

Elicitation of Willingness to Pay for Upgradeable Products with Calibrated Auction-Conjoint Method

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INTRODUCTION

Innovation is a means to compete while satisfying consumers' constantly changing needs and desires. New product development originates from new technologies or from new market possibilities (Eliashberg et al. 1995). But the ultimate success of new products is based on the assessment of judgments of the consumer (Brown and Eisenhardt 1995; Cooper & Kleinschmidt 1987).

In terms of experimental economics, products or services not currently presented on the marketplace (or there is no marketplace for such goods) are called non-market goods and include new products; both private and public (Lusk and Shogren, 2007).

The incorporation of the 'voice of the consumer' in the early stages of new product development has been identified as a critical success factor for the development of new products (Van Kleef et al. 2005). Consumer oriented studies could be carried out at four different stages of new product development: 1) at the stage of identification of technological opportunities, 2) at the development stage, 3) at the testing stage, 4) market launch stage. Most often, consumer research is performed during the development, testing or launching of a new product, while various studies show that successful new product development is mainly based on the quality of the identification of possibilities: analysis of a market (consumer needs and market opportunities) (Veryzer, 1998), technology possibilities, anticipation of new product costs, etc.

The importance and success on the market of new innovative products can be also explained by an added value to consumer according to Moors and Donders (2003). The estimation of an added value may pose several difficulties depending on the type of a new product: radical or genuinely vs. artificially or evolutionary new products (Veryzer, 1998).

Numerous research has been conducted on both types of new products, however, few research has been made on new products in terms of sustainable development. A new evolutionary product (including improvements, line extensions and upgrades) may be interpreted as a product, which avoids an obsolescence of the product itself. Nidumolu, Prahalad and Rangasami (2009) claim that "[S]mart companies now treat sustainability as innovation's new frontier."

A fundamental research on upgradeable products (named flexible) by Alptekinoglu and Ramachandran (2014) consists of claiming that consumer may adjust some attributes of the product while using/consuming it. The authors suppose that if consumers' preferences change in time, a consumer may have a disutility from having a 'bad' product at time $t+1$, when he/she has bought this product at time t while it was 'good' yet. A consumer is interested in buying an upgradeable product when he has a high valuation of it, so he is ready to pay a premium. At the

same time a consumer anticipates a significant costs reduction in future due to the economies realized by upgrading the product's obsolete parts only and not buying a new expensive product. The paper claims as well that "a flexible product may lead to more profits [to a producer] than a portfolio of standard products when consumer preferences are more stable" due to an elevated value of each upgrade. These notions are supported in the empirical work of Ülkü et al. (2012). The authors use a titration method and state that the valorization of an upgradeable product depends on the initial price and the price of upgrade, the periods between upgrades, the perceived quality of the upgrade and perceived efforts to install it. The results show that in general consumers are willing to pay premiums for upgradeable products, however, the more distant the upgrade is, the smaller are the premiums. Consumers tend to undervalue future savings when the product has a short upgrade period and to overvalue future savings in case of a long upgrade period. So, an upgradeable strategy is advantageous for long-life-cycle products with slow technology development processes. The authors also conclude that consumers are willing to pay less if the perceived quality of an upgrade is low and the perceived efforts are high.

Previous empirical research on upgradeable products (Inoue et al., 2014) is focused on a vacuum cleaner with a performance upgrade by exchanging a motor part. Three different scenarios are proposed to a consumer: an upgrade with an amelioration of suction power, an upgrade leading to a noise decrease and an upgrade leading to an energy consumption decrease. An upgrade time is taken as seven years, estimated trade-up time. At the same time another empirical research (Pialot and Millet, 2014) approaches to upgradability from two sides: an upgrade because of the end of the physical lifetime of a product (the product does not work anymore) and because of the end of the value lifetime (the product has no value for a consumer but may still work). Consumers may want to change/upgrade a product because of the products' desired characteristics, situation on the market and its' influences, and consumer characteristics (changed preferences). The authors conduct multi-country quantitative (480 questionnaires) and qualitative (focus groups) surveys and obtain results that more than 55% of products are replaced when they still work, these replacements are provoked by an accumulation of dissatisfaction by the product (accumulation of product's problems) and by new products' functions/design/etc available of the market, in other words by the "versatility" of consumers faced to potential innovations. These research papers take into consideration a price of an upgrade and its' installation, and whether it is installed by the user or by a specialist. The researchers state that these parameters influence consumers preferences and the acceptability of an upgrade. In our research these issues are not taken into account, because the research is about the fact of acceptability of an upgrade principle and not about the reasons of it.

The next section discusses the methods of willingness-to-pay revelation. Section 2 presents the concept of upgradeable vacuum cleaners and the experimental design. In section 3 we present the results of our research on desirability of attributes and their repartition. Finally, the WTP is presented in the last section.

1. Methods of WTP revelation

As mentioned above, consumer preferences are an important element of innovation processes and new product development. To a large extent, consumers construct their preferences when faced with a specific purchase decision, rather than retrieve pre-formed evaluations according to

Moors and Donders (2003). So in empirical perspective, willingness to pay is a measure of strength of preferences (Hausman, 2012).

By now there are many value elicitation methods had been developed to measure consumer's willingness to pay for a good or a service. In general, they can be divided for two main groups: revealed and stated preferences methods. The distinction, which is important for the current research, is that revealed preference methods (RP) analyze real choices and are possible only for goods which already exist, whereas stated preference methods (SP) can be used on a hypothetical market, created by researcher to sell/buy any good. Therefore, the class of innovative products, including upgradeable products (Krishnan and Ramachandran, 2011) can be analyzed by the latter.

