public attitudes towards *safe and fair working conditions* and the attention devoted to this subject in Directives and by consumer organisations. While some guidelines exist for working conditions, these apply only within the EU, while problems concerning working conditions express themselves mainly outside the EU due to the globalisation of supply chains. Here, consumer organisations can utilise their role as provisioners of information and educate residents on globalisation. Increasing the awareness of residents on the origin of their products could make them more aware of the working conditions in foreign countries and potentially impact the awareness on other DfS requirements, such as *reducing the impact of transport and storage*. Consumer organisations could also respond to the interests of residents in *safe and fair working conditions* by including this requirement in their product evaluations by conducting e.g. factory visits.

Opportunities for policy development can be found in formulating preconditions for the working conditions of products imported into the EU. Setting minimum levels of safety and wages of workers is an essential step in increasing the social sustainability of supply chains and furthering the progression to DfS.

Following from the ranking for a t-shirt and the interviews with consumer organisations, these recommendations would be especially relevant for product groups such as textiles. This product group thus presents itself as important to include in future Directives on *safe and fair working conditions*.

Job creation is not highly valued by residents and is addressed to a limited extent in Directives. Nevertheless, the requirement does present opportunities for policy development. Considering the ambitions of the CE Action Plan, the CE and service economy will form a more substantive base for the development of policy. As a result, *job creation* will become more critical in future EU Directives. Therefore, it would be valuable to start increasing the understanding among residents of the link between *job creation* and the CE as well as the benefits *job creation* can have for economic growth. Both consumer organisations and other governmental agencies can supply EU residents with information on this transition.

9.2. Planet

Residents consider *durability* the most critical environmental DfS requirement. While the Directives analysed in this research address *durability*, it is not considered the most important requirement. Hence, more or stricter durability requirements would be fruitful areas of policy development. For example, future Directives could include a minimum guaranteed lifetime or an extension of the warranty period. Consumer organisations can also stimulate designers to increase the *durability* of products by including stricter conditions in their product tests. In addition, consumer organisations and governmental agencies can work together to create a durability score. The effectiveness of such a score can be derived from the discussions in France on a durability score and the fact that French respondents value *durability* significantly higher than others. Consequently, more attention to the durability of products in e.g. media and policy discussions could influence residents' valuation of this requirement.

As seen from the rankings across the product groups, these requirements would mainly be necessary for products requiring more significant investments, such as a mobile phone or refrigerator.

While EU residents do not value *reusability, recyclability or recoverability* particularly high in the design of products, policymakers identify this requirement as having a significant impact. Here, the discrepancy addressed by Boesen et al. (2019) can be observed. Boesen et al. (2019) indicate that residents' preferences may not always align with the environmental impact that measures can have. However, policymakers have identified reusing, recycling and recovering as impactful requirements, and the discrepancy in valuation by residents and policymakers could be resolved by initiating information campaigns that educate residents on the impact of reusing, recycling, and recovering products. Again, consumer organisations could aid the spread of this information. Additionally, making these practices more convenient for residents could stimulate residents to pursue this and close the gap between residents' and policymakers' valuations.

Waste management was not highly valued by EU residents but is the core subject of multiple Directives, primarily waste Directives. Again considering the discrepancy addressed by Boesen et al. (2019), first, an assessment of the exact impact of this requirement could be made. Second, reviewing the influence that *waste management* can have in resolving environmental problems, a decision can be made whether increasing the interest in the requirement would be valuable. When it results that *waste management* can indeed have a substantial environmental impact, again educational campaigns initiated by both governments and consumer organisations could inform residents on the impact they can make by processing their waste responsibly. Additionally, implementing measures can be included in e.g. the Ecodesign Directive on how designers should integrate the end-of-life in the design of a product, making it easier for residents to contribute to responsible *waste management*.

9.3. Profit

According to EU residents, the *replacement because of fashion and/or technology* is a highly valued DfS requirement according to EU residents. However, this subject is not addressed in the Directives analysed in this research. To resolve this misalignment, future EU Directives could include more measures on premature replacement of products, especially for products that are replaced not because of failure but because of fashion or technological newness (e.g. t-shirts and mobile phones). The specific content of these measures can be based on the outcomes of the PROMPT project. Consumer organisations across Europe work together on this project, intending to establish an independent testing programme for premature obsolescence.

While the introduction of PSS is not mentioned in any of the Directives and is also considered the least favoured requirement by residents, the move towards service-oriented economies is an integral part of e.g. the CE Action Plan. Consequently, it can be foreseen that the interest of policymakers in this subject will upsurge. Taking these future policy developments in consideration, it could be relevant for policymakers to enhance the favourability of this requirement. More specifically, future policies could focus on the barriers that are now identified by consumer organisations in the use of PSS. These barriers include the investment of time and money that PSS often requires of its users. Consequently, subsidies for e.g. sharing services could resolve barriers of costs. To identify essential barriers in PSS adoption, consumer organisations need to work with governments to share their market knowledge.

