

Behaviour and emotion for sustainable product design: a review

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ABSTRACT: Design for Sustainable Behavior focuses on how products can be designed so that users behave in a more sustainable way. User behavior is also associated with emotional interaction with products. This article aims to identify, through a systematic review of the literature, the scope of research addressing user behavior in the development of products for sustainability and the approach of emotion in this context. Also, what aspects of sustainability and types of products are lacking in the scope of research.

Keywords: Design for Sustainable Behaviour. Product design. User concerns. Emotional design.

1. INTRODUCTION

A few decades ago, Papanek (1985) stated that product development would directly impact society and the environment, stressing that designers can be dangerous as they design products that persuade people to buy what they don't need. Concerns over the consequences of industrialization began to emerge when it was already mature in the 1970s with the Stockholm Conference and culminating in the United Nations Environment Conference - ECO 92, held in 1992 in Brazil. Between the 1970s and 1990s, some reports, the results of commissions formed to address the issue, were released worldwide, warning of the risk of disasters if palliative and preventive measures were not introduced. In this period, the concept of sustainable development emerges which, besides the concern with the current state of the planet, proposes its maintenance to guarantee the survival possibilities of future generations (KREMER, 2007).

Social problems involve behaviours that play a crucial role in triggering desired change, with design being a powerful means for behavioral change. This

is a topic of common interest in the field of design and sustainability (HEKKERT, P.; Tromp, N; e Verbeek, 2011). The eco-design approach can provide designers with a set of design strategies to reduce the environmental impact of a product throughout its life cycle (PIGOSSO; MCALOONE; ROZENFELD, 2015). However, this approach pays no attention to the influence that user behaviour can have on the overall impact of a product. The way consumers interact with products can have environmental impacts (SHERWIN; BHAMRA, 1998). For this reason, design researchers began to explore the role of design in influencing user behaviour (LILLEY, 2007; TUKKER *et al.*, 2008; WEVER; VAN KUIJK; BOK, 2008) and later to develop approaches, tools and guidelines, which explicitly focus on Design for Sustainable Behaviour (DfSB) (BHAMRA; LILLEY; TANG, 2011; LILLEY, 2009; LOCKTON; HARRISON; STANTON, 2008).

User behaviour and its interaction with products are strongly affected by the way products are designed (NORMAN, 1988). Understanding the axis of influence allows the designer to position an intervention that balances user needs with the nature of the desired behaviour (HARATTY; BHAMRA; MITCHELL, 2012). There are different ways in which designers can try to induce behaviours, such as a scripting approach, with immediate feedback after use, by automating certain functions or even extending the number of different configurations of a product. The best approach depends on the specific product and its context. The greater the intrusion of the designer into the user-product interaction, the greater the extent of the improvement (WEVER; VAN KUIJK; BOKS, 2008). One common approach to starting a sustainable behaviour change project involves selecting a target behaviour. Looking across some review studies (COSKUN; ZIMMERMAM; ERBUG, 2015; LOCKTON, HARRISON; STANTON, 2008), the majority of the formative field studies investigating user behaviour focused on electricity consumption in the home, followed by water consumption. Also, most of the studies explored domestic environments. A few looked at work environments and even fewer at public spaces.

Products have direct and indirect relationships with users, and the intensity of these relationships (Figure 1) should be considered in the product development process. The further away a user is from owning or using a product, the greater their indifference to it (Löbach, 2001).

Figure 1: Intensity of User-Product Usage Relations



Source: Adapted from Löbach (2001)

Products for individual use encompasses industrial products used exclusively by a particular person (e.g. mobile phone, clothing), and causes a continuous and close relationship between user and product. Household products are used by a group of known people (e.g. washing machine, television). Products for public and collective use, for example, are more prone to depredation (PIZZATO, 2013). They are used by a larger group of users, who do not know each other (e.g. street furniture, public dumps). In this group, the relations between user and product are not so intense and can often be used irresponsibly because the user is not individually aware of co-ownership with the product (LÖBACH, 2001).

Shared-use products often do not arouse individual awareness of the co-ownership of these products; one can thus understand the irresponsible use of public facilities that are intentionally destroyed by the users themselves. The type of product configuration of this type may influence the user's conduct towards it. Product designs must take into account the individual relationships and desires that can be aroused, adapting such characteristics to appeal to multiple users (LÖBACH, 2011).

When we are addressing the issue of sustainability, we must address these influences collectively. Individual and collective interests may collide and there may be little user motivation to change behaviour (HEKKERT, P.; Tromp, N; e Verbeek, 2011). Studies (DESMET; HEKKERT, 2007; PIZZATO, 2013) show a tendency among design and emotion publications to take advantage of the excitement about the attractiveness of consumer and individual products, with a view to increasing consumption and sales.