As one of SP method, a classical conjoint analysis (CA) proposes the respondents to evaluate a series of alternatives one at a time, using a numerical rating scales (Voelckner, 2006). Each choice is defined in terms of a set of attributes whose levels are varied across questions according to an experimental design. Such technique forces to evaluate each choice separately and to give a preference rating. There is also made some research, which allows "personalizing" or adapting CA for each consumer: the estimations made by LINMAP (Srinivasan and Shocker, 1979) and later in Srinivasan and Park (1997) and Srinivasan and Netzer (2007).

Another efficient type of WTP elicitation methods is auctions. The obvious advantage of an auction among other value elicitation methods is their potential to put a player in active market environment, incorporating market feedback (or create a market for nonmarket goods) and possible future consequences (Harrison et al., 2004).

In this paper, we use a calibrated auction-conjoint method (CACM) (Lusk and Norwood, 2011). This method combines benefits of a conjoint analysis, such as simplicity for respondents (Adamovicz et al., 1998, Voelckner, 2006) and revealing demand separately for each alternative, with those of auctions, as a less biased measure of WTP, possibility to answer more thoughtfully placing the bids for a product. These particular features of the method allow assessing the components of preferences and WTP for the product's upgrades. In addition, CACM permits to evaluate a large number of attributes with many levels and for numerous products, decomposing preferences by this.

The method consists of three stages (Lusk and Norwood, 2011; Kovalsky and Lusk, 2013, Avitia et al., 2011). First stage proposes a participant to rate the desirability of each attribute level of the product on the Likert scale (1 is the least desirable and 10 is the most desirable), assuming that all other characteristics are hold constant.

On the second stage respondents are invited to indicate the relative importance of each attribute of the product on the Likert scale of 1 to 7 (1 is very unimportant and 7 is very important).

We use the same scales as in Lusk and Norwood (2011) in order to avoid inconsistencies due to differences in methodology and be able to exactly replicate it.

These two stages may be referred as a conjoint analysis part, whereas the third stage is an auction part. So, on the third stage participants see the summary of their bids for several configurations of the product, which are calculated on the basis of the answers on previous stages.

In order to calculate WTP after conjoint analysis part, an attribute-based utility is calculated by multiplying the relative importance of each attribute by each attribute's rating (Kovalsky and Lusk, 2013).

Individual's part-worth utility for an attribute-level is

$$P_{ijl} = D_{ijl}W_{ij},$$

where W_{ij} is individual i 's importance weight for attribute j (normalized, $\sum W_{ij} = 1$); D_{ijl} is individual i 's desirability ranking for the l th level of attribute j (normalized).

Then, an individual's non-price utility for a particular product type with its set of attributes and their levels is calculated by summarizing part-worth utilities for all attributes and their levels:

$$U_{it} = \sum_{j=1}^J \sum_{l=1}^{L_k} A_{jl} P_{ijl},$$

where U_{it} is individual i 's non-price utility for product t ; J is the total number of attributes; A_{jl} is a dummy variable which equals to 1 if product t has the l th level of the j th attribute, and 0 otherwise.

Final step of WTP calculation is based on estimation of difference in WTP for one product over another, in other words a premium:

$$WTP_{itk} = (U_{it} - U_{ik})/W_{ip},$$

where WTP_{itk} is individual i 's WTP premium for product t over product k ; U_{it} is individual i 's utility for product t ; U_{ik} is individual i 's utility for product k ; W_{ip} is individual i 's importance weight for price attribute.

This method allows a participant to analyze a large number of attributes one by one and recalculate the bids (by changing the weight for an attribute (W_{ij})) if at the end of the session they do not agree with the calculation of their bids. So, on this stage participants "calibrate" their answers of two previous stages. The ability to revise the rating makes these hypothetical answers more sincere. In Lusk and Norwood (2011) is reported that 99% of participants change their ratings after having seen the results of WTP calculation. In Kovalsky and Lusk (2013), when using an online survey tool this parameter is 45%.

To our knowledge our research is the only research, which uses CACM for durable products with upgrade possibility.

2. The experiment

2.1. General information

For CACM (Calibrated auction-conjoint method) treatment the WTP measurements are calculated on the basis of consumers' answers to multiple questions about vacuum cleaners. This type of product is chosen with our industrial partner.

The concept of upgradeable products has been implied for two types of vacuum cleaners: an upright wireless vacuum cleaner and a wired vacuum cleaner. On the results of previous studies (Michaud et al., 2015) as well as on the commercialization results of a non-upgradeable version

of the product the main characteristics of a vacuum cleaner (both an upright wireless vacuum cleaner and a wired vacuum cleaner) have been defined.

The industrial partner has indicated that he is interested in future development of upgrades in two directions: usage optimization and connectivity upgrade, and a functional upgrade. The functional upgrade is in line with recent research (Inoui et al, 2014) and represents a change of an important part of a vacuum cleaner, such as a motor or a battery.

The upgrade option is presented as an after-purchase service on warranty. The producer proposes this service for a consumer on the principle that their product can be upgraded with the current technology development. So a consumer has no need to buy a new product to benefit from new technologies' advantages or new functions proposed in stores.

On the basis of these explorations we have designed our experiment.

2.2. Experimental design

This study focuses on two types of vacuum cleaners as described above:

- an upright wireless vacuum cleaner;
- a wired vacuum cleaner.

