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Consumer buying behaviour of sustainable vacuum cleaners - consequences for design and marketing

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Abstract

Although most people claim to prefer a more sustainable product, only a limited number of 'green buyers' act on their words at the moment of purchase. To find out how to get mainstream buyers to buy more sustainable products, we used data on 950 Western European buyers of 32 different vacuum cleaner models. The issue was why three out of four consumers bought a less sustainable high input power model when an energy-efficient model with equal specifications was also on offer at the same price. Only 6% of buyers bought their vacuum cleaner for environmental reasons. The remaining 94% of buyers stated that their purchase decision was mainly based on reliability, durability, key features, the brand and value for money, regardless of whether they bought an energy-efficient or -inefficient model. The 73% who bought energy-inefficient vacuum cleaners opted for heavier models (perceived as more robust) featuring bags for dust collection, and were more sensitive to messages addressing technological innovation. Beside energy-efficiency legislation, we see two options to encourage mainstream consumers to buy more energy-efficient products: (1) link technical advancement in innovation to lower power ('we can create more suction with less energy') in product branding, and (2) seduce mainstream consumers with models that are redesigned for performance, robustness and durability. With this quantitative consumer research, we add both to the knowledge of buying behaviour in terms of sustainability as well as to the knowledge on how to redesign and market green products in mainstream markets.

Keywords: Value creation; Sustainable consumption; Design; Consumer research; Durables; Preferences

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1. Introduction

To ensure sustainable consumption it is necessary to attract mainstream consumers with sustainable and energy-efficient products (Mont and Plepys, 2008). A majority of consumers indicate they prefer more environmentally friendly products; however, only a minority (5-10% depending on the product category) of those same consumers act on their promise to buy more sustainable products (United Nations Environmental Programme, 2005). As a result, in the present market, most sustainable products are not able to attract large segments of customers. Most literature studies on sustainable consumption (Dangelico and Vocalelli, 2017; McDonald et al., 2012; Mont and Plepys, 2008; Mont and Power, 2010; Rex and Baumann, 2007) assume that a preference of sustainable products is a predictor for sustainable buying, based on the theory of planned behaviour (Ajzen, 1991). However, the intention to buy in a sustainable way is most often not followed by a sustainable consumer choice. The existence of this gap between 'sustainable intention' and 'behaviour' (Auger and Devinney, 2007; Carrington et al., 2010; Liobikienė et al., 2016; United Nations Environmental Programme, 2005) indicates that, consumer behaviour is far more complex than being driven by rational decisions alone.

This paper deals with two issues: (1) the preferences of people at the moment of purchase in the shop, i.e. why do the majority of buyers refrain from buying more sustainable options, and (2) the consequences of these consumer preferences with regard to the design and the marketing of green products.

In the literature review of Section 2, we will summarize the latest views of researchers in sustainable consumption, and will define our research questions. In this section, we will also explain why we have chosen vacuum cleaners as the subject of our research. In Section 3, we will describe our research method, the source of data, the respondents, and the specifications of the vacuum cleaners. In Section 4, we present the results of the data analyses. In Section 5, we discuss the theoretical, managerial (marketing and redesign), and policy implications, as well as the limitations of our research. We will finalize this paper with Section 6, in which we will draw our conclusions.

2. Literature on sustainable consumption

2.1. Consumer preferences for sustainable products

A number of reasons have been reported for why consumers do not show preferences for sustainable products in the shop. The first reason is that environmental products often come with negative perceptions; consumers perceive such products as being more expensive (van Doorn and Verhoef, 2011), less fashionable (Visser et al., 2015) or lower in quality (Luchs et al., 2010). The second reason is that the buying of a product is the fulfilment of a need, wish or emotion, in a trade off with sustainability (Hüttel et al., 2018). The environmental attributes of products are often of lower importance than other attributes (Niinimäki, 2010; Visser et al., 2015; Vogtländer et al., 2013), and only come into play when other more important attributes do not lead to a final choice (Vogtländer et al., 2002). The third reason is that consumers might perceive lower energy consumption to be related to performance, an experience attribute that will only be understood after prolonged use of the product. During the buying process, the evaluation of a new product is based on experiences with prior products (Creusen and Schoormans, 2005). The fourth reason is that the ecological burden (i.e. impact of material and energy consumption) is very difficult to understand and judge, even for sustainability conscious consumers (Ellen, 1994). This leaves people with limited decision-making abilities (Brown, 2015).

In contrast, a limited number of, mostly, experimental studies show that consumers do react positively towards sustainable products. De Angelis et al. (2017), for example, show that green luxury fashion products are preferred if the design of these fashion products is not dissimilar to the design of traditional non-green products. Magnier and Schoormans (2015) show, that the use of sustainable material in packaging increases the sustainable products' credibility for consumers.

Although all these experimental results are promising, intentions are not actions, and studies researching consumer behaviour in the marketplace might show different results. So far, there is limited quantitative consumer research on marketing of green products (Baumann et al., 2002; Carrington et al., 2010; Dangelico and Vocalelli, 2017); this is especially the case when it comes to durables or addressing those who are not green buyers or self-proclaimed green consumers (McDonald and Oates, 2006). McDonald et al. (2009) point out that the brand is by far the most important decision-making criterion for small electronic appliances, and that sustainability criteria are rarely used in relation to these purchases, even by very green consumers. Most quantitative empirical studies focus on food (Tanner and Kast, 2003), textiles, packaging or tourism. On durables we found quantitative research only on electronic and alternative fuel vehicles (Jansson et al., 2017) and solar systems (Elmustapha et al., 2018), which both concluded that the visibility of sustainability is an important factor in sustainable buying.

2.2. Buying behaviour insights

Findings from social science studies on consumers and consumption behaviour demonstrate that consumption behaviour is not merely rational, and influenced by a wide range of individual, social and institutional factors (Power and Mont, 2010). Individual customers show biases that may potentially interfere with sustainable consumption. They tend to stick to: (1) the status quo or their, often unsustainable, default choice; (2) satisfice instead of go for the best solution; (3) are loss averse; (4) are risk averse; (5) recover their sunken cost; (6) perceive things as less valuable or significant if further away in time; and (7) act in conformity with social norms (Frederiks et al., 2015). These biases might explain why consumers who say they would prefer environmentally friendlier products do not actually buy such products. Lorek and Spangenberg (2014) think biases are difficult to overcome with mainstream economic business thinking and therefore call for governmental leadership to strengthen social innovation by means of carrots and sticks.

Policymakers have used behavioural insights and biases to nudge consumers towards more sustainable behaviour and the industry towards sustainable innovations (Sousa Lourenco et al., 2016). To curb the growing share of European household energy consumption accounted for by electrical appliances (Odyssee-Mure, 2017), the European Commission decided to implement legislation to limit the maximum input power of consumer electronics. Since September 2015 (after the collection of data for this paper), the maximum input power of vacuum cleaners in the European market is limited to 1600 W (European Union, 2013), which will be limited even further to 900 W. This legislation met with consumer and consumer group resistance, and was even challenged in court (The week, 2015).