It is possible to motivate behaviour through emotion. Emotion is linked to cognition, it contributes to decision-making and is fundamental to one's relationship with the outside world (DAMÁSIO, 2000). Emotions dominate decision making because they trigger and motivate behaviour (DESMET; HEKKERT, 2007). Assuming emotions can be predictable and controllable, a product acts as a model for emotional experiences (TONETTO; COSTA, 2011). The study of emotions involved in consumer experience is an important object of study, since emotions influence both the purchase decisions of a product and its use after purchase (DESMET; HEKKERT, 2007). It is the role of designers, as responsible for stimulating consumption in our society, to use methods to contribute to the sustainable development of the planet and motivate positive behaviours (DAMÁSIO, 2000).

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Given the relevance of the theme in the current world scenario, this paper aims to identify the scope of research on user behaviour in the development of products for sustainability. More specifically, to investigate with the selected set of works the following approaches: (i) theoretical basis of DfSB; (ii) the different types of product and use; (iii) aspects of sustainability; and (iv) positive and negative emotions associated with user behaviour.

2. METHODS

In order to achieve the objectives proposed in the introduction of this article, a systematic literature review was performed, which makes it possible to incorporate a broader spectrum of relevant results rather than limiting the conclusions to a limited number of studies. The systematic review answers a clearly formulated question using systematic and explicit methods to identify, select and critically evaluate relevant research, and collect and analyse data from the selected literature (SAMPAIO; MANCINI, 2007).

The research was conducted during the period from July to August 2019. According to Sampaio and Mancini (2007), the systematic review is useful for integrating information on a set of studies carried out separately, allowing to identify coincident and conflicting themes as well as knowledge gaps, guiding future investigations.

2.1 Method Steps

The development of the review involves five steps, defined by Magarey (2001): (i) problem definition; (ii) search of articles; (iii) selection and critical evaluation of articles; (iv) data collection; and (v) data analysis.

2.1.1 Problem definition

The definition of the problem, the inaugural stage of the process, is the product of the intention of this work to investigate if the development of physical products that stimulate more sustainable practices is based on the scope of the publications that are being made about design for sustainable behaviour. Identify the state of the art of behaviour analysis's contribution to the development of more sustainable products.

2.1.2 Search for articles

The period covered by the publications subject to search is represented by the last eleven years (2008-2019), period determined from an initial investigation that did not result in previously published records. In the search strategy, the exploration of the articles was performed first, through the strings: "sustainability" and "design for behaviour change" included; however, it was found that their inclusion greatly restricted the search result, and both were already covered by the two other strings defined in the second and final strategy: "design for sustainable behaviour" and "product design". Therefore, the final research took place with the following Boolean search (ALL "design for sustainable behaviour" AND ALL "product design" AND DOCTYPE (ar OR re) AND PUBYEAR > 2007).

The justification for selecting only articles published in journals, rather than those published in annals of congresses / symposia and publications in the format of books, theses and dissertations, is due to the careful evaluation that is usually made for their acceptance. Selected publications belong to 2 of the most comprehensive and relevant online databases, Scopus and Science Direct. The choice of these databases was due to the fact that all relevant article journals found in other searches were included in this database.

Quantitatively, the search resulted in one hundred and sixty-five articles (34 from the Science Direct database and 131 from the Scopus database). Of the total, 13 articles were common to both platforms and 11 articles were rejected because they were related to conference proceedings. Thus, the initial sample resulted in 141 selected articles. These were saved and pre-sorted for reading and analysis.

2.1.3 Selection and critical evaluation of articles

The article selection process began with the evaluation of the titles and abstracts of the 141 selected in order to relate the articles explored with the guiding objective of the research, all tabulated in a spreadsheet according to the objectives of the study. In order to avoid cutting important publications for review, the introductions and conclusions of all 141 articles were read and 72 articles were not in accordance with the research objectives, as they did not simultaneously address product development, user behaviour and sustainability. The main themes identified among the excluded articles were production processes, business management, business models, education, industrial systems, carbon footprint, service development, product manufacturing, materials, marketing and communication, construction, governance, health, food, HCI and exploitation of natural resources.

At the end of this stage, the sample of articles that comprised content that could be used to analyse the defined criteria and variables that supported the association between physical product development and design for sustainable behaviour was reduced to 69 articles: 21 theoretical articles and 48 practical or theoretical/practical articles.

2.1.4 Data Collection

The 69 selected articles were read in full and a table was organized in the Excel data analysis software, with data validation lists in the cells for subsequent

cross-checking of responses and analyses. The columns were organized according to the evaluation criteria defined in step 3.1.5 for an initial screening. They have also been organized to separate articles that actually address the theoretical basis of Design for Sustainable Behaviour and those that do not address it directly.