9.4. Concluding remarks

To conclude, the recommendations provided in this chapter are focused on resolving discrepancies between the valuation of DfS requirements by EU residents and the current policy landscape. Also, the role that consumer organisations can have in resolving these misalignments is addressed. In addition to resolving discrepancies, current discussions on DfS requirements considered to identify future disputes between residents and Directives. Many recommendations include increasing the awareness of residents towards requirements. Here, providing this information is different from the requirement *information provision* that focuses on supplying residents with information on a product. Consumer organisations play a crucial role in informing consumers and working with governments to share their knowledge on market conditions and measurement methodologies. Ultimately, the recommendations provided in this chapter are relevant to take into account to increase the adoption and effectiveness of DfS across the EU.

10. Conclusion

This research contributes to the theoretical field of DfS by developing a comprehensive list of DfS requirements and expanding the general perspective towards product design from eco-design to DfS. Furthermore, by integrating the perspective of EU residents towards these requirements, a perspective largely overlooked in previous research is explored. The following research questions were defined:

How do EU residents value requirements for Design for Sustainability?

- A. *What Design for Sustainability requirements are most prevalent in academic literature?*
- B. *To what extent do the positions towards Design for Sustainability requirements of EU consumer organisations and EU residents align?*
- C. *To what extent does the valuation of Design for Sustainability requirements of EU residents align with current Directives?*

To answer these research questions, a ranking was developed that presents how EU residents value the 20 DfS requirements derived from academic literature. Several conclusions have been drawn from the alignment of these rankings with the viewpoints of consumer organisations and EU Directives. Overall, the rankings by residents align reasonably well with the work of consumer organisations. The content of the Directives also largely aligns with the preferences of residents. However, multiple areas for improvement have been identified. The most important conclusions were that *durability* was considered the most important environmental DfS requirement by both residents and consumer organisations. The importance of this requirement was also recognised in Directives. However, since few durability obligations are established, it can be concluded that *durability* should become a much more urgent subject in future Directives. Another pronounced observation is the disagreement between stakeholders on the importance of *safe and fair working conditions*. This requirement was ranked exceptionally high by EU residents but was included to a minimal extent in the work of consumer organisations. Also the Directives do not recognise the complications that arise in global supply chains. The inclusion of broader and stricter requirements for *safe and fair working conditions* in both Directives and the work of consumer organisations could be considered valuable to residents.

This study provides multiple conclusions on how DfS requirements are valued and recommendations on how to further the sustainable design of products in the EU. Nevertheless, some limitations and uncertainties remain.

First, allocating the DfS requirements to the triple bottom line has several implications for the research. Many DfS requirements are holistic concepts and can often be allocated to more than one aspect of sustainability. For example, *durability* has a substantial impact on resource efficiency (planet) but can also impact the profit made from products. Ultimately, the allocation was guided by the literature from which the requirements were retrieved. Nevertheless, it can be concluded that this allocation was a complex process, and there are grounds for discussions on the allocation of each of the requirements. Additionally, some requirements contain multiple sustainability aspects, and consequently, no conclusions can be drawn on the relative valuation of the separate parts of requirements by residents. For example, as can be seen from the alignment of *the use of hazardous and/or unsustainable materials*, no conclusions can be drawn on whether residents value both the use of hazardous and unsustainable materials evenly or value either one of these parts more.

Second, because closed-ended questions were used, no conclusions can be derived on why residents deem specific requirements more important than others. Additionally, the questions in the survey could result in very normative based answers. To resolve these issues, future research could focus on conducting in-depth interviews with EU residents to provide more insight into the motivations for the ranking and take away the normativity of answers.

Third, the countries in which the survey was distributed do not entirely align with the countries where interviews were conducted. Specifically, no interviews were conducted with Eastern European consumer organisations. While interviewees indicated eco-design was not yet a common subject in consumer organisations from this region, it could be valuable to ascertain how

far along the organisations are in adopting eco-design/DfS and what their view is on each of the requirements. Furthermore, consumer organisations are not the only organisations that mediate between residents and policymakers. Non-governmental organisations (NGOs) can also fulfil this role, and hence their notions and work on DfS would also be valuable to explore in future research. Additionally, validating public attitudes within consumer organisations and corporate actors could be a practical application of the research findings.

Fourth, as also mentioned in the introduction, the value residents allocate to requirements does not necessarily coincide with the impact these requirements can have on either people, planet or profit (Boesen et al., 2019). Hence an exciting avenue of future research could be to compare the results of this research with the actual impact each requirement could potentially have by using LCAs. This would also be especially valuable for the development of policy, where compromises need to be made on which requirement is most important to address first.

Fifth and final, a considerable amount of data was collected in this study and while the majority of this data was integrated to answer the research questions, many paths could be explored more in-depth. One such path is the analysis of the NEP scale. Here, a deeper analysis of the valuation of the fifteen NEP scale items or the five NEP facets could reveal more correlations with the valuation of specific DfS requirements or buying behaviour.

Ultimately, this study has provided a foundation for more research into DfS preferences by establishing a comprehensive list of DfS requirements. Subsequently, by adding the previously unexplored perspective of EU residents, this study provides a more holistic view of DfS requirements.

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