2.3. Research questions

A few conclusions can be drawn from the literature. For one, there is hardly any quantitative empirical research published on consumer buying of durables. While durables like household appliances might not be bought primarily because of their sustainability attributes, they significantly contribute to (un-)sustainable consumption and their contribution to total household energy consumption is rising (Odyssee-Mure, 2017). As 75%-80% of the environmental burden of appliance life cycles is caused by energy consumption during use (Coronado Palma and Visser, 2012), the choice of power input of these appliances has a major impact on sustainable consumption. Secondly, there is reason to believe that buying intention cannot be interpreted as buying behaviour. To understand consumer behaviour and eventually change it towards sustainable consumption, it is vital to research sustainable product choices in the market place. The use of real market data, however, is not without problems. To arrive at valid results we need both to find a market place in which a comparison can be made between products that differ only in terms of the product attribute 'sustainability' and substantial consumer choice data need to be available.

For this study, we searched for a durable where sustainable consumption is not related to other product attributes and people's product preferences could be met with both a sustainable and a less sustainable choice. Vacuum cleaners are an excellent product category to research why consumers are not acting on their promises to choose the greener option when all other product specifications are equal. First of all, because of the utilitarian nature of a vacuum cleaner (Creusen, 1998), its product specifications – such as energy use, suction power, weight and price – are considered critical in the buying decision and can be measured in a both objective and nominal way. Secondly, vacuum cleaners of all input powers are available within a broad line of other attributes, making it possible to meet the requirements of every customer with both an energy-efficient and -inefficient version (Heiskanen et al., 2010). Furthermore, the European Union has in its energy-efficiency policies defined what constitutes a sustainable vacuum cleaner i.e. one of less than 1600W.

For this paper, we were able to use an extensive data set that was collected by the Philips Consumer Electronics Consumer Lifestyle division. This data shows the actual buying behaviour of 950 consumers of both energy-efficient and -inefficient vacuum cleaners of equal specifications that were sold by Philips in 2010. Buyers indicated one of ten reasons why they bought one of 32 specific product models. This consumer data was combined with the specifications of the bought product, the used communication focus and its recommended retail price. For all vacuum cleaners with an input power of less than 1600 W, Philips used communication messages promoting the environmental benefits, such as 'this is an energy-efficient product'. For other models, the packaging or leaflets might refer to their 'technologically advanced' product features.

The vacuum cleaners included in this study showed a wide spread of specifications in terms of suction power, weight, bag or bagless dust collection, price and communication focus. For every attribute, a model was available in both the low and high input power categories, and therefore a lower or higher level of sustainability for every preference in specification attributes. Philips' broad product portfolio gave us the possibility to research why most people buy a non-sustainable model when a more energy-efficient model of equal specification and price is available.

Based on the above, we defined our research questions as:

1. How many people bought an energy-efficient vacuum cleaner in this survey?
2. Are there differences in the reasons for buying either an energy-efficient or -inefficient vacuum cleaner?
3. How are the reasons to buy and the attributes of the bought vacuum cleaners related to input power?
4. What is the difference between the preferences of the buyers of energy-efficient and -inefficient vacuum cleaners?

3. Methods and materials

3.1. The data set

The analysis of this paper is based on the consumer research database of Philips Consumer Lifestyle. Philips collected this data to analyse the reasons why a specific customer bought a specific vacuum cleaner as well as to measure the satisfaction of buyers with their newly bought product.

Philips used a specific procedure to determine the preferences of their customers. Buyers of Philips products were invited by a warranty leaflet in the packaging of the vacuum cleaner to promptly register their product on the Philips website in exchange for an extra year of warranty. Upon registration of their product (by registering article and serial number) customers are asked to provide their demographics (sex, age, education, family composition, country, city, etcetera) and buying behaviour (market channel, reason to buy) and contact details. It is obvious that not all buyers register their product, but the data of this study cover 951 European consumers who bought one of the 32 different vacuum cleaners in 2010. Given the fact that the vacuum cleaner models as well as preferences and buying behaviours differ between regions (Coronado Palma and Visser, 2012) and cannot be compared as such, we concentrated our tests on European consumers.

Buyers were asked to indicate one out of 10 reasons (see Appendix A for Reason to Buy list and definitions) as their primary reason to buy their particular vacuum cleaner. The 10 reasons were: brand reputation; key features (the vacuum cleaner's key features, such as dust chamber size, accessories, filter(s), performance, cord length, etcetera); service; design and looks; ease of use (manoeuvrability, easy to store); environment; warranty; value for money; reliability & durability; none of these. These data[*] of a specific buyer is combined with the specifications of the bought vacuum cleaner that were available to the consumer either on the product leaflets, at Philips.com and/or on its packaging.

3.2. Specifications of the vacuum cleaners

The specification attributes of the 32 vacuum cleaner models in the data set are input power (W), suction (W), noise (dB), weight (kg) and whether they have a bag (69.3%) or not (30.7%), the communication focus on technology innovation (in 57.7% of the cases, all for high input power versions) or environment (in 26.2% of the cases all for low input power versions) and recommended retail price in Euros (collected from the Philips.com webstore). As indicated before we use vacuum cleaners as a product category because their attributes have no or a low correlation with input power. There would thus be no reason for customers to select an energy-inefficient model other than the fact that it has more input power. Of the different attributes, only suction is significantly correlated with input power (p = .001), with a medium-size effect (R^2

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[*] For those who would like to replicate the results of the study, the authors are willing to share the dataset in Excel

=.30). Figure 1 shows in most cases, lower input power versions offer somewhat lower suction for the existing designs, e.g. 300-400 W compared with 300-500 W in the high input versions.

The correlations between other attributes and input power were all low (price R^2 = .02, weight R^2 =.05, noise R^2 =.05, and all input powers were on offer with and without a bag R^2 = .01). These correlations confirm that the attributes of vacuum cleaners are independent of their input power and sustainable vacuum cleaners do not differ from non-sustainable ones in terms of their specifications.

Both the correlation table and scatterplots are presented in Appendix B.