2.1.5 Data Analysis

At this step, a data extraction with the 69 selected articles has been conducted. To this end, the set of publications underwent a critical evaluation of the researchers. Reading the mapped articles encouraged the elaboration of the following classification approaches for data evaluation: (i) method of study: practical or theoretical-practical / theoretical studies; (ii) products categorized by use: for individual or collective domestic use / for public collective use / unspecified use and others; (iii) sustainability aspect addressed: energy saving / water saving / obsolescence / recycling / paper saving / circular economy / recycling / reuse / others; and (iv) approach to emotions, positive and negative.

In the analysis of the study method, the practical and theoretical-practical studies were grouped, since the practical approach of all responds to the analysis criteria in a similar way, whereas the theoretical studies do not fit in several analysis criteria and, therefore, will be analysed separately. In the course of reading the articles, it was also noted that some studies actually support the theoretical basis of Design for Sustainable Behaviour while others do not address the theoretical basis but are empirically referring to behaviour and sustainability in the use phase of products.

Regarding the approach of the type of use of the product, the products of individual use or collective domestic use were grouped, because both are distinguished from the products of collective and public use. The classification “unspecified and others” refers to studies that address products in general (without

mentioning the user group they are intended for) in addition to products that are not part of the other product groups (e.g. products for commercial use).

Regarding the approach of the sustainability aspect, all aspects addressed in more than one article within the analysed ones were used in the analysis, and the classification “others” was used for aspects addressed only once. Also, there were classified the most recurrent product types among the papers analysed. Regarding the emotion approach or not, we analysed the number of studies that addressed or not some emotion related issue in product development and, for the articles that approached emotion, a deeper analysis was performed in order to understand the type of emotion and the way they were addressed.

After classifying the studies, the results were obtained by the following analysis criteria and their relationships: a) practical/theoretical-practical and theoretical studies, year of publication and approach to the theoretical basis of Design for Sustainable Behaviour; b) category of use and number of publications; c) aspect of sustainability addressed and product types d) addressing emotion: number of publications, method of approach and emotion addressed; e) intersection of analyses: emotion approach x use category x sustainability aspect.

3. RESULTS AND DISCUSSION

The 69 articles selected were located in 26 journals of international circulation, related to different areas of knowledge, among them: Engineering, Design, Anthropology and others. It was observed that there are a wide variety of journals practice areas, many of which are interdisciplinary. The journal with the most selected publications 11 (15.9%) was the interdisciplinary Journal of Cleaner Production, focused on clean production and covering sustainability issues in companies, governments, educational institutions and society. Next, a journal of research in design (Journal of Design Research) with 10 publications

(14.5%), which takes an interdisciplinary approach, emphasizing human aspects as a central design issue through integrative studies of social sciences and design disciplines. In addition to design, engineering is another discipline that addresses behaviour in sustainability product development, making it the third journal with the most selected articles (International Journal of Sustainable Engineering) with 8 publications (11.6%). The main objectives of this journal are to stimulate innovation and development of sustainable products and production technologies, as well as new services and business models.

3.1 Classification of articles according to study method, year of publication and approach

As defined in the methodology, practical and theoretical-practical studies were grouped for analysis separately from purely theoretical studies. After this separation, the years of publication of the studies were analysed (Table 2). Subsequently, the studies were classified according to the approach or not of the theoretical basis of Design for Sustainable Behaviour (Table 3).

Table 2 – Distribution of articles according to year of publication and type of study

Method/ Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Theoretical	2	0	1	1	2	2	1	6	3	1	2	0	21
Practical/ Theoretical- Practical	1	1	1	1	4	3	4	5	9	4	9	6	48
Total	3	1	2	2	6	5	5	11	12	5	11	6	69

Source: authors

The articles with practical or theoretical-practical approach correspond to the majority, totalling 48 (69.5%). Twenty-one (30.5%) articles with a theoretical approach were identified, being 9 literature reviews and 12 with other approaches, namely: analysis or development of frameworks, design recommendations, design strategies and toolkit development. As for the year of publication, the first papers identified date from 2008, and most publications are between 2012 and 2019. In general, there seems to be a growing number of studies that address behaviour in the development of sustainable products.