There are attributes that are common for both products, several of them, however, have different levels, and there are some attributes applicable only for one type of vacuum cleaners, such as the type of the battery for an upright wireless vacuum cleaner and the length of the cable for a wired vacuum cleaner. Table 1 lists and defines these attributes and their respective levels:

Table 1. Products' attributes and their levels.

Attribute	Levels	
	Upright wireless vacuum cleaner	Wired vacuum cleaner
Brand	Low quality brand	Low quality brand
	Medium quality brand	Medium quality brand
	High quality brand	High quality brand
Power max	Less than 10 Volts	Less than 1600 W
	10-20 Volts	1600-2000 W
	More than 20 Volts	More than 2000 W
Capacity of the dust tray	Less than or equal to 0,5 L	Less than or equal to 2,5 L
	0,5- 1 L	More than 2,5L
Price	Less than 100 Euros	Less than 100 Euros
	100-150 Euros	100-150 Euros
	150-200 Euros	150-200 Euros
	200-250 Euros	200-250 Euros
	250-300 Euros	250-300 Euros
	More than 300 Euros	More than 300 Euros
Number of suction modes	1 mode	1 mode
	2 modes	2 modes
	3 modes or more	3 modes or more
Accessories	One brush	One brush
	Two brushes	Two brushes

	More than two brushes	More than two brushes
Weight	Less than 3 kg	Less than 5 kg
	3-4 kg	5-6 kg
	More than 4 kg	More than 6 kg
Noise level	Less than 71Db	Less than 71Db
	71-75 Db	71-75 Db
	75-79 DB	75-79 DB
	More than 79 Db	More than 79 Db
After-sales service (Upgrade)	Standard warranty	Standard warranty
	Usage optimization and connectivity	Usage optimization and connectivity
	Evolution of the battery/the motor	Evolution of the battery/the motor
Energy consumption		Less than 160 kWh/year
		160-200 kWh/year
		More than 200 kWh/year
Length of the cable		Less than 5 m
		5-7,5 meters
		7,5-10 meters
		More than 10 meters
Presence of a dust bag		yes
		no
Autonomy time	Less than 20 min	
	20-40 min	
	More than 40 min	
Duration of recharge time	Less than 5 hours	
	5-10 hours	
	More than 10 hours	
Battery	Ni-mh	
	Lithium	

3. Results

To study people's preferences for eco-innovative products with upgrades, we have conducted an online recruitment from the laboratory database of contacts in mid May 2014 (total 323 participants) in France. Participants were sent an email invitation, containing a link to an inscription procedure on the website dedicated to the survey. In this email, the participants were told that they were invited to participate in a "study on vacuum cleaners' characteristics".

To reward the participation we told participants that among all participants there will be a lottery for a "coupon" with 50€ value (1 coupon for 300 participants).

At the beginning of the survey all participants were asked whether they possess a wired vacuum cleaner or an upright wireless vacuum cleaner, and whether they plan to buy one. Afterwards, each participant was directed to a questionnaire corresponding to his/her answer (a vacuum cleaner or an upright wireless vacuum cleaner) or proposed to choose which

questionnaire to answer if they have both vacuum cleaners or none. At the end of the questionnaire they were proposed to fill in the same survey for another vacuum cleaner anyway with the possibility to decline it. After the main part of the survey, the participants are asked to answer a socio-demographical questionnaire including questions about their age, marital status, education, etc.

Each attribute, as well as each level of an attribute is explained for a subject. For example, for an upgrade attribute a participant is informed that:

- Option “standard warranty” is an option that provides a phone and / or online support allowing the customer to get personalized assistance on the functioning of the upright vacuum cleaner, as well as a standard exchange service at home with the manufacturer's warranty.
- Option “usage optimization and connectivity” is based on a system of sensors that tell you about your "performance" when vacuuming (duration of use, sucked dust levels, the degree of dirt ...). The "connection" function is to control various connected devices at your home from the upright vacuum cleaner (lights, shutters ...).
- Option "evolution of the battery/the motor" is based on upgrades at regular intervals of the engine and the battery of the cleaner. These upgrades are available depending on technological developments. For an upgrade of the upright vacuum cleaner, it will be necessary to replace the old engine and / or battery by its improved version.

In the same manner all other attributes and their levels are described to the subjects.

We get 224 participants for a wired vacuum cleaner and 98 participants for an upright wireless vacuum cleaner with following characteristics (Table 2):

Table 2. Subjects characteristics.

Characteristics	Levels	Vacuum cleaner (%)	Upright vacuum cleaner (%)	Average (%)
Gender	Men	29.41	31.63	30.52
	Women	70.59	68.37	69.48
Age of participants	Less than 34 y.o.	31	25	28
	35 to 45 y.o.	27	27	27
	45 to 55 y.o.	20	25	22.50
	More than 55 y.o.	22	23	22.50
Family situation	Single	31,22	29.59	30.41
	Married	42,53	40.82	41,68
	Separated	15,84	17.35	16,60
	Civil union	10,41	12.24	11.33
Children in the household	No Children	53,84	54 .08	53.96
	1 Child	20.81	20.41	20.61
	2 Children and more	25.34	25 .5	25.42
Education	No diploma	10.86	9.18	10.02
	Vocational Qualification	17.65	19.39	18,52
	High School qualification	21.27	16.33	18,8