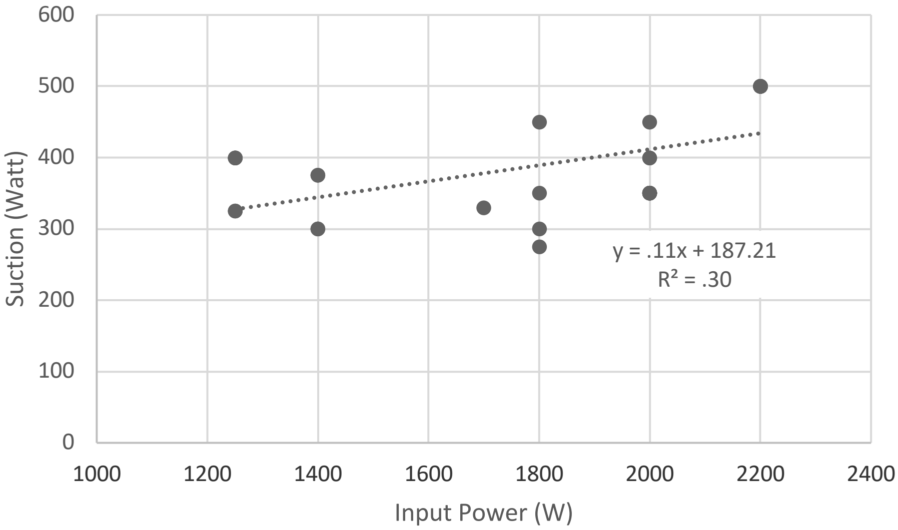

Figure 1:Scatterplot Suction versus Input Power (N=32)

3.3. Respondents

The 951 respondents in the analysed dataset comprise buyers from Austria, Belgium, Switzerland, Germany, France, Ireland, Italy and the Netherlands. In line with the regulations of the European Union (European Union, 2013) that limit the maximum input power of vacuum cleaners to 1600 W, we split the consumers into two groups: those who bought, a vacuum cleaner with input power of 1600 W or less, and one group of those who bought one rated above 1600 W.

See Table 1 for the respondent groups by the input wattage of their vacuum cleaners.

Table 1: Respondents by input power (Wattage) of the vacuum cleaner they bought (N=951)

	Wattage	Frequency	Percent	Cumulative percent
Low input power <1600 Watt	1250	78	8.2	8.2
	1400	177	18.6	26.8
High input power >1600 Watt	1700/1800	94	9.9	36.7
	2000	356	37.4	74.1

2200	246	25.9	100.0
Total	951	100.0	

4. Data analysis and results

4.1. The sustainable buyers

Our first research question is how many people are buying an energy-efficient vacuum cleaner? The answer to this question is found in Table 1. It shows that only 27% (N=255) of buyers bought a low power energy-efficient vacuum cleaner with less than 1600 W input power. A large group of 73% buyers (N=696) bought an energy-inefficient model.

4.2. Consumers' reason to buy in relation to energy efficiency of vacuum cleaners

To answer the second research question concerning the reason why consumers buy a vacuum cleaner, we analysed the self-reported main reasons for buying. The indicated reasons for buying in both consumer groups are presented in Figure 2, which shows reliability & durability, key features, value for money and brand reputation as the main reasons to select a certain vacuum cleaner model for 74% of all consumers (68% of all buyers <1600 W and 79% of all buyers >1600 W).

An independent t-test showed no significant difference in scores between the two groups on reliability & durability (t (494) = -1.33, p = .20, two-tailed), key features (t (494) = -.55, p = .58, two-tailed), value for money (t (494) =.75, p = .46, two-tailed) or brand reputation (t (494) = -1.96, p = .05, two-tailed).

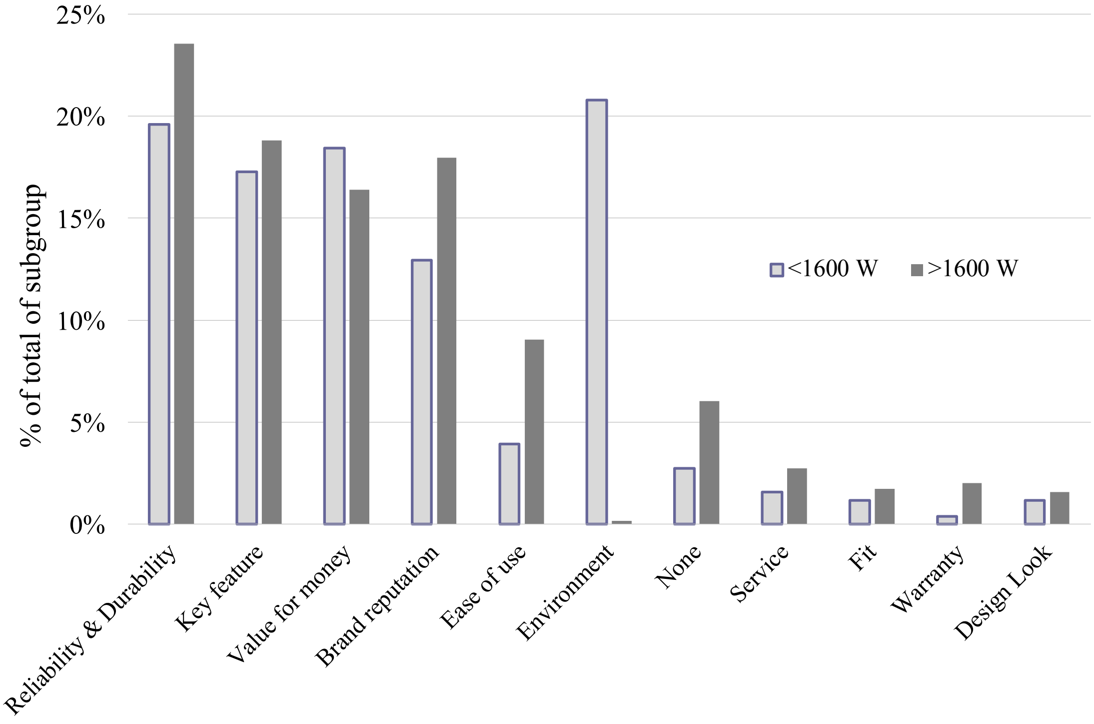

Figure 2: Consumer preferences: the primary reason to buy this specific article. Divided in Low (<1600W Input, N=255) and High (>1600 W Input, N=696) buyers, sorted in order of preference of the Grand Total (N=951).

There was a significant difference between buyers of lower and higher input power versions on ease of use (t (494) -3.14, p = .01, two-tailed), which was however only slightly more important (Eta squared = .01) to buyers of energy-inefficient vacuum cleaners. Environmental friendliness is, as expected, only important to buyers of energy-efficient vacuum cleaners (*t* (494) 8.09, $p < .001$, two-tailed). There is a large difference between them and energy-inefficient buyers in terms of environmental friendliness as a reason to buy (Eta squared = .2).

74% of the buyers did not differ in their preferences, irrespective of their choice of an energy-efficient or -inefficient vacuum cleaner. On the other hand, although all low power vacuum cleaners were advertised as such, only 21% of the buyers of energy-efficient models said they bought one for environmental reasons. These 'green buyers' account for only 6% of all respondents. In contrast, nearly 80% of the low input power buyers made their selection for other reasons and their preferences hardly differ from those of buyers of energy-inefficient models.

4.3. Reasons to buy in relation to the product attributes of the bought product

To answer our third research question (how the reasons to buy and the attributes of the bought vacuum cleaners are related) we performed a correlation analysis (Appendix C). A summary of relevant correlations between the product attributes of the 952 bought vacuum cleaners and the two input power groups is given in Table 2.

Table 2: Correlation between the bought product attributes and low/high power (906<N<951).