Table 3: Approach to Design for Sustainable Behaviour Theoretical Basis

	Addresses DfSB	Do not addresses DfSB
Theoretical	PETTERSEN; BOKS (2008); LOCKTON; HARRISON; STANTON (2008); LOCKTON; HARRISON; STANTON (2012); ZACHRISSON; BOKS (2012); GEELEN; REINDERS; KEYSON (2013); LILLEY; WILSON (2013); DAAE; BOKS (2014); COSKUN; ZIMMERMAN; ERBUG (2015); WILSON; BHAMRA; LILLEY (2015); BOON; WEVER; QUIST. (2015); DAAE; BOKS (2015a); CESCHIN; GAZIULUSOY. (2016); MEDEIROS; ROCHA; RIBEIRO (2018)	THORPE (2010); MORENO; LOFTHOUSE; LILLEY (2011); MACDONALD; SHE (2015); WALTERSDORFER; GERICKE; BLESSING (2015); DI SORRENTINO; WOELBERT; SALA (2016); MORENO <i>et al.</i> (2016); PIETZSCH; RIBEIRO; MEDEIROS. (2017); KUO; SMITH (2018)
Practical / Theoretical-Practical	WEVER; VAN KUIJK; BOKS (2008); LILLEY (2009); WEVER <i>et al.</i> (2010); BHAMRA; LILLEY; TANG (2011); LAITALA; BOKS (2012); TANG; BHAMRA (2012); LOCKTON <i>et al.</i> (2013); LOCKTON; HARRISON; STANTON (2013); SERNA-MANSOUX; POPOFF; MILLET (2014); CHENG; SHIH; HA (2014); SERNA-MANSOUX <i>et al.</i> (2014); SOHN; NAM (2015); DAAE; BOKS (2015b); SPENCER; LILLEY; PORTER (2015a); SPENCER; LILLEY; PORTER (2015b); COR; ZWOLINSKI (2015); POPOFF; MILLET; PIALOT (2016a); WITHANAGE <i>et al.</i> (2016); SHIN; BHAMRA (2016); WILSON; BHAMRA; LILLEY (2016); POPOFF; MILLET; PIALOT (2016b); DAAE <i>et al.</i> (2016); ROCHA; SATTTLER (2017); SELVEFORS <i>et al.</i> (2017); KUO <i>et al.</i> (2018); BOCKEN <i>et al.</i> (2018); CHOI; STEVENS; BRASS (2018); DAAE; CHAMBERLIN; BOKS. (2018); SELVEFORS <i>et al.</i> (2018); WASTLING; CHARNLEY; MORENO (2018); TU; NAGAI; SHIH (2018); MARSHHAD; BEHDAD (2018); PORTMAN <i>et al.</i> (2019); SIERRA-PÉREZ; BOSCHMONART-RIVES; OLIVER-SOLÀ (2019); BAO <i>et al.</i> (2019)	LAITALA; KLEPP; BOKS (2012); SCOTT; BAKKER; QUIST (2012); SRIVASTAVA; SHU (2013); APOSTOLOU; REINDERS (2014); SALVIA (2016); APOSTOLOU; REINDERS (2016); SIU; XIAO (2016); ADEYEYE; SHE; BAÏRI (2017); SHIN; AL-HABAIBEH; CASAMAYOR (2017); SATYRO <i>et al.</i> (2018); MOSES; PAKRAVAN; MACCARTY (2019); BRIDGENS <i>et al.</i> (2019); VINCK; SCHEELEN; DU BOIS (2019)

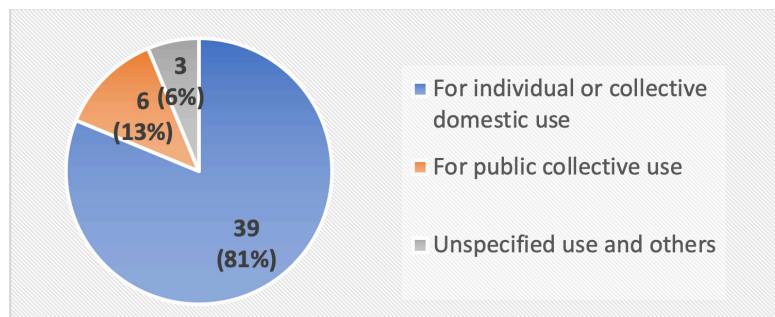
Source: authors

As cited in the method, in the course of reading the articles, it has been noted that some studies actually rely on the Design for Sustainable Behaviour (DfSB) theoretical basis while others do not address the theoretical basis, but are empirically referring to behaviour and sustainability in the use phase of products. Among the 21 theoretical studies analysed, 13 address in their theoretical basis DfSB articles while 8 articles refer to behaviour and phase of use in the product life cycle, but do not have specific DfSB literature. Among the 48 practical or theoretical-practical studies analysed, 35 present a literature review of DfSB while 13 empirically address issues related to product use behaviour.

3.2 Classification of practical and theoretical-practical articles according to category of use

As defined in the method of this paper, theoretical studies do not fit several analysis criteria because they do not carry out approaches with specific products, but rather address the themes analysed in this work more broadly. Therefore, for the next analysis will be considered only the 48 selected practical and theoretical-practical articles. Figure 1 shows the distribution of studies according to the category of use of the products addressed in case studies, user research and prototyping.