	Bachelor's degree	19	21.43	20.22
	Master's degree	31.22	33.67	32.45
Accommodation	Apartement	76	85	80.5
	House	24	15	19.5
Income	Less than 1200€ per month	24.43	21.43	22.93
	1200€-1900€ per month	43.89	41.84	42.86
	1900€-2650€ per month	18.55	24.49	21.52
	More than 2650€ per month	13.12	12.24	12.68
Occupation	Farmer	0	0	0
	Craftsman, manager or entrepreneur	2.26	2.04	2.15
	Executive	22.62	25.51	24.07
	Middle level profession	15.38	11.22	13.3
	Employees	40.72	35.71	38.21
	Worker	0.45	1.02	0.74
	Senior	8.14	10.20	9.17
	Student	4.07	5.10	4.59
	Other	6.33	9.18	7.76
Surface	Less than 40 m2	9.05	7.14	8.09
	40-100 m2	67.42	67.35	67.39
	More than 100 m2	23.53	25.51	24.52
Floors	One-storeyed	38.91	37.76	38.34
	Multystoried	61.09	62.24	61.67
Location	Urban	56.11	27.15	41.63
	Suburban	33.94	13.57	23.76
	Rural	9.95	3.62	9.95

To facilitate the comparison, the analysis is made on normalized desirability ratings, hence the maximum equals to 1, where 1 is “very desirable” and 0 “not desirable”.

3.1. An upright vacuum cleaner

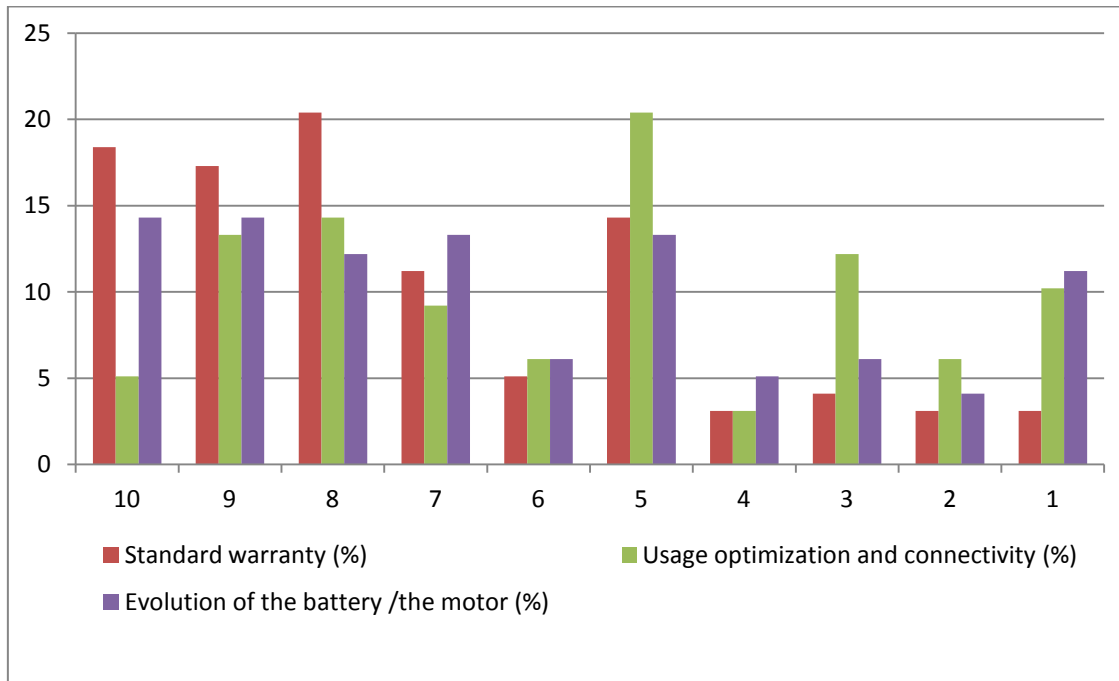
Logically, people prefer upright vacuum cleaners from low price segment (0,66 and 0,67 for prices inferior to 100€ and between 100€-150€ respectively). Then the desirability of increasing prices declines and constitutes only 0,14 for the price of more than 300€. Moreover, men prefer lower prices than women and owners of apartments largely prefer low-price upright vacuum cleaners.

The time of recharge has a high level of desirability for consumers, when it is less than 5 hours (0,85) and the desirability is much less when 5 to 10 hours is needed to change an upright vacuum cleaner (0,5). However, a longer period of recharge is more enviable for house owners than for apartment owners. As well as for men it is more favorable to have an upright vacuum cleaner with a longer recharge time.

As for the time of autonomy, weight and power there is no surprise - participants have a rational behavior and prefer higher levels: higher power and longer autonomy, light weight of an upright vacuum cleaner.

For the warranty attribute the distribution is not that clear (Figure 1).

Figure 1. Upgrade attribute (after-purchase services) distribution, by desirability rate.



For an upright vacuum cleaner participants indicate standard warranty as important level of after-purchase services attribute, ranking 0,68 on average, only 0,31 for the usage optimization and connectivity and 0,46 for the evolution of the battery /the motor (Table 3.). However, there is a significant difference between men and women ratings for upgrade functions: men largely prefer (0.13 more) the evolution of the battery or the motor than women, when women (0.07 more) prefer the usage optimization and connectivity.