Product Specification		Power low/ high Buyers
Price RPP/ NL EURO	Pearson Cor.	-.00
	Sig. (2-tail)	.924
Message Technology	Pearson Cor.	.36**
	Sig. (2-tail)	.000
Weight (kg)	Pearson Cor.	.33**
	Sig. (2-tail)	.000
Noise level (dB)	Pearson Cor.	-.09**
	Sig. (2-tail)	.004
Suction (watt)	Pearson Cor.	.55**
	Sig. (2-tail)	.000
Bag less/Bag	Pearson Cor.	.42**
	Sig. (2-tail)	.000

** Correlation is significant at the 0.01 level (2-tailed).

In Section 3.2, we showed that there were no correlations between the factual, measured, product attributes and input power of the 32 vacuum cleaner models, with the exception of suction power. In contrast to this, Table 2 shows significant (*p.* <.01) correlations between low/high power and all attributes except for price. The differences between the factual vacuum cleaner attributes and the bought attributes seem to arise from a difference between fact and perception, which might be caused by bias or interaction and mediation among attributes and preferences.

The correlation of low/high power with noise level is small (Pearson correlation <.3) but correlation is large with suction, and medium with bagless/bag and weight .

Price is not correlated with low/high input power but it is, to a great extent (Pearson >.5), with suction, noise and weight as well as message technology, signalling willingness to pay for more suction and weight and for less noise. Since price is not related to input power, this opens up possibilities to create more consumer value with low input power machines.

There are no significant correlations between the consumers' reason to buy and input power (Appendix C), except for a small effect of ease of use as a preference for high power input buyers and the environment as a reason to buy, medium in size, as a preference for low input buyers. These are in line with the results of 4.2. Environmental preference is slightly negatively correlated (Pearson -.25) with suction power, which would indicate that green buyers seem willing to accept somewhat lower suction performance for greater environmental benefits.

4.4. Customers' preference for either low or high input power vacuum cleaners

A discriminant analysis was conducted to predict whether people would buy a low or high input power vacuum cleaner. To avoid both singularity and multicollinearity we selected as our predictor variables those variables that showed (Appendix C) a significant Pearson's relation with input power between .3 and .8. Suction as a predictor with a large effect created singularity due to its similar importance for both low and high input categories. We found that the differentiating predictor variables were: environment, weight, technology message, and bagless/bag. For detailed results of the discriminant analysis see Appendix D (supplementary material). The means of the groups are shown in Table 3.

Table 3: Group statistics low versus high input power vacuum cleaner buyers (N=909)

POWER LOW/HIGH	VARIABLES	MEAN	STD. DEVIATION	N
LOW <1600 WATT	Weight (kg)	5.832	.568	243
	Message Technology	.272	.446	243
	Bagless/Bag	.383	.481	243
	RS7 Environment	.202	.402	243
HIGH >1600 WATT	Weight (kg)	6.196	.422	666
	Message Technology	.703	.457	666
	Bagless/Bag	.800	.400	666
	RS7 Environment	.002	.039	666
TOTAL	Weight (kg)	6.099	.492	909
	Message Technology	.587	.493	909
	Bagless/Bag	.689	.463	909
	RS7 Environment	.055	.228	909

The Box's Test (Appendix D) showed that, although there were similar log determinants per group, the assumption of equality of covariance was violated (p <.001). Tabachnick and Fidell (2013), however, suggest that if the samples are large, as in this case, the probability values will be conservative and can be trusted. The discriminant function revealed a significant relation between the two groups and the four variables and accounted for 31% of all variations between the groups.

The canonical discriminant function (Table 4) results in two groups centroids with means of -1.097 for low input power buyers and .400 for high input power buyers.

Table 4: Canonical Discriminant Function coefficients (Unstandardized)

Function Coefficients	Function 1
Weight (kg)	1.212
Message Technology	-.300
Bagless/Bag	1.533
RS7 Environment	-2.720
(Constant)	-8.119

This model correctly classified 67% of the low input buyers and 100% of the high input buyers (91% of the cases in total).

These results show the high impact of weight and bags for dust collection on the decisions made by buyers of energy-inefficient machines. Unsurprisingly, they are less focused on the environmental impact. Addressing environmental benefits might even lead to rejection due to negative associations.

The constant in the equation is high compared to the function coefficients, showing that the remaining attributes and the reasons to buy are of equal importance to both low and high power buyers. They can be used to create value-added designs to attract all buyers and increase the perceived suction, performance and main preferences, i.e. reliability & durability, key features, value for money and brand reputation.

5. Discussion

5.1. Theoretical implications

5.1.1. Consumer preferences for sustainable products

In line with most literature (McDonald et al., 2009; United Nations Environmental Programme, 2005) the percentage of people who base their purchases on environmental preferences is small in our case, just 6% (see 4.1). These 'green buyers' seem willing to accept lower performance if their sustainable preferences are satisfied. This is different from the other 80% of the consumers of energy-efficient vacuum cleaners who based their purchase decision on non-environmental reasons. Their top four preferences – reliability and durability, key features, value for money or brand reputation – are not different from those of the 73% of customers who bought energy-inefficient vacuum cleaners. Brand reputation was not decisive in their choice for energy (in)efficiency, unlike as suggested by McDonald et al. (2009) for household appliances. Many researchers researching sustainable consumption (Dangelico and Vocalelli, 2017; Lorek and Spangenberg, 2014; Peattie, 2001) focus on the green consumer. We showed that a focus on the green consumer is not the most effective approach to encourage sustainable consumption or development, as most consumers do not show a commitment to sustainable appliances in our study.

The consumer research performed on sustainable durables and preferences, alternative energy cars (Jansson et al., 2017) and solar systems (Elmustapha et al., 2018) has shown that visible evidence of sustainability is an important factor in the buying process. We did not find support for this. Which might be because household appliances like vacuum cleaners are usually not used in front of third parties.

5.1.2. Buying behaviour insights

Although the product preferences of most consumers are the same, most (73% in our case) buy energy-inefficient vacuum cleaners even when a more efficient model with the same specifications and price is on offer. Even self-pronounced green consumers often do not act on their promises (McDonald and Oates, 2006). We showed that there are differences between the factual product attributes and how these attributes are perceived in the buying process (see 4.2). Due to biases (Frederiks et al., 2015), consumers expect the energy-inefficient vacuum cleaner to provide better performance and offer a more reliable and durable product. Especially the buyers of energy-inefficient vacuum cleaners value technology, and perceive high weight to be related to high quality (durability). People probably avoid the potential risk that a more energy-efficient model might provide lower performance and instead hang on to their default option: their last, probably energy-inefficient, vacuum cleaner. This is comparable to the results of research by Luchs et al. (2010) who found that the performance of tyres, also a low involvement product, is negatively affected by sustainable attributes.

5.2. Managerial implications

In this section we will provide guidelines to meet the preferences of mainstream, non-green consumers with sustainable, energy-efficient products.