Figure 1: Distribution of articles by product use category



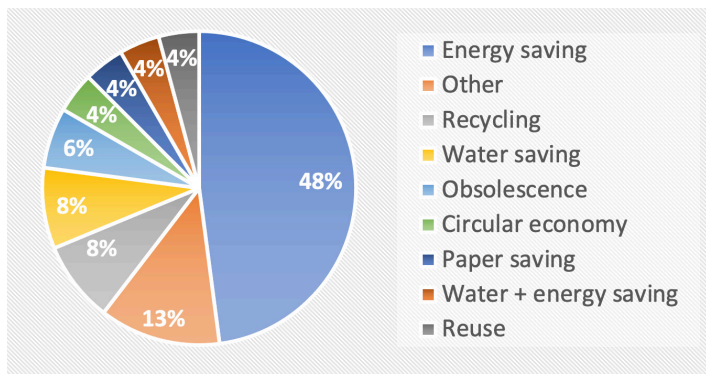
Source: authors

Among the 48 publications analysed, 39 (81%) dealt with products for individual or collective domestic use such as cell phones and washing machines, among other home appliances. Products for public collective use were addressed in only 6 (13%) studies, including dispensing of paper towels (2), trash bin (2), tap (1) and heater (1). Finally, 3 (6%) publications did not fit the previous criteria, 2 for not having the defined type of use and 1 for addressing an issue in commercial environment (food waste in restaurants).

3.3 Classification of practical and theoretical-practical articles according to sustainability aspect addressed and product types

The sustainability aspects to be analysed were defined by reading and analysing the 48 selected practical and theoretical-practical articles. All aspects that appeared in more than one article were considered, and those that appeared only once were grouped in "other" (Figure 2).

Figure 2: Distribution of articles according to sustainability aspect



Source: authors

The most recurring aspect of sustainability among the 48 publications analysed was energy saving, having been addressed by 23 (48%) studies, totalling

almost half of the selected articles. Other articles have addressed energy saving indirectly, focusing on other aspects of sustainability but analysing energy in product use. Among the 6 (13%) publications classified as 'other', issues were addressed regarding gas emissions, social impact, built environment, hygiene items saving, hybrid electric-gasoline cars and gas saving.

The types of products addressed in the studies were organized in Table 4 according to their recurrence. Publications set as 'Multiple' addressed several product types that do not match a single category.

Table 4: Product Types Addressed

Products	Papers	Total
Multiple	VINCK; SCHEELEN; DU BOIS (2019); SATYRO <i>et al.</i> (2018); CHOI; ESTEVENS; BRASS (2018); WASTLING; CHARNLEY; MORENO (2018); DAAE; BOKS (2015b); CHENG, SHIH; HA (2014); LOCKTON <i>et al.</i> (2013).	7
Washing machine	BOCKEN <i>et al.</i> (2018); SPENCER; LILLEY; PORTER (2015a); SIERRA-PÉREZ; BOSCHMONART-RIVES; OLIVER-SOLÀ (2019); TU; NAGAI; SHIH (2018); SPENCER; LILLEY; PORTER (2015b); LAITALA <i>et al.</i> (2012b)	6
Home appliances	SALVIA (2016); SELVEFORS <i>et al.</i> (2018); SELVEFORS <i>et al.</i> (2017); WITHANAGE <i>et al.</i> (2016)	4
Shower	ADEYEYE; SHE; BAÏRI (2017); SRIVASTAVA; SHU (2013); SCOTT, BAKKER, QUIST, (2012)	3
Mobile phone	LILLEY (2009); BRIDGENS, <i>et al.</i> (2019)	2
Trash bin	PORTMAN <i>et al.</i> (2019); SIU; XIAO (2016)	2
Computers	KUO <i>et al.</i> (2018a); MARSHHADI; BEHDAD (2018)	2
Heating system	WILSON; BHAMRA; LILLEY (2016); LOCKTON; HARRISON; STANTON (2013)	2
Vacuum cleaner	POPOFF; MILLET; PIALOT (2016a); POPOFF; MILLET, PIALOT (2016b)	2
Tap	BAO <i>et al.</i> (2019); SOHN; NAM (2015)	2
Clothing	DAAE; CHAMBERLIM; BOKS (2018); LAITALA <i>et al.</i> (2012a)	2
TV	SHIN; BHAMRA (2016); SHIN; AL-HABAIBEH; CASAMAYOR (2017)	2
Cookstove	DAAE <i>et al.</i> (2016); MOSES; PAKRAVAN, MOHAMMAD; MACCARTY (2019)	2
Paper towel dispenser	SERNA-MANSOUX <i>et al.</i> (2014); SERNA-MANSOUX; POPOFF; MILLET (2014)	2
Refrigerator	TANG; BHAMRAI (2012); BHAMRA; LILLEY; TANG (2011)	2
Lamp	APOSTOLOU <i>et al.</i> (2016); APOSTOLOU <i>et al.</i> (2014)	2
Green roof/wall	ROCHA; SATTLER (2017)	1
Coffee machine	COR; ZWOLINSKI (2015)	1