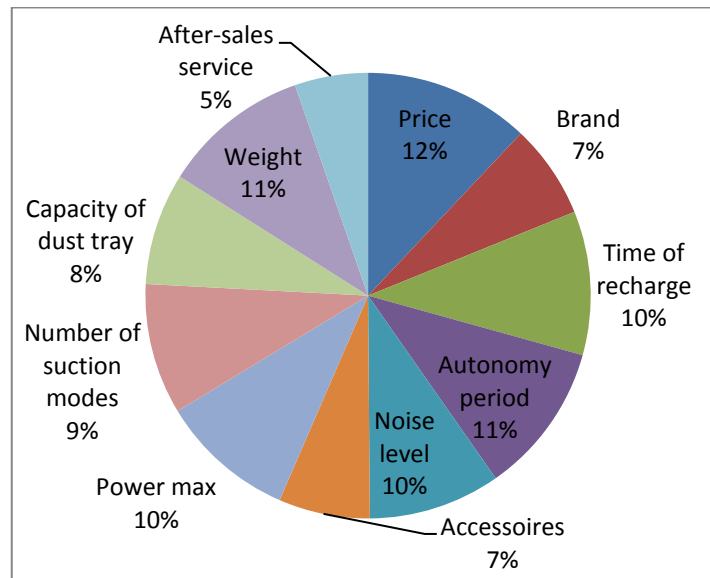
Table 3. Average desirability rates for the upgrade attribute.

	Standard warranty	Usage optimization and connectivity	Evolution of the battery/the motor
Mean	0,678	0,311	0,459
Women	0,694	0,331	0,422
Men	0,647	0,259	0,552

Example of screen pages presented to participants on contingent valuation stages (Stage 1 and Stage 2) are presented in Annex 1:

The distribution of weights shows that most of the attributes have equal weight for the consumers. The three less valued attributes for an upright vacuum cleaner are the brand, the accessories and the warranty services.

Figure 2. Weights distribution for attributes for an upright vacuum cleaner.



3.2. A wired vacuum cleaner

The distribution of price desirability follows an intuitive behavior, most desired (0,56) is the price of a product which varies between 100-150€, little less (0,52) desired are products with a price below 100€, probably due to perceived low quality, and a price between 150€ and 200€ is equal to 0, 54 rating of desirability. Other levels of prices are undesirable. In general, women have a gradual decrease in desirability when prices increase, when men have the slope more abrupt (0,59 (0,46) for prices between 150-200€ (200-250€) for men, and 0,52 (0,43) for women respectively). People with low income (less than 1200€ per month) prefer a price inferior to 100€, when the average desirability level of medium class participants is around 150-200€.

The power superior to 2000W gets the note of desirability more than 0,83, declining preferences for medium power (1600-2000W) for 0,53 and only 0,1 for less than 1600W vacuum cleaners. Owners of private houses prefer even more the high power of a vacuum cleaner.

Most of the participants give high rates of desirability to a vacuum cleaner with low energy consumption (less than 160 kwh/year), the opinion is divided (0,51) for the medium consumption (160-200 kwh/year) and the rate of desirability for more than 200 kwh/year attains 0,1. So, an average consumer has a preference for a powerful vacuum cleaner with low consumption.

The levels of noise get extreme values: 0,97 rating indicates that consumers highly appreciate the noise level less than 71db, 0,62 indicates that the level 71-75 db may also be accepted and only 0,03 is a desirability level for a noise more than 79db.

Following the logic of facility of use and practicality, an absence of a dust sac in a vacuum cleaner is enviable (0,65).

Another specific characteristic of a wired vacuum cleaner is a length of the power cable. Clearly, consumers prefer long-cabled vacuum cleaners, because it makes them easy to handle and clean large surfaces or just move easily in small places. The desirability level of the cable length increases gradually, almost 0,5 for the cables 5-7,5m long, 0,76 for the cables 7,5 - 10m long, when 0,8 (0,73 for men and 0,83 for women) for the length more than 10m, which may be due to estimated excessive length.

An attribute, where each level has comparable desirability with others is an upgrade attribute. Participants indicate high levels of each option, which show their interest in each and at the same time indifference between them.

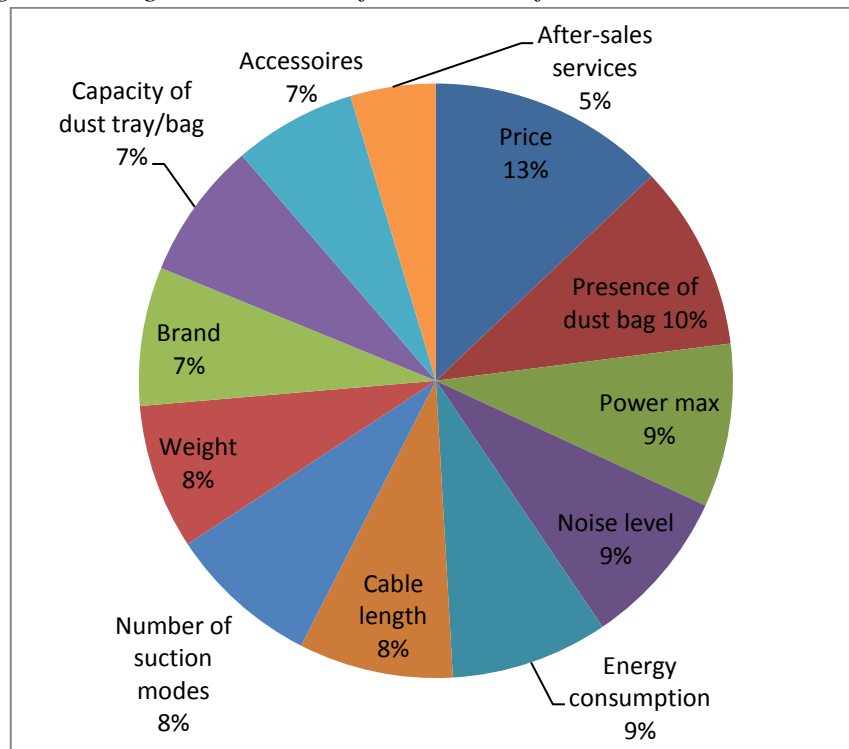
Table 4. Average desirability rates for the upgrade attribute.