5.2.1. Communication and Branding

'Green' is the primary buying reason for only 6% of the buyers in our study. These buyers are so different from the rest of the buyers that our research suggests they would even be willing to accept somewhat lower performance if their environmental preferences are met. On the other hand, current buyers of high input power machines were even put off by the environmental benefits, or at least were indifferent to the promotion of energy efficiency. The two groups are so different that it would be best to address them separately. It is well documented that 'green' does not have positive connotations for everybody in the retail shop: 'green' is perceived as being either less reliable (Luchs et al., 2010) or more expensive (Niinimäki, 2010; Visser et al., 2015). A study on sustainable packaging and environmental messages also concluded that people with low environmental consciousness are more successfully reached with packaging without an environmental claim (Magnier and Schoormans, 2015). In addressing non-green buyers, combining communication with an environmental visual image seems to hurt both the brand and product. Ottman (1995) was one of the first researcher to have realized the dilemmas of green marketing, and introduced the idea of 'personal benefit', which is predominant in the retail phase, and the 'environmental benefit', which has long-term importance for the same buyers. The benefits of radical designs, in this case higher performance with lower input power through technologically advanced design, should be actively marketed in communications and promotions (Mugge and Dahl, 2013). Vogtlander et al. (2014, Section 8) describe the consequences: create a green brand and deliver sustainable products and services, but emphasize their high performance (personal benefit) to counteract the negative connotations of green at the moment of purchase. This is supported by our results (4.2 and 4.3), which showed that the preferences of 'non-green' buyers do not differ from each other and are focused on performance. To these buyers, lower energy consumption should be promoted in the form of superior performance through technological innovation, while an emphasis on environmental benefits should be avoided in product communications. This is in contrast to the communications used by Philips for the vacuum cleaners in our dataset, where all energy-efficient vacuum cleaners were promoted in terms of environmental benefits. Their communication focused purely on the few 'green' buyers.

5.2.2. Redesign

To attract mainstream buyers with energy-efficient products, innovative redesign is required. To satisfy customers, the actual suction performance of energy-efficient vacuum cleaners should be at least as good as that of less energy-efficient models. Heiskanen et al. (2010) provided several technical solutions to this. At the moment of purchase, the perceived power is even more critical than the actual input power. Product design can counter the biases and incorrect perceptions of consumers that high input power stands for high performance and low input power means an inferior product. In fact, the current high power buyers should be seduced to buy low power innovations. Mugge et al. (2017) provided guidelines for influencing consumer perceptions of durable products. The redesign of low input power vacuum cleaners must be fine-tuned to the specific requirements of high performance buyers. It should show robustness (including weight) and suction power, and be equipped with a bag. Extra weight and bags for dust collection will add some additional environmental cost but, since 75-80% of the environmental cost is caused by energy consumption, this will be more than offset by moving mainstream buyers over to buy energy-efficient models. The additional weight can be used for value-adding features such as higher perceived performance and quality, additional sound-proofing to reduce noise or heavier filters for cleaner air.

It is important to mention that buyers of vacuum cleaners do not base their decisions solely on price and technical specifications. Most of the consumer preferences in Figure 2 concern emotions, biases and perceptions, not facts. The perceived customer value (i.e. the utility and fun the customer expects after the purchase) is mainly determined by their preferences in the retail channel and are similar among nearly all buyers: reliability & durability, key features, value for money and the reputation of the brand. Most of the specifications are irrelevant to preferences for either a low or high input power version (4.2.), and are not functionally linked to performance. This is an advantage, since exactly these product attributes can be used to reinforce perceptions of performance and reliability without compromising either performance or energy consumption.

We believe that these recommendations to counter the perceived reduced performance of energy efficiency could be applied to other energy-efficient appliances as well. Mugge and Schoormans (2012) have already shown this for washing machines and cameras.

5.3. Policy implications

Our research showed that three out of four of our buyers opted for an energy-inefficient vacuum cleaner although an equal energy-efficient model was on offer. We view the implementation of energy-efficiency legislation as an effective tool to foster sustainable consumption. It instantly forced the majority, roughly 73% of the consumers in our consumer database, towards more energy-efficient consumption. This was likely much quicker (Brown, 2015; Koomey, 1994) than convincing the majority of consumers through marketing and education. Legislation also forces manufacturers to develop energy-efficient technologies to meet mainstream customer needs and wishes. Lorek and Spangenberg (2014) pointed out that sustainable economies do not match the mainstream economic business models and can never be a driver for sustainable development without governmental intervention. Legislation also has limitations as it has no or limited impact outside the European Union and should not be seen as a silver bullet (Lehner et al., 2016; Sousa Lourenco et al., 2016). Redesigns of products and communication are therefore needed to address the needs and perceptions of buyers outside the EU.

5.4. Limitations of the dataset

The advantage of using the Philips dataset is that it is sufficiently large to do statistical analysis. The disadvantage is that the consumer preferences part falls short on details. The quality of the analysis could have been better if (1) the consumer preferences had been asked using a scale per aspect, rather than by asking for one primary reason, because it could be that different preferences are related and would yield more insight into individual biases, and (2) the reason for the choice related to the product specifications had been asked as well. There is thus room for improvement in future measurements.

Another issue is that the analysis was restricted to Western European consumers, because the data on other regions of the world were both smaller in quantity and the model offerings differ too much over regions. Extrapolation of conclusions to other regions of the world must be done with great care due to cultural differences, especially since consumers in other regions such as China and Brazil prefer and buy smaller input power machines with lower weight and size (Coronado Palma and Visser, 2012) to start with.

5.5. Future research

Our research provided support for the biases against sustainable and energy-efficient products (Frederiks et al., 2015). Further research is needed to show the relevance for other product categories like food, cosmetics or fashion. Preferences play an important role in sustainable consumption, as other research has pointed out (Auger and Devinney, 2007; Carrington et al., 2010; Luchs et al., 2010; Rex and Baumann, 2007). However, most of this research is focused on green consumers rather than the mainstream. We would like to encourage our colleagues to add to our work and adapt the models to include mainstream buyers in sustainable consumption.

6. Conclusions

In our research, we see basically three types of buyers of appliances: (1) a small minority (here 6%) of green buyers that regard the environment as a primary selection criterion, (2) the majority (here 73%) of buyers who think that only high input power cleaners provide the best performance and reliability & durability and (3) buyers (21%) who prefer low power cleaners because they either consider other specifications not discriminating enough and base their final choice on environmental aspects, or consider energy efficiency as a no-brainer and base their decision on other aspects. With the exception of environmental buyers, most buyers have the same primary preferences: reliability/durability, key features, value for money or brand reputation. All these preferences could be equally realized with an energy-efficient model.

We showed that perception and biases are major obstacles to sustainable consumption of durables. The people who did not buy energy-efficient vacuum cleaners did so because they, incorrectly, perceived that higher input power stands for higher performance and value. Getting this group of buyers to buy energy-efficient products has been a difficult and slow process. European legislation instantly more than tripled sales of energy-efficient vacuum cleaners and is regarded by us as both an efficient way to increase sustainable consumption and as a means to put pressure on the industry to innovate towards sustainable consumption. We think that with this research we open up possibilities to increase consumer acceptance and enthusiasm for energy-efficient consumer electronics. By applying this knowledge to future product design and communications of household appliances and consumer electronics in general, it would be possible to deliver low power versions with an higher perceived consumer value than that of the high-power versions, while also being energy efficient. These innovative energy-efficient designs must be marketed as providing high performance thanks to their high technology, low noise and robustness.

In general, one should realize that although environmental benefits are important for the long-term transition towards a sustainable society, personal benefit dominates the mainstream buyers' choice at the moment of purchase. As a consequence, communication of product attributes must be done with great care: (1) direct communication of the energy efficiency of products must always go hand in hand with a message of technological advancement, since 'less energy' is perceived as coming at the cost of 'lower performance' and (2) the mainstream consumer must be seduced at the moment of purchase to buy the energy-efficient product by relying on benefits other than 'less energy'. Such a double approach requires a high level of integration of design and marketing.

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References

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes 50, 179-211.
Auger, P., Devinney, T.M., 2007. Do What Consumers Say Matter? The Misalignment of Preferences with Unconstrained Ethical Intentions. Journal of Business Ethics 76, 361-383.
Baumann, H., Boons, F., Bragd, A., 2002. Mapping the green product development field: engineering, policy and business perspectives. Journal of Cleaner Production 10, 409-425.
Brown, M., 2015. Innovative energy - efficiency policies: an international review. Wiley Interdisciplinary Reviews: Energy and Environment 4, 1-25.
Carrington, M.J., Neville, B.A., Whitwell, G.J., 2010. Why Ethical Consumers Don't Walk Their Talk: Towards a Framework for Understanding the Gap Between the Ethical Purchase Intentions and Actual Buying Behaviour of Ethically Minded Consumers. Journal of Business Ethics 97, 139-158.
Coronado Palma, N., Visser, M., 2012. Sustainability creates business and brand value. Journal of Brand Strategy 1, 217-222.
Creusen, M.E.H., 1998. Product appearance and consumer choice, Industrial Design Engineering. Delft University of Technology, Delft, The Netherlands, p. 231.
Creusen, M.E.H., Schoormans, J.P.L., 2005. The Different Roles of Product Appearance in Consumer Choice*. Journal of Product Innovation Management 22, 63-81.
Dangelico, R.M., Vocalelli, D., 2017. "Green Marketing": An analysis of definitions, strategy steps, and tools through a systematic review of the literature. Journal of Cleaner Production 165, 1263-1279.
De Angelis, M., Adıgüzel, F., Amatulli, C., 2017. The role of design similarity in consumers' evaluation of new green products: An investigation of luxury fashion brands. Journal of Cleaner Production 141, 1515-1527.
Ellen, P.S., 1994. Do we know what we need to know? Objective and subjective knowledge effects on pro-ecological behaviors. Journal of Business Research 30, 43-52.
Elmustapha, H., Hoppe, T., Bressers, H., 2018. Consumer renewable energy technology adoption decision-making; comparing models on perceived attributes and attitudinal constructs in the case of solar water heaters in Lebanon. Journal of Cleaner Production 172, 347-357.
European Union, 2013. Implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for vacuum cleaners, in: Commision, E.U. (Ed.), Brussels.
Frederiks, E.R., Stenner, K., Hobman, E.V., 2015. Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. Renewable and Sustainable Energy Reviews 41, 1385-1394.
Heiskanen, J., Mälkki, H., Vanhanen, H., 2010. Product-specific EuP studies of LOTS 15 to 18. Nordic Council of Ministers.
Hüttel, A., Ziesemer, F., Peyer, M., Balderjahn, I., 2018. To purchase or not? Why consumers make economically (non-)sustainable consumption choices. Journal of Cleaner Production 174, 827-836.
Jansson, J., Nordlund, A., Westin, K., 2017. Examining drivers of sustainable consumption: The influence of norms and opinion leadership on electric vehicle adoption in Sweden. Journal of Cleaner Production 154, 176-187.
Koomey, J.G.J.J.G., 1994. Technical evidence for assessing the performance of markets affecting energy efficiency. Energy Policy 22, 826-832.
Lehner, M., Mont, O., Heiskanen, E., 2016. Nudging – A promising tool for sustainable consumption behaviour? Journal of Cleaner Production 134, 166-177.
Liobikienė, G., Mandravickaitė, J., Bernatonienė, J., 2016. Theory of planned behavior approach to understand the green purchasing behavior in the EU: A cross-cultural study. Ecological Economics 125, 38-46.
Lorek, S., Spangenberg, J.H., 2014. Sustainable consumption within a sustainable economy – beyond green growth and green economies. Journal of Cleaner Production 63, 33-44.
Luchs, M.G., Naylor, R.W., Irwin, J.R., Raghunathan, R., 2010. The Sustainability Liability: Potential Negative Effects of Ethicality on Product Preference. Journal of Marketing 74, 18-31.
Magnier, L., Schoormans, J., 2015. Consumer reactions to sustainable packaging: The interplay of visual appearance, verbal claim and environmental concern. Journal of Environmental Psychology 44, 53-62.
McDonald, S., Oates, C., Thyne, M., Alevizou, P., McMorland, L.A., 2009. Comparing sustainable consumption patterns across product sectors. International Journal of Consumer Studies 33, 137-145.
McDonald, S., Oates, C.J., 2006. Sustainability: Consumer Perceptions and Marketing Strategies. Business Strategy and the Environment 15, 157-170.
McDonald, S., Oates, C.J., Alevizou, P.J., Young, C.W., Hwang, K., 2012. Individual strategies for sustainable consumption. Journal of Marketing Management 28, 445-468.
Mont, O., Plepys, A., 2008. Sustainable consumption progress: should we be proud or alarmed? Journal of Cleaner Production 16, 531-537.
Mont, O., Power, K., 2010. The Role of Formal and Informal Forces in Shaping Consumption and Implications for a