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Packaging	WEVER <i>et al.</i> (2010)	1
Power meter	WEVER; VAN KUIJK; BOKS (2008)	1
Total		48

Source: authors

Of the 48 articles selected, 7 addressed multiple product categories, some of which recurring with products analysed exclusively in other studies such as home appliances (2), clothing (2), mobile phone (1), tap (1), cookstove (1) and packaging (1). In addition to recurring products, studies with multiple product categories also addressed car, printer and home décor items. Articles classified in the home appliances category (4) represent studies that addressed more than one type of home appliance (e.g. electric kettle, coffee machine and others). However, other home appliances were individually classified in publications in which they were studied exclusively as: washing machine (6), cookstove (2), vacuum cleaner (2), TV (2), refrigerator (2) and coffee machine (1). Thus, home appliances are the most recurring type of product in the studies, followed by clothing (4), mobile phone (3), shower (3) and tap (3).

3.4 Studies addressing emotion: number of publications, method of approach and emotion addressed

Among the 48 practical and theoretical-practical publications evaluated, only 6 (12.5%) presented the use of emotion in some stage of the study of products for sustainable behaviour. Table 5 presents the articles that addressed emotion, how they did it, and which emotions were addressed.

Table 5: Emotion Approach

Papers (6)	Approach	Emotions
BAO <i>et al.</i> (2019) Investigating user emotional responses to eco-feedback designs.	Product prototyping and user interviews	Interest; Excitement; Pride; Joy; Satisfaction; Hope; Warmheart; Surprise; Upset; Worry; Annoyance; Guilt; Embarrassment; Anger; Shame; Boredom;
BRIDGENS <i>et al.</i> (2019) Closing the Loop on E-waste: A Multidisciplinary Perspective.	Prototyping for user-product affective bond assessment over time	Not specified
CHOI; STEVENS; BRASS (2018) Creative Factors in the Design Development Process: Towards Understanding Owner-Object Detachment and Promoting Object Longevity.	Toolkit development for designers: experts' workshop	Affection; Responsibility; Commitment; Benevolence
SALVIA (2016). The satisfactory and (possibly) sustainable practice of do-it-yourself: The catalyst role of design.	User interviews	Satisfaction
SOHN; NAM (2015). Understanding the attributes of product intervention for the promotion of pro-environmental behaviour: A framework and its effect on immediate user reactions.	User interviews	Not specified
CHENG; SHIH; HA (2014). Design framework of household appliance for users' sustainable behaviours.	User interviews	Proud; Enchantment; Satisfaction; Guilt; Disappointment; Courage

Source: authors

Although 6 papers address emotion, only 2 use emotional aspects to prototype products and test their affective interaction with users. 'Satisfaction'

appears as the most recurring emotion, having been cited in 3 articles. Only 3 studies address negative emotions such as 'guilt' and 'shame', with 1 of them not defining emotions, only pointing out that they are positive and negative.

The article by Bridgens *et al.* (2019) does not specify the type of emotion, being the approach related to the affective bond user-product in the evaluation of consumer product obsolescence over time. Technological obsolescence is mitigated by updating functional components, while stylistic obsolescence is mitigated by the emotional connection between the owner and the exterior of the device. The authors' goal was not to reduce the need to manufacture external compartments, but to understand how an emotional bond with the user can be generated (BRIDGENS *et al.*, 2019).

According to Bao *et al.* (2019), higher degree of certainty of users when taking action to conserve resources was linked to strong negative emotions regarding waste, such as guilt and shame. However, users' perceptions of the aesthetics, utility, and overall quality of the projects correlated most with positive emotions such as satisfaction, pride and joy. This suggests that evoking negative emotions in users may be an effective strategy for stimulating immediate and sustainable behaviours, while stimulating positive emotions may be more important for engaging users with long-term products (BAO *et al.*, 2019).

The study by Choi, Estevens e Brass *et al.* (2018) suggests that designers can benefit from a deeper understanding of end-of-use scenarios, particularly users' persistent attachment to objects and their effect on their obsolescence, and how to project objects to last longer from affective factors. On the other hand, Salvia (2016), addressed self-production (DIY) as a strategy to extend the life of products after the end-of-life is reached, reusing, redoing the purpose and re-appropriating. A sense of satisfaction from DIY practice was perceived by all participants, regardless of age, gender, background and motivations (SALVIA, 2016).