	Standard warranty	Usage optimization and connectivity	Evolution of the battery/the motor
Mean	0.57	0.395	0.46
Men	0.53	0.40	0.56
Women	0.59	0.39	0.41

We can observe that consumers' preferences are not homogenous. Women prefer (0,6) standard warranty more than men (0,53) being probably more risk averse, however, men prefer more the evolution of motor and battery (0,56) than women (0,41), when the usage optimization and connectivity upgrade is equal for both sexes (Table 4.).

The distribution of weight for a wired vacuum cleaner is also rather uniform with minimums observed for accessories attribute and the after-sales services and maximum for the price attribute (Figure3.):

Figure 3. Weights distribution for attributes for a wired vacuum cleaner.



Attribute levels of 4 upright vacuum cleaners and for 4 wired vacuum cleaners are presented in Annex 2.

3.3. Bids distribution and WTP for two types of vacuum cleaners

Before displaying the WTP estimations we need to have a bid for an average vacuum cleaner, because the WTP are calculated as differences according to the method. We added a reminder of

ranges of attributes to allow more precise estimation of this average upright cleaner. On the last screen a participant saw four bids for 4 upright vacuum cleaners, with changed levels in blue color (see Annex 3). To eliminate the ambiguity (what attribute's change causes such bid) of estimations we have varied each level only once, except the warranty attribute (one of interest). We have not varied accessories and weigh levels.

We proposed the participants to change their estimated bids if they do not agree with them by means of varying the weight of each attribute. We communicated as well that in order to allow the bid change more significantly they should diminish the weight of the price attribute.

Screen example of the Stage 3 for an upright vacuum cleaner is presented in Annex 3.

Table 5. Bids distribution for both types of vacuum cleaners.

	Bid for an upright vacuum cleaner #1	Bid for an upright vacuum cleaner #2	Bid for an upright vacuum cleaner #3	Bid for an upright vacuum cleaner #4	Bid for a vacuum cleaner #1	Bid for a vacuum cleaner #2	Bid for a vacuum cleaner #3	Bid for a vacuum cleaner #4
Median	100	102.89	98.43	97.94	135	124.64	119.56	121.66
Mean	115.47	120.38	113.18	113.17	142.56	141.13	136.99	139.19
Min	38	38.84	28.34	24.53	25	25.61	14.62	25
Max	350	351,04	347.5	348.46	400	401.64	398.92	401.64
Standard deviation	57.52	58.03	58.93	58.70	75.47	75.25	75.30	74.54

Table 5 reports descriptive statistics on participants' bids for upright vacuum cleaners of 4 types. Remember that the first (upright) vacuum cleaner is an “average” (upright) vacuum cleaner, for which we have asked to give a bid at beginning of the stage 3 in order to calculate bids for (upright) vacuum cleaners of interest. So, the stated bids for an upright vacuum cleaner and for a vacuum cleaner are 115.47€ and 142.56€ respectively. For the second upright vacuum cleaner (with a standard warranty) the mean bid is 120.38€, which is the most elevated bid among all upright vacuum cleaners. The same case is for vacuum cleaners, where the second vacuum cleaner is “cheaper” than the 1st but it is still the most “expensive” (141.13€) than others. The bid for the second vacuum cleaner is higher than for the first one but the WTP for the third (optimization of use and connectivity upgrade) and forth (evolution of the battery/the motor) (upright) vacuum cleaner are lower. As we can see the bids, and then the WTP for different upgrade options are very low in comparison with an average (upright) vacuum cleaner even if the distribution of the bids is rather scattered from ~38€ to ~350€.

When we calculate WTP for both upright and wired vacuum cleaners (Table 6). For upright vacuum cleaners we can see that positive WTP are observed only for UVC2vsUVC1 (2.8kg vs 4.1kg, 3 suction modes vs 1 suction mode, High quality brand vs medium quality brand, both with standard warranty), UVC4vsUVC3 (6h vs 12h time of recharge, 12V vs 18V, 80dB vs 73dB and evolution of the battery/the motor vs evolution of use and connectivity). For wired vacuum cleaners there are more positive results, so only VC3 vs VC1 and VC3 vs VC2 hav negative WTP. However, these WTP are still very weak for a product with a wigh price, such as a vacuum cleaner.

We should mention that extreme values (in maximum and minimum of WTP) are due to very small weight attributed to price (in 0,01 and less).

Table 6. WTP for upright and wired vacuum cleaners.