Sustainable Society. Part I. Sustainability 2, 2232.
Mugge, R., Dahl, D.W., 2013. Seeking the Ideal Level of Design Newness: Consumer Response to Radical and Incremental Product Design. Journal of Product Innovation Management 30, 34-47.
Mugge, R., Dahl, D.W., Schoormans, J.P.L., 2017. "What You See, Is What You Get?" Guidelines for Influencing Consumers' Perceptions of Consumer Durables through Product Appearance. Journal of Product Innovation Management, n/a-n/a.
Mugge, R., Schoormans, J.P.L., 2012. Newer is better! The influence of a novel appearance on the perceived performance quality of products. Journal of Engineering Design 23, 469-484.
Niinimäki, K., 2010. Eco-Clothing, consumer identity and ideology. Sustainable Dev. 18, 150-162.
Odyssee-Mure, 2017. Household energy consumption by energy in the EU.
Ottman, J.A., 1995. Green Marketing: Challenges & Opportunities for the new marketing age, 3rd. ed. NTC Business Books, Chicago.
Peattie, K., 2001. Golden goose or wild goose? The hunt for the green consumer. Business Strategy and the Environment 10, 187-199.
Power, K., Mont, O., 2010. The Role of Formal and Informal Forces in Shaping Consumption and Implications for Sustainable Society: Part II. Sustainability 2, 2573.
Rex, E., Baumann, H., 2007. Beyond ecolabels: what green marketing can learn from conventional marketing. Journal of Cleaner Production 15, 567-576.
Sousa Lourenco, J., Ciriolo, E., Almeida, S., Troussard, X., 2016. Behavioural insights applied to policy. European Commission) Available at:(accessed 28 September 2017).
Tabachnick, B.G., Fidell, L.S., 2013. Using multivariate statistics, 6th ed. Pearson Education, Boston.
Tanner, C., Kast, S.W., 2003. Promoting sustainable consumption: Determinants of green purchases by Swiss consumers. Psychology & Marketing 20, 883-902.
The week, 2015. Dyson loses lawsuit over EU energy tests, UK.
United Nations Environmental Programme, 2005. Talk the walk; Advancing Sustainable Lifestyles through Marketing and Communications. United Nations Environmental Programme.
van Doorn, J., Verhoef, P.C., 2011. Willingness to pay for organic products: Differences between virtue and vice foods. International Journal of Research in Marketing 28, 167-180.
Visser, M., Gattol, V., van der Helm, R., 2015. Communicating sustainable shoes to mainstream consumers: The impact of advertisement design on buying intention. Sustainability (Switzerland) 7, 8420-8436.
Vogtländer, J.G., Bijma, A., Brezet, H.C., 2002. Communicating the eco-efficiency of products and services by means of the eco-costs/value model. Journal of Cleaner Production 10, 57-67.
Vogtländer, J.G., Mestre, A., van der Helm, R., Scheepens, A., Wever, R., 2013. Eco-efficient Value Creation, sustainable design and business strategies.

Appendix A. Reasons to Buy Definitions

What was your reason to buy this specific model vacuum cleaner? Choose one of the following reasons. I bought it while ….

Reason to buy	Definition
RS0 None of those	
RS1 Fit	The vacuum cleaner fits with the other products I own
RS2 Brand reputation	This brand has a good reputation in vacuum cleaners
RS3 Key feature	The vacuum cleaner's key features as dust chambers size, accessories, filter(s), performance, cord length etcetera
RS4 Service	Customer service helps me to solve my problems as soon as possible, user manual is clear and complete
RS5 Design/ Look	The vacuum cleaner's colours look nice, modern design, its shape is nice
RS6 Ease of Use	The vacuum cleaner is easy to store, good to manoeuvre, compact, easy to carry, easy to use on stairs
	It is easy to empty the dust chamber/ change the bag, clean the filter, to vacuum clean under furniture
RS7 environment	The vacuum cleaner has low power consumption
	It is made from environmental friendly materials
RS8 Warranty	The warranty is good, its period is long
RS9 Value for Money	Price compared to what you get is good
RS10 Product Reliability/ durability	The vacuum cleaner, and its accessories and parts, feel durable

Appendix B. Specification Attributes versus Input Power

Table B.1Pearsons Correlations between Specification Attributes (N=32).

		Input Power	Price	Weight	Noise	Suction	Bagless Bag
Pearson Correlation	Input power	1	-.136	.224	.213	.546	.121
	Price	-.136	1	.857	-.635	.192	-.168
	Weight	.224	.857	1	-.651	.054	-.365
	Noise	.213	-.635	-.651	1	-.251	-.025
	Suction	.546	.192	.054	-.251	1	.671
	Bagless Bag	.121	-.168	-.365	-.025	.671	1
Significance (1-tailed)	Input power	.	.263	.126	.125	.001	.256
	Price	.263	.	.000	.000	.184	.216
	Weight	.126	.000	.	.000	.393	.028
	Noise	.125	.000	.000	.	.087	.447
	Suction	.001	.184	.393	.087	.	.000
	Bagless Bag	.256	.216	.028	.447	.000	.
N	Input power	32	24	28	31	31	32
	Price	24	24	21	24	24	24
	Weight	28	21	28	28	28	28
	Noise	31	24	28	31	31	31
	Suction	31	24	28	31	31	31
	Bagless Bag	32	24	28	31	31	32

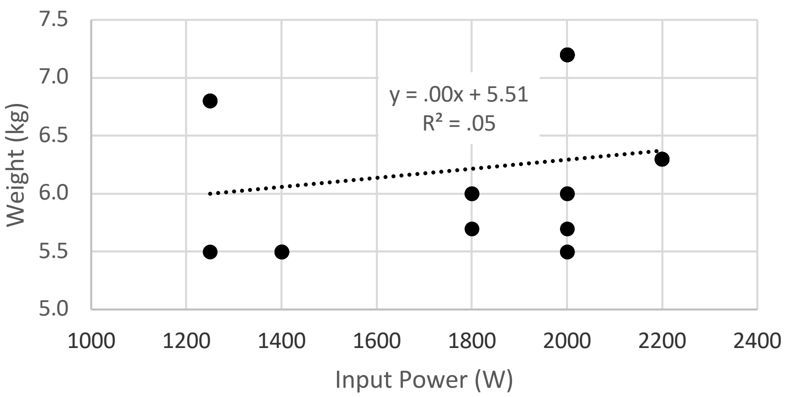

Figure B.1. : Weight (kg) versus Input Power (W) (N=28)

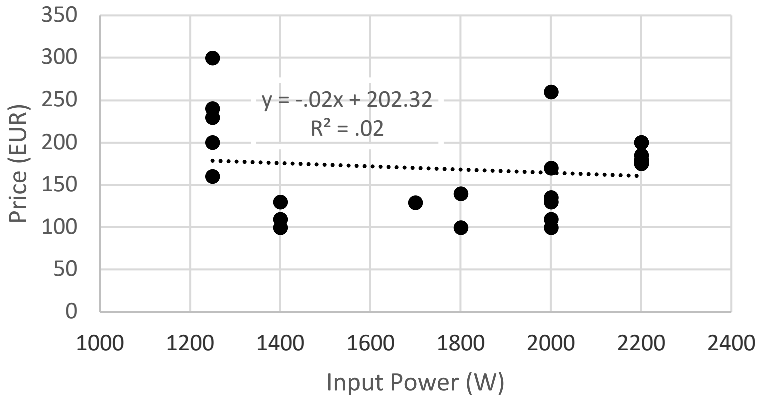

Figure B.2: Price (EUR) versus Input Power (W) (N=24)