The research by Sohn e Nam (2015) drew on the use of metaphors to assess users' perceptions of product use. The authors found that participants perceived content that was expressed with metaphors as stronger interventions because empathic metaphors, such as animals and plants, made them feel guilty and this strongly interfered with their behaviour. Participants also mentioned that negative metaphors were more intervening than positive metaphors. When a product evokes positive emotions, such as humour, for example, intervention is bearable for users (SOHN; NAM, 2015).

According to Cheng, Shih e Ha (2014), research has indicated that increasing personal positive emotion and reducing negative emotion were the best strategies for boosting sustainable intent. Empirical research on home appliances has revealed that behavioural intention is directly affected by desire individually and indirectly affected by anticipated positive and negative emotions (CHENG; SHIH; HA, 2014).

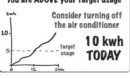








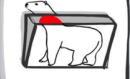


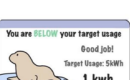



3.4.1 Approach to measuring emotions

Amongst these 6 studies, the one from Bao *et al.* (2019) has a more detailed method on how measuring emotion in sustainable product use. The aim of the study was to explore the emotions that arise from users' interaction with eco-feedback products and investigates links between emotions and users' resource conservation behaviors. In-lab experiments were conducted with 68 participants of varying backgrounds. Each participant was shown sketches of four conceptual designs of eco-feedback products and reported how they would feel and behave in different scenarios using the products. Detailed usage scenarios were described to the participants to help reveal more realistic emotions.

Two versions of each product that provided feedback information were created: a Quantitative design that displayed the resource consumption information in the

form of text or a chart, and a Figurative design that used a drawing of an animal as a reminder of resource usage's impact on environmental sustainability. In addition, a Neutral design was created for each product, with either no specific instruction on resource conservation or no feedback information at all. These neutral designs served as a baseline control group for user emotions and actions. Figure 3 presents the sketches of each version of the four eco-feedback products.

Figure 3: Sketch of the four eco-feedback products

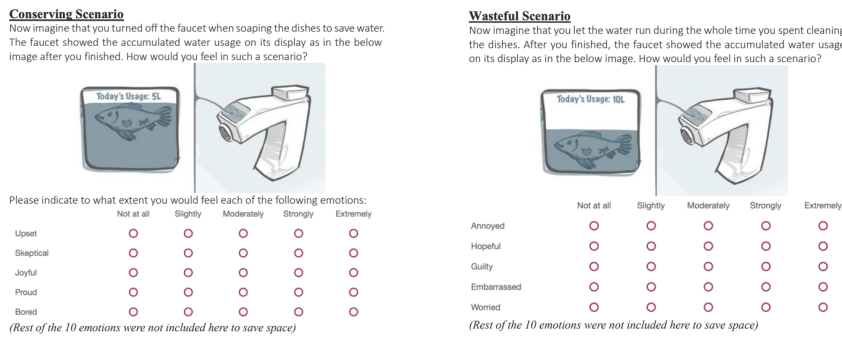
	Electricity Meter	Light Switch	Water Faucet	Washing Machine
Quantitative Designs	Wasteful Scenario You are ABOVE your target usage Consider turning off the air conditioner 10 kWh TODAY 	Thank you for saving energy! Turn off lights to save 120W electricity 	TODAY'S USAGE 10 L 	NORMAL WATER SAVING 150L water per Load 30% Less Water Usage 
	Conserving Scenario You are BELOW your target usage Good job! 1 kWh TODAY 	Thank you for saving energy! Turn off lights to save 120W electricity 	TODAY'S USAGE 5 L 	NORMAL WATER SAVING 150L water per Load 30% Less Water Usage 
Figurative Designs	Wasteful Scenario You are ABOVE your target usage Consider turning off the air conditioner Target Usage: 5kWh 10 kWh TODAY 		Today's Usage: 10L 	NORMAL WATER SAVING 
	Conserving Scenario You are BELOW your target usage Good job! Target Usage: 5kWh 1 kWh TODAY 		Today's Usage: 5L 	NORMAL WATER SAVING 

Source: Bao et al. (2019)

The fifteen emotions shown in Table 5 were evaluated. The emotions were intended to span positive and negative options, and to include words associated with a user's consumption experience and resource conservation behavior. The sequence in which the 15 emotions were presented was randomized in the survey. Participants reported the extent to which they would feel each emotion on a 1-5 scale: 1 - Not at all, 2 - Slightly, 3 - Moderately, 4 - Strongly, and 5 - Extremely. In the

conserving scenario, participants were asked to imagine that they used the product sustainably or followed the directives of the product to conserve resources. In the wasteful scenario, participants were asked to imagine that they failed to use the product sustainably, as shown in Figure 4. Participants were then asked to report their emotions (how they would feel) in both the conserving and the wasteful scenarios.

Figure 4: Example of conserving and wasteful scenario's survey questions



Source: Bao *et al.* (2019)

The experiment was conducted with individual participants. Though the intensity of emotions with respect to using an eco-feedback product varied across participants and was influenced by the types of products, the trend was consistent that more positive emotions arose in conserving scenarios and more negative emotions arose in wasteful scenarios.

3.5 Sustainability, product and emotion

As shown in Figure 1, the classification of the 48 articles by type of product use resulted in 39 studies addressing individual or collective domestic use, 6 studies

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addressing public collective use, and 3 studies with unspecified use/others. For the analysis of the intersection between product type, sustainability aspect and use of emotion (Table 6), only the 45 articles that were classified as products for individual or collective domestic use or products for public collective use will be considered.

Table 6: Articles by product type, sustainability aspect and emotion approach or not

		Do not addresses emotion		Addresses emotion		Total
		Individual or collective domestic use	Public collective use	Individual or collective domestic use	Public collectiveuse	
Sustainability aspect	Energy saving	20	2	1		22
	Water saving	3			1	4
	Recycling	1				3
	Obsolescence	2	1	1		3
	Paper saving		5			2
	Circular economy	2	34			2
	Reuse			2		2
	Water + energy saving	1		1		2
	Other	5				5
	Total	34	5	5	1	45

Source: authors

As indicated in Table 6, there are several gaps not addressed by the works selected in the literature review, especially regarding products for public collective use. The use of emotion in the development of products for sustainable behaviour, as presented in Table 5, is addressed only in 6 studies, whereas only 1 of them addresses products for public collective use. Of the 22 studies that approach energy saving - the sustainability aspect most addressed in publications as shown in Figure 2 - only 1 deal with products for public collective use.

As noted earlier, studies (DESMET; HEKKERT, 2007; PIZZATO, 2013) indicate a trend among design and emotion publications to take advantage of emotional aspects for consumer and individual products over public collective ones. The results of Table 6 show that most publications dealing with emotion are for individual use products. Products can influence behaviour and have individual or collective implications. When we are addressing the issue of sustainability, we must address these influences collectively. According to Löbach (2001), shared use products often do not arouse individual awareness of co-ownership of these products, resulting in their inappropriate use.

All material things provoke emotions, strong or subtle, positive or negative, conscious or unconscious (DAMÁSIO, 2000) that directly affect the way people feel, think and behave. In this sense, the design of products for public collective use should not differ from the design of other products (CREUS, 1996 apud PIZZATO, 2013), as all types of products interfere with the emotion of their users, due to the fact that there are no emotionally neutral products (DEMIR; DESMET; HEKKERT, 2009). Product designs should take into account the individual relationships and desires that can be aroused, but it's important to adapt these characteristics to appeal to multiple users in the use of public collective products.

4. CONCLUSIONS

This study aimed to identify the scope of research on user behaviour in the development of sustainability products. More specifically, to investigate with the selected set of works the following approaches: (i) theoretical basis of DfSB; (ii) the different types of product and use; (iii) aspects of sustainability; and (iv) positive and negative emotions associated with user behaviour.

As seen from the results, the theoretical basis of DfSB is not a common sense, since many studies do not mention it. Although, many researches empirically investigate the use-phase of products in order to achieve more sustainable behaviours. In general, it is noted that the vast majority of works address energy saving in the domestic context.

The main findings of this study show that there is a gap of studies that address other aspects of sustainability such as recycling and obsolescence. In addition, studies for public use products that address collective concerns are lacking. Besides, very few studies approached the influence of emotion in sustainable behaviour.

This article is a contribution in the sense of pointing out the gaps in literature for relating DfSB and other aspects of literature, rather than energy and water saving. Also, it identifies the types of products addressed most. Lastly, it shows the lack of use of emotions when designing products for a more sustainable use, even more in the public use context.

Considering the influence of emotions on user behaviour, it is important that further studies analyse how can emotions be useful in stimulation behaviour when designing products for a more sustainable use. Perhaps, this article can be useful in stimulating further research and presenting literature that can support the latent need of measurement for the use of emotion in product experience.

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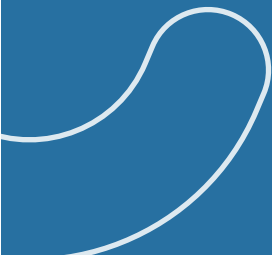
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