	UVC2vsUVC1	UVC3vsUVC1	UVC4vsUVC1	UVC3vsUVC2	UVC4vsUVC3	UVC4vsUVC2
mean	4,60	-2,83	-2,39	-7,43	0,44	-6,99
median	2,11	-1,28	-1,25	-3,29	-0,01	-3,21
min	-0,85	-36,87	-29,09	-96,16	-3,80	-88,38
max	59,29	2,25	1,02	1,37	16,38	0,51
	VC2vsVC1	VC3vsVC1	VC4vsVC1	VC3vsVC2	VC4vsVC3	VC4vsVC2
mean	0,17	-2,68	0,28	-2,85	2,95	0,11
median	0,02	-0,71	0,17	-0,80	0,92	0,13
min	-22,09	-129,56	-29,67	-111,17	-4,96	-33,47
max	16,32	9,41	25,48	6,96	104,59	28,53

However, it is more interesting to calculate marginal WTP for attributes of interest: attributes that have been changed across different modifications of (upright) vacuum cleaners (Table 7). As we can see for uprights vacuum cleaners, the weight and the number of suction modes have positive marginal values, at the same time, for instance, it is clear that consumers are willing to pay less for an upright vacuum cleaner, which is less powerful (12V) than another (18V). For the after-purchase services attribute standard warranty is always more attractive for a consumer, however, when choosing between two upgrades consumers are willing to pay more for the evolution of the battery/the motor. The close situation is for a wired vacuum cleaner: consumers' WTP is as expected: positive for "better" levels of attributes and negative for "worth" ones.

Table 7. Marginal WTP values for selected attributes.

	Attribute of comparison	Levels of comparison	Mean Marginal WTP
Upright vacuum cleaner	Weight	2.8kg vs 4.1kg	2,100
	Time of recharge	12h vs 6h	-0,760
	Number of suction modes	3 modes vs 1 mode	2,040
	Power	12V vs 18V	-0,884
	Level of noise	80dB vs 73dB	-1,213
	After-purchase services	Usage optimization and connectivity vs Standard warranty	-0,515
		Evolution of the battery/the motor vs Standard warranty	-0,291
		Evolution of the battery/the motor vs Usage optimisation and connectivity	0,223
	Autonomy	13min vs 40min	-1,554
	Brand	High quality brand vs Medium quality brand	0,464
Wired vacuum	Attribute of comparison	Levels of comparison	Mean Marginal

cleaner			WTP
	Dust bag presence :	No vs Yes	0,442
	Brand :	High quality brand vs Medium quality brand	0,354
	Length of power cable :	4.5m vs 8m	-1,444
	Power :	1400W vs 2200W	-1,853
	Energy consumption :	130kW/yeat vs 180kW/year	0,463
	Weight :	6.5kg vs 4kg	-1,890
	Number of suction modes :	3modes vs 1 mode	1,261
	Level of noise :	82dB vs 74dB	-1,377
	Capacity of the dust tray :	4L vs 2L	1,381
	After-purchase services :	Usage optimisation and connectivity vs Standard warranty	-0,353
		Evolution of the battery/the motor vs Standard warranty	-0,104
		Evolution of the battery/the motor vs Usage optimisation and connectivity	0,250

As reported in the original CACM method article (Lusk and Norwood, 2011) about 99% of participants have changed the weights at the 3rd stage of the experiment and the weight of the price attribute has increased afterwards. As shows our experiment, only about 65% of subjects have changed their weights for the price attribute (30,6% increased it and 34,7% decreased it). For the after-purchase services attribute about 64% have changed the weight, however for this attribute more than 45% (of those who did) has decreased the weight. There is no visible trend of how participants change the weights - the number of each attribute changes is almost constant (exception is the accessories attribute for which more than half of the participants changed the weight negatively after the revision). However, most of people got their "new" WTP increased for the 2st upright vacuum cleaner, decreased for the 3rd and being very dispersed for the 4th upright vacuum cleaner. These results support the idea that when people have a possibility to refine and change their preferences they do that in majority, what is not possible in other preference elicitation methods.

CONCLUSION

Previous studies raise the risks of selling a new product and a current one at the same time, emphasizing the risks in case when consumers anticipate future evolution (development) of the product (Krishnan and Ramachandran, 2011). A possible solution of this problem is the introduction of upgradeable products (with upgradeable parts), which allows consumers to buy a product now and to upgrade it in future. This works as well in interest of sustainable development.

The goal of this research is to estimate WTP for an upgrade of a product. A new (for this type of product) method has been chosen for this. The advantage of the CACM method is in a possibility to have a clear image of how preferences are formed and permits to get WTP estimations of all

variations of (upright) vacuum cleaners from the attribute-based utility functions. This advantage allows a long post-experience estimation of WTP for different vacuum cleaners' configurations, depending on needs of the research during new product development stages.

However, these are some limits in using this method. As found in previous papers using this method, it is valid and allows getting significant result for products with a low price. The calculation of utility function allows a small bids variation in the presence of a large number of attributes and in case of high prices this variation is too small to be perceived by a consumer. At the same time, low weights of the price attribute (because of large number of attributes) create in turn small WTP values. In our case, due to product complexity – a presence of large number of attributes which matter to a consumer, the distribution of weights does not show much preference for any attribute, so there is no “decisive” attribute. Therefore, the CACM method is a good WTP elicitation method for those products where: a) there are many attribute but few crucial for a consumer, b) the price of a product is low. A further analysis is needed to confirm the results for durable innovative products with high price.

However, as a key advantage of the CACM is the possibility to estimate numerous attributes with large number of attribute levels, we can still have a good overview of preference composition due to developed analysis of attributes and their levels. If we look at the ratings given by each participant for each level of attributes we can conclude that participants had a behavior as expected: the notes decreased for some attributes (i.e. price, time of recharge, noise) or increased (i.e. autonomy, number of accessories, number of speed modes).