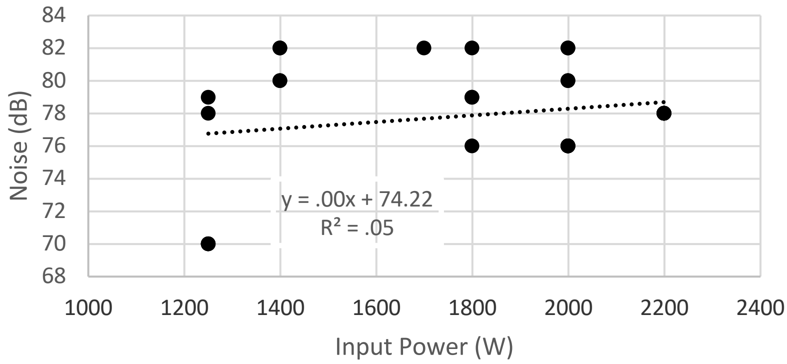

Figure B.3. Noise (dB) versus Input Power (W) (N=31)

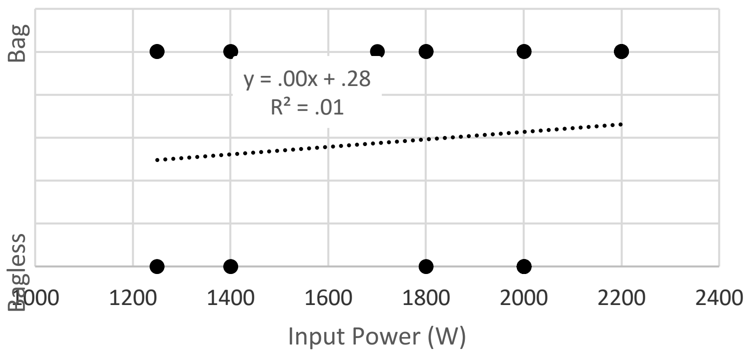

Figure B.4.: Bagless/Bag versus Input Power (W) (N=32)

Appendix C. Correlations Reason to buy with specifications

Table C.1. Pearson correlations. N=951. * Correlation is significant at the .05 level (2-tailed). ** Correlation is significant at the .01 level (2-tailed).

	Power low/high	RS0 None	RS1 Fit	RS2 Brand reputation	RS3 Key feature	RS4 service	RS5 Design Look	RS6 Ease of use	RS7 Environment	RS8 Warranty	RS9 Value for money	RS10 reliability durability	Price RPP/NL EURO	Message Environment	Message Technology	Weight (kg)	Noise level (dB)	Suction (watt)	Bagless/ Bag
Power low/high	1																		
RS0 None	.066*	1																	
RS1 Fit	0.019	-0.03	1																
RS2 Brand reputation	0.06	-.104**	-0.057	1															
RS3 Key feature	0.018	-.111**	-0.06	-.212**	1														
RS4 service	0.033	-0.037	-0.02	-.070*	-.075*	1													
RS5 Design Look	0.015	-0.028	-0.015	-0.055	-0.058	-0.019	1												
RS6 Ease of use	.085**	-.067*	-0.037	-.129**	-.137**	-0.045	-0.035	1											
RS7 Environment	-.395**	-0.057	-0.031	-.110**	-.117**	-0.039	-0.03	-.071*	1										
RS8 Warranty	0.058	-0.03	-0.016	-0.057	-0.06	-0.02	-0.015	-0.037	-0.031	1									
RS9 Value for money	-0.024	-.105**	-0.057	-.202**	-.214**	-.071*	-0.055	-.130**	-.111**	-0.057	1								
RS10 reli- &durable	0.042	-.126**	-.068*	-.241**	-.256**	-.085**	-.066*	-.155**	-.132**	-.068*	-.243**	1							
Price RPP/NL EURO	-0.003	0.056	0.024	-.073*	.125**	0.059	-0.001	0.014	-0.02	-0.018	-.110**	0	1						
Message Environ.	-1.000**	-.072*	-0.018	-0.058	-0.024	-0.032	-0.013	-.083*	.392**	-0.053	0.031	-0.039	-0.057	1					
MessageTechnology	.358**	0.013	0.057	-0.064	.125**	.080*	0.016	0.039	-.156**	0.034	-.097**	0.021	.769**	-.358**	1				
Weight (kg)	.328**	0.028	0.048	-0.048	.136**	.066*	0.011	0.025	-.174**	0.018	-.091**	0.017	.839**	-.328**	.835**	1			
Noise level (dB)	-.094**	-0.003	-0.041	0.038	-.106**	-0.06	0.007	0.046	.105**	-0.007	.081*	-0.059	-.709**	.094**	-.723**	-.799**	1		
Suction (watt)	.547**	0.038	0.035	-0.001	0.054	.079*	0.01	0.06	-.251**	0.036	-0.043	0.015	.484**	-.547**	.718**	.393**	-.389**	1	
Bagless/Bag	.415**	0	0.048	0.022	-0.002	.075*	0.044	0.021	-.221**	0.029	-0.01	0.037	.148**	-.404**	.511**	.184**	-.438**	.807**	1

Appendix D. Supplementary Materials

Discriminant Function Analysis

D.1. Group Statistics

Power low/high	Attributes	Mean	Std. Deviation	Valid N (listwise) Unweighted	Weighted
low <1600 Watt	Weight (kg)	5.832	.5679	243	243.000
	Message Technology	.272	.4457	243	243.000
	Bagless/Bag	.383	.4871	243	243.000
	RS7 Environment	.202	.4021	243	243.000
high >1600 Watt	Weight (kg)	6.196	.4215	666	666.000
	Message Technology	.703	.4574	666	666.000
	Bagless/Bag	.800	.4001	666	666.000
	RS7 Environment	.002	.0387	666	666.000
Total	Weight (kg)	6.099	.4921	909	909.000
	Message Technology	.587	.4926	909	909.000
	Bagless/Bag	.689	.4633	909	909.000
	RS7 Environment	.055	.2281	909	909.000

D.2. Log Determinants

Power low/high	Rank	Log Determinant
low <1600 Watt	4	-9.482
high >1600 Watt	4	-15.077
Pooled within-groups	4	-9.720

D.3. Test

Box's M		3504.563
F	Approx.	348.175
	df1	10
	df2	988488
	Sig.	.000

D.4. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.440[a]	100.0	100.0	.553

D.5. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.694	329.996	4	.000

D.6. Classification Function Coefficients

	Power low/high	
	low <1600 Watt	high >1600 Watt
Weight (kg)	124.305	126.119
Message Technology	-125.919	-126.368
Bagless/ Bag	55.904	58.200
RS7 Environment	19.305	15.233
(Constant)	-359.317	-369.944

Fisher's linear discriminant functions

D.7. Classification Results

			Predicted Group Membership		
		Power low/high	low <1600 Watt	high >1600 Watt	Total
Original	Count	low <1600 Watt	165	78	243
		high >1600 Watt	1	665	666
	%	low <1600 Watt	67.9	32.1	100.0
		high >1600 Watt	.2	99.8	100.0

91.3% of original grouped cases correctly classified