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Figure 1. Desirability ranking of attributes' levels screen.

Power

The power indicator supplied by producers is the operating voltage of the battery, expressed in volts. The higher it is, the more engine power is high. It is between 6 V and 30 V for upright vacuum cleaners currently available for sale.

Please indicate your level of desirability for each of the following specifications.

	not at all satisfied					very satisfied				
Less than 15 V	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9	<input type="radio"/> 10
Between 15 and 20 V	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9	<input type="radio"/> 10
More than 20 V	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9	<input type="radio"/> 10

Figure 2. Distribution of weights for attributes.

Importance of the characteristics

	not at all important					very important	
Price	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Accessories	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Battery charge time	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Weight	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Number of suction modes	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Power	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
	not at all important					very important	
Dust tray capacity	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Noise level	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
After-purchase services	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Battery type	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
Brand	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7
	not at all important					very important	

Annex 2

Table 1. Upright vacuum cleaner characteristics.

Chracteristics	Upright vacuum cleaner #°1	Upright vacuum cleaner #°2	Upright vacuum cleaner #°3	Upright vacuum cleaner #°4
Accessories :	2 brushes	2 brushes	2 brushes	2 brushes
Time of recharge :	6 h	6 h	12 h	6 h
Weight :	4,1 kg	2,8 kg	4,1 kg	4,1 kg
Number of suction modes :	1 mode	3 modes	1 mode	1 mode
Power :	18 Volt	18 V	18 V	12 V
Capacity of the dust tray :	0,4 L	0,4 L	0,4 L	0,4 L
Level of noise :	73 dB	73 dB	73 dB	80 dB
After-purchase services :	Standard warranty	Standard warranty	Usage optimisation and connectivity	Evolution of the battery/the motor
Autonomy :	40 min	40 min	13 min	40 min
Brand :	Medium quality brand	High quality brand	Medium quality brand	Medium quality brand

Table 2. Vacuum cleaner characteristics.

Caractéristique	Vacuum cleaner #°1	Vacuum cleaner #°2	Vacuum cleaner #°3	Vacuum cleaner #°4
Dust bag presence :	yes	no	yes	yes
Brand :	Medium quality brand	High quality brand	Medium quality brand	Medium quality brand
Length of power cable :	8 m	8 m	8 m	4,5 m
Power :	2200 W	2200 W	1400 W	2200 W
Accessories :	2 brushes	2 brushes	2 brushes	2 brushes
Energy consumption :	180 kWh per year	180 kWh/year	130 kWh/year	180 kWh/year
Weight :	4 kg	6,5 kg	4 kg	4 kg
Number of suction modes :	1 mode	3 modes	1 mode	1 mode
Level of noise :	74 dB	74 dB	82 dB	74 dB
Capacity of the dust tray :	2 L	2 L	2 L	4 L
After-purchase services :	Standard warranty	Standard warranty	Usage optimisation and connectivity	Evolution of the battery/the motor

Figure 1. Stage 3 screen of the experiment

3rd step: Determining your price

In this step we propose to determine the price you would be willing to pay for a first upright vacuum cleaner (vacuum cleaner #1), which characteristics are presented in the table below.

Attribute	vacuum cleaner 1	Range
Accessories	2 brushes	1 to 3 brushes and more
Charging time:	6 hours	from 3 to 16 h
Weight	4.1 kg	2 to 5.3 kg
Number of suction modes	1 Speed	from 1 speed to 3 speed modes
Power:	18 Volt	6 to 30 V
Capacity:	0.4 L	from 0.3 to 1 L
Noise level:	73 dB	from 62 to 84 dB
After-purchase services	Standard warranty	Standars warranty, Evolution of the battery/the motor, Usage optimization and connectivity
Autonomy period	40 min	12 to 60 min
Brand	Medium quality brand	low, medium, high quality brand

Even if your answer does not result in an actual purchase, we ask you to specify the maximum price you would be willing to pay for this vacuum cleaner #1

Maximum amount you are willing to pay for the vacuum cleaner #1:

100

Figure 2. Stage 3 screen of the experiment

Characteristics	UVC 1	UVC 2	UVC 3	UVC 4	Importance	Instructions
Price	100 €	100.6 €	99.74 €	100.2 €	9 % +5% -5%	decreases/increases the price difference between upright vacuum cleaners
Accessories	2 brushes	2 brushes	2 brushes	2 brushes	9 % +5% -5%	decreases or increases the price of the upright vacuum cleaner, which has more weight on this particular characteristic.
Time of recharge	6 h	6 h	12 h	6 h	13 % +5% -5%	
Weight	4,1 kg	2,8 kg	4,1 kg	4,1 kg	7 % +5% -5%	
Suction modes	1 mode	3 modes	1 mode	1 mode	9 % +5% -5%	
Power	18 V	18 V	18 V	12 V	9 % +5% -5%	
Capacity of dust tray	0,4 L	0,4 L	0,4 L	0,4 L	9 % +5% -5%	
Level of noise	73 dB	73 dB	73 dB	80 dB	11 % +5% -5%	
After-purchase services	Standard warranty	Standard warranty	Usage optimization & connection activity	Evolution of battery/motor	7 % +5% -5%	
Autonomy	40 min	40 min	13 min	40 min	11 % +5% -5%	
Brand	Medium quality	High quality	Medium quality	Medium quality	7 % +5% -5%	
					100 %	

If you are satisfied with proposed prices, click on the button below: