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1 **BATTERY PACK RECYCLING: BEHAVIOUR CHANGE INTERVENTIONS**  
2 **DERIVED FROM AN INTEGRATIVE THEORY OF PLANNED BEHAVIOUR**  
3 **STUDY**

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51 **Abstract**

52 Belgium has passed the 45% cap, mandated by the European Union, by achieving a collection rate of over 50%  
53 in 2012. Having such a collection rate, Belgium is amongst the frontrunners in battery recycling in Europe.  
54 However, despite the efforts, about 40% of used batteries are still not properly collected. Particularly  
55 troublesome according to the national producer responsibility organization are the battery packs. In this paper  
56 we therefore investigate the drivers and barriers to battery pack drop-off intention perceived by Belgian  
57 households using an integrative model based on the Theory of Planned Behaviour. An  $R^2$  of 0.64 was found,  
58 which according to the literature on partial least squares structural equation modelling signals a moderate yet  
59 very close to substantial coefficient of determination. We find that on average perceived behavioural control and  
60 moral norms have the largest influence on the intention to drop-off used battery packs as quickly as possible.  
61 Based on the insights gained, recommendations are made for both behaviour change interventions and future  
62 research.

63 **Key words:** Pro-environmental behaviour; Recycling; Structural equations modelling; Pro-environmental  
64 communication

65 **Highlights:**

- 66 • We investigate battery pack specific recycling behaviour
- 67 • We test an integrative model using PLS-SEM and assess observed heterogeneity
- 68 • We stress the role of perceived behavioural control, moral norms, and awareness of consequences
- 69 • Having kids under the age of 12 and an ecological worldview drive heterogeneity the most
- 70 • We recommend assessing spill-overs between battery pack and WEEE recycling behaviour

## 71 **1. Introduction**

### 72 **1.1. The environmental impact of portable batteries**

73 We are increasingly mobile, and therefore, so are our electronic devices. Consequently, to feed our increasing  
74 energy hunger the use of portable batteries has been firmly rising (Li et al., 2013). Typical household batteries  
75 such as the AA, AAA, and AAAA-sized batteries may have a negative impact on the environment if they are  
76 not properly collected and processed. If such batteries end up in landfills, hazardous metal pollutants such as the  
77 toxic heavy metals cadmium, lead, and mercury have the potential to slowly leach into soil, groundwater or  
78 surface water (Karnchanawong and Limpiteeprakan, 2009). Recently, however, lithium-based batteries have  
79 displaced nickel–cadmium and nickel metal hydride battery types to become the dominant energy supply  
80 components in the portable consumer electronics market because of their higher energy density. Yet, these  
81 batteries may also be considered hazardous because of the presence of cobalt, copper, nickel, thallium, and silver  
82 (Kang et al., 2013).

83

84 Lithium itself has been shown to be less harmful for mankind and its environment (Aral and Vecchio-Sadus,  
85 2008). Additionally, the further development of the lithium-based battery technology, which is crucial for the  
86 diffusion of renewable energy technologies and electric vehicles, is threatened by scarcity in the metals used  
87 (Larcher and Tarascon, 2015). Cobalt is considered a critical metal for the sustainable development of the whole  
88 of Europe’s economy (European Commission, 2014). Silver and nickel on its turn, though not critical for the  
89 entire economy, are considered a potential bottleneck for the continued development of renewable energy  
90 technologies (Moss et al., 2011). Finally, lithium, copper and aluminium are plain valuable metals that can be  
91 recovered from lithium batteries (Jha et al., 2013, Zeng and Li, 2014). Recycling metals from batteries has been  
92 shown to result in natural resource savings compared to virgin production (Dewulf et al., 2010). Consequently,  
93 recycling batteries may not only avoid environmental pollution, but also saves natural resources.

94

95 As a result it is no surprise that the collection of portable batteries, both primary (i.e. non-rechargeable) and  
96 secondary (i.e. rechargeable), in Europe is mandated by Directive 2006/66/EC which requires Member States to  
97 achieve a collection rate of 25% in 2012 and 45% in 2016 (European Union, 2006). To meet these targets, battery

98 producers and importers, intermediaries, and the final seller are legally obliged to accept used batteries due to  
99 the extended producer responsibility (Dubois, 2012). To meet the legal obligation to collect 45% of used  
100 batteries by 2016, in Belgium these actors have created Bebat. The latter is the name of the single non-profit  
101 organization acting as the national producer responsibility organization and is in charge for collecting, sorting,  
102 and recycling of portable batteries. It has over 24,000 free collection points spread across Belgium, resulting in  
103 a coverage of about 0.8 collection points per squared kilometre. The separate disposal of used batteries at  
104 designated collection points is mandatory in Belgium. However, it is not strictly enforced. Having a longstanding  
105 tradition in separate waste collection, Belgium has passed the 45% cap by achieving a collection rate of over  
106 50% in 2012 (European Portable Battery Association, 2013).

107

108 Reaching such a collection rate, Belgium is amongst the frontrunners in battery recycling in Europe. However,  
109 despite the efforts 24% of used batteries and accumulators were found to be hoarded at home and 10 to 13.5%  
110 end up in the waste bin. In absolute terms, an average family was found to have on average 129 batteries in its  
111 possession, be it used, new, or in use (Openbare Vlaamse Afvalstoffen Maatschappij, n.d.). This number exceeds  
112 the number of batteries that people think to have in-house (Coonen and Peeters, 2014). Whereas the obtained  
113 collection rate is worthy of praise, it should be noted that it does not differentiate between types of portable  
114 batteries. In Belgium, legislation differentiates between three types of portable batteries, being: (1) (the typical)  
115 batteries, (2) button cells, and (3) battery packs (Royal Decree, 2009). According to Bebat battery packs are  
116 collected poorly compared to other portable battery types. This is motivated by observing that the battery pack  
117 volumes being collected (which include direct collection via collection points and indirect collection from the  
118 channels collecting waste electrical and electronic equipment) over the volumes brought onto the market, while  
119 correcting the calculation for the expected average lifetime, are smaller than those for other battery types  
120 (Coonen and Peeters, 2014). Consequently, people need to be stimulated to return battery packs faster.

121

122 Battery packs are often rechargeable lithium-based batteries used to power mobile phones, digital cameras,  
123 portable game consoles, power tools, and the likes (see Figure 1). Officially, they are defined as *'any set of*  
124 *interconnected batteries forming a unit having a casing which is not intended to be divided or opened by the*

125 *end user*'. A poor level of collection is troublesome as it has been established that recycling batteries may not  
126 only avoid environmental pollution, but also increases resource efficiency. For these reasons, our research  
127 investigates the predictors of battery pack drop-off intention perceived by Belgian households as we want to be  
128 able to infer recommendations that will motivate and facilitate people to start bringing back battery packs to a  
129 Bebat collection point more quickly.



130

131 Figure 1. Examples of battery packs:

132 Left: from a mobile phone, Middle: from a power tool, Right: from a laptop

### 133 1.2. Why do people recycle?

134 Pro-environmental behaviour refers to behaviours that either harm the environment as little as possible or benefit  
135 the environment (Steg and Vlek, 2009). The stimulation of such conduct is necessary as many environmental  
136 problems (e.g. heavy metal leaching) are rooted in human behaviour, such as not sorting correctly (Vlek and  
137 Steg, 2007). Our focus will be on a specific type of pro-environmental behaviour, i.e. recycling, being the act of  
138 collecting, sorting, and depositing waste to a suited waste management provider. Whereas it involves  
139 economically feasible actions that can greatly benefit the environment in the long run if many people perform  
140 the behaviour, it requires considerable individual effort whereas others may freeride. Note that being effortful  
141 is related to being composed of several, consequential steps, which each might be habitually performed  
142 separately, but still require thought in between each step (Limayem et al., 2007). Such routines have been named  
143 semi-automatic (Ajzen, 2002).

144

145 The difficulty to explain why people do endeavour in such a behaviour is the reason for it being one of the most  
146 and longest studied forms of environmentally responsible behaviour (Boldero, 1995, Huffman et al., 2014). We  
147 outline three types of research that have studied recycling behaviour. Firstly, research following the  
148 psychological research tradition, which signals that the study subject is people-environment interaction. This

149 stream has in a more or less chronological order evolved from (i) studies aiming to profile recyclers such as the  
150 research by Vining and Ebreo (1990) and Schultz et al. (1995) and explain willingness to participate in recycling  
151 schemes such as the investigations by Saphores et al. (2006), Wang et al. (2011), and Saphores et al. (2012) to  
152 (ii) research building socio-psychological models which help to understand socio-psychological influences,  
153 captured by latent variables, on people's recycling behaviour. Support for such models has grown ever since  
154 Hopper and Nielsen (1991) and Vining and Ebreo (1992) have shown that internal factors are better predictors  
155 than socio-demographic variables. Moreover, it has been observed that, even when situational constraints are  
156 resolved, all people still don't (fully) participate (Thomas and Sharp, 2013). For the same reason, we expect the  
157 amount of battery packs that have been adopted by the respondent to be a lesser predictor than internal variables.  
158 Secondly, research adhering to the socio-cultural research tradition, which means that the study subject is  
159 society-environment interaction. This line of research has picked up more recently and deals with the question  
160 of how environmental problems are caused by social factors and social structures, how environmental problems  
161 impact societies, and how they can be solved from a societal perspective (Hannigan, 2006). For an example of  
162 a study on pro-environmental behaviour change adopting this perspective, we refer the interested reader to  
163 Hargreaves (2011). In their study a behaviour change initiative, driven by appointing volunteers as environment  
164 champions in a workplace context, was studied by answering questions resulting from social practice theory  
165 using ethnography. Thirdly, there are studies using laboratory or field experiments to explain why people  
166 recycle. However, in this case "why" can be best understood as "what interventions induce recycling behaviour  
167 (the most)". In the typical experiment, one or more interventions are compared with a control group to determine  
168 the effect (size) of the intervention. For the results of a meta-analysis on past field experiments in the pro-  
169 environmental domain we refer to Osbaldiston and Schott (2011). The authors show that overall the largest  
170 effect sizes were found for the interventions based on cognitive dissonance (Festinger, 1962), goal setting (Locke  
171 and Latham, 2002), social modelling, and prompts, but that different treatments work better for different waste  
172 streams and recycling mechanisms. For instance, for central recycling, and hence in principle for battery pack  
173 collection, they found instructions and rewards to be most effective among the treatments that have been studied.  
174 To the best of our knowledge no quantitative or qualitative review is available that condenses the findings of  
175 laboratory pro-environmental behaviour experiments. For a recent example of such a study, the reader is referred

176 to Zhang et al. (2016). The authors show that enhanced accessibility of recycling facilities would lower  
177 behavioural costs and encourage people to recycle more mixed waste.

178

179 Our study is situated within the branch of literature analysing pro-environmental behaviour while using a socio-  
180 psychological model. Most often within the literature on recycling the framework provided by the Theory of  
181 Planned Behaviour (TPB) is used to explain or predict what drives recycling (Ramayah et al., 2012). The TPB  
182 has generally been favoured over other models because of its structural simplicity and general applicability across  
183 domains and cultures (Klößner, 2015). For instance, it has been successfully used to understand a range of pro-  
184 environmental behaviours such as sustainable tourism (Han et al., 2010), public transportation use (Heath and  
185 Gifford, 2002), energy use (Abrahamse and Steg, 2009), water conservation (Lam, 2006), and more. Additionally,  
186 on several instances the TPB has proven to outperform other decision-making models belonging to this strand of  
187 research. For instance Kaiser et al. (2005) and Aguilar-Luzón et al. (2012) showed that the TPB outperforms the  
188 Value Belief Norm (VBN) theory, which was first presented by Stern et al. (1999), in predicting recycling  
189 behaviour.

190

191 The VBN is a refined version of Schwartz's (1968) norm-activation model (NAM), which asserts that behaviour  
192 is displayed when altruistic, moral norms are activated and that their activation depends upon people's awareness  
193 of the negative consequences for others and on whether they ascribe responsibility for ameliorating these  
194 consequences. Stern et al. (1999) adapted this theory to be suited for pro-environmental behaviour by stating  
195 that people will take environmental action when they are aware of the consequences for themselves, other people  
196 and non-human species and when they consider themselves to be responsible for these consequences. Yet, as  
197 argued by Klößner and Blöbaum (2010) none of the mentioned, often used models on their own adequately  
198 represents the multi-determination of environmental behaviour. For a further review on decision making models  
199 that can be applied to pro-environmental behaviour, we refer to Klößner (2015) and Darnton (2008) for brevity.

200

201 Pioneering studies that kick-started TPB-based research on recycling are those of Boldero (1995) on newspaper  
202 recycling and Taylor and Todd (1995) on household waste recycling. In its original conception the degree to



203 which actual behaviour is displayed, is directly related to behavioural intention, being the degree to which a  
204 person plans to exert effort to enact the behaviour. On its turn, behavioural intention is formed by the following  
205 variables: (i) attitude, (ii) subjective norm, and (iii) perceived behavioural control (Ajzen, 1991). Attitude (ATT)  
206 reflects feelings of favourableness or unfavourableness towards the behaviour. Subjective norm (SN) reveals  
207 the perception that significant referents desire the individual to perform the behaviour. Perceived behavioural  
208 control (PBC) assesses beliefs about the ability of performing the behaviour. The latter was added to the Theory  
209 of Reasoned Action (Fishbein and Ajzen, 1975) as it was recognized that not all behaviours are under full  
210 volitional control. Previous efforts support the predictive power of these three constructs in predicting intention  
211 and actual behaviour (Cheung et al., 1999, Armitage and Conner, 2001). Intention and behaviour are expected  
212 to be more strongly related when measured at the same level of specificity (Ajzen, 2011) and when intentions  
213 are stable (Macey and Brown, 1983). In a review of recycling studies, Schultz et al. (1995) indicated that many  
214 studies support this assertion.

215

216 Despite the fact that such correspondence has not always been respected, the TPB has been criticized for only  
217 being able to explain a limited amount of variance in both behavioural intention and behaviour (Conner and  
218 Armitage, 1998). By consequence, under the premise of being willing to continue working with the core of the  
219 TPB, it is recommended to include additional variables in the model to be able to more adequately explain  
220 intentions and behaviour. Doing so leads to an integrative, more comprehensive model. For instance, we have  
221 included moral norms to capture the degree to which one feels morally obliged to act in a certain way. Recently  
222 it has also been recognized that the role of negative or positive emotions is neglected in pro-environmental  
223 behaviour studies stemming from a more general neglect of their role in cognitive psychology and neuroscience  
224 throughout the twentieth century. Indeed, the position on the usefulness of emotions has evolved from the  
225 position where they were considered as a separate and undesirable part of thought to an integral and adaptive  
226 part of cognition that is stored and retrieved in the same way as and alongside with cognitive structures (Vining  
227 and Ebreo, 2002). However, the evidence is mixed regarding whether emotions mediate other predictors or the  
228 other way around (Carrus et al., 2008).

229

230 It has also been questioned whether TPB is suited to study continuance, i.e. keeping up with the desired  
231 behaviour. An initial adoption decision, which is likely to require deliberate thought, is argued to differ from  
232 continuance, which is likely to be determined by habit, and thus might require a different subset of antecedents  
233 (Limayem et al., 2007). However, Ajzen (2002) contends that routinization of behaviour is consistent with a  
234 reasoned action perspective. He says that the TPB does not propose that individuals actually review their  
235 behavioural, normative, and control beliefs prior to every enactment of a frequently performed behaviour.  
236 Instead, once formed and well-established, they are assumed to be activated automatically and to guide  
237 behaviour without the necessity of conscious thought. Hence, reasoning simply implies that conduct is guided  
238 by beliefs. Reasoning does not necessarily need to be effortful. Consequently, the fundamental difference in  
239 both views is that the habituation perspective asserts that routinized behaviour is under the control of stimulus  
240 cues, whereas the reasoned action perspective postulates that such behaviour is guided by automatically  
241 activated or spontaneous attitudes and intentions. The result of both views is identical: given the right conditions,  
242 routinized behaviour is performed in a largely automatic fashion with minimal conscious thought. In sum, this  
243 reflects the different views on the suitability of TPB to explain different types of behaviour on the continuum  
244 going from requiring actual effortful thought to behaviour that is fully automatic. Still, models that explicitly  
245 take habits into account have empirically been found to provide a better fit. This being said, we would like to  
246 remind the reader that section 1.1 serves to illuminate that the problem at hand is one of getting people to start  
247 bringing back battery packs faster and less one of motivating them to continue to do so.

### 248 **1.3. Portable battery and waste electric and electronic equipment recycling**

249 To the best of our knowledge, only a single, model-based socio-psychological study has specifically targeted  
250 recycling behaviour concerning spent portable batteries and it does not differentiate between battery types.  
251 Hansmann et al. (2006) found that recycling knowledge, self-organization of recycling, and disagreement with  
252 justifications for non-recycling were positively related to self-reported battery recycling behaviour, while the  
253 more general attitude towards ecological waste disposal<sup>1</sup> was not directly related to Swiss respondents' self-  
254 reported battery recycling behaviour. The Swiss are excellent recyclers as proven by having the highest

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<sup>1</sup> Attitude consisted of the following items: (a) the personal importance of ecologically positive waste disposal, (b) the acceptance of personal efforts in order to achieve ecologically positive waste disposal, and (c) the trust in administration and waste disposal companies concerning the appropriate use of the waste fragments that are separately collected

255 collection rate in Europe and have put in place legislation and a collection system which is very similar to that  
256 of Belgium (European Portable Battery Association, 2014). Other studies, such as Tang et al. (2011), at most  
257 consider battery recycling as an item in explaining the intention to recycle household waste. Furthermore, we  
258 note that little research has considered explaining the intention and enactment of (small) e-waste recycling using  
259 the TPB framework. However, batteries and waste electric and electronic equipment (WEEE) are clearly  
260 interconnected.

261

262 Le et al. (2013) constitute the exception and show that PBC and SN are stronger predictors of the intention to  
263 recycle e-waste than ATT for Vietnamese residents. Also, Ylä-Mella et al. (2015) have reported on the findings  
264 from a survey gauging Finnish consumers' awareness and perceptions towards mobile phone recycling and re-  
265 use. Similar to our case, they found that high awareness of the waste electrical and electronic equipment recovery  
266 system and proximity of collection points is inadequate in promoting their return. Mobile phones are an example  
267 of an up-to-date product, as defined by Cox et al. (2013). Such products are often discarded before the end of  
268 their functional lifetime and subsequently kept at home "as a spare", presumably out of attachment due to the  
269 fact that the devices are a representation of their identity and success in life, or because "they did not get round  
270 to it" rather than returned. Consequently, enormous resource potential is stored in homes waiting to be given  
271 new life, as shown by for example Saphores et al. (2009). A change in storing habits and the provision of  
272 additional information on who takes back these waste streams is considered needed in turning this evolution  
273 around.

274

275 Our study adds to socio-psychological literature on recycling in two ways. First, we formulate recommendations  
276 for national battery producer responsibility organizations based on the insights gained from a integrative, TPB-  
277 based framework in order to facilitate behavioural change concerning battery pack collection. Second, we  
278 provide recommendations for future research based on insights from literature. The remainder of this paper  
279 contains the following sections. First, we discuss the method. In the next section we present the results. In section  
280 4 we discuss these results. Section 5 holds the main findings of our work.

## 281 **2. Method**

### 282 **2.1. Hypothesis development and model building**

283 As was established in the introduction the TPB is the socio-psychological model that has been used most often  
284 to explain recycling. Yet, it has not been used to study batteries specifically, let alone the recycling intentions  
285 of battery packs. We aim to fill this gap viewing the resource potential that lies dormant. Furthermore, it has  
286 been argued that predictors might differ between (i) types of pro-environmental behaviour (Whitmarsh and  
287 O'Neill, 2010), (ii) waste management options (Barr, 2007), and (iii) studies focusing on recycling different  
288 products (Boldero, 1995). As the TPB only provides information about what relationships are likely of being  
289 relevant, empirical case studies provide the basis for their actual significance, sign and magnitude. The results  
290 of a literature review<sup>2</sup> focusing on TPB studies on recycling are displayed in Table 1. It displays the relative  
291 magnitude, sign, significance and measurement method of the relationship between the main effects of the three  
292 original TPB constructs and behavioural intention.

293

294 It can be concluded that quite generally, the more positive one's attitude, the more social pressure, and the more  
295 perceived behavioural control one has, the higher one's intention is towards performing the behaviour. This  
296 finding gives rise to hypothesis 1 (H1), 4 (H4), and 6 (H6), as can be seen in Table 2. Furthermore, it can also  
297 be realised that generally attitude outweighs the impact of perceived behavioural control which prevails over  
298 subjective norms. However, for the publications covering recycling behaviour, which requires travelling to a  
299 collection point, the order between attitude and perceived behavioural control is sometimes reversed. This seems  
300 to indicate that having to transport materials can create a barrier. Hence, besides product type, differences in  
301 predictors may also be caused by the way in which the waste is collected. Finally, the overview shows that most  
302 diversity is found in how perceived behavioural control is conceptualised. Attitude is generally measured  
303 directly on semantic differentials covering mainly affective judgements towards performing the specific  
304 behaviour (Rhodes et al., 2015). Subjective norms are generally measured directly using statements capturing  
305 the agreement with injunctive norms towards the specific behaviour upheld by selected peers (Nigbur et al.,

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<sup>2</sup> The following query on the Web of Science, performed on 08/04/2015, resulted in finding 22 qualified peer-reviewed, English journal papers: TS=(("recycling" and "theory of planned behavio\*") or ("collection" and "theory of planned behavio\*")) AND TI=("recycling")

306 2010). Perceived behavioural control has not only captured control and difficulty, but also situational constraints  
307 such as lack of facilities and personal constraints such as a lack of knowledge. Though not mentioned in the  
308 table, intention was found to be measured by items measuring the degree to which people “plan”, “intend”,  
309 “will”, “want to” execute the desired behaviour. Note that due to our suspicion of hoarding behaviour we  
310 introduced a time dimension into the equation. We want people to recycle their battery packs as soon as possible.  
311 Therefore, intention statements measured the degree to which people intend, plan, and want to drop-off battery  
312 packs to a Bebat collection point as soon as possible. For an overview of the way we itemized the measurement  
313 models, we refer to Table 3 (section 2.2).  
314

Table 1: Literature review on TPB-based studies investigating recycling behaviour

Reference	ATT	SN	PBC	Topic
Taylor and Todd (1995)	+, 1 (specific attitude) <sup>d</sup>	-,3 (referents) <sup>d</sup>	+,2 (control) <sup>d</sup>	Household waste recycling: sorting at home
Boldero (1995)	-, 1 (benefits, inconvenience, lack of conviction) <sup>cm</sup>	NS (referents) <sup>cm</sup>	NS (control) <sup>d</sup>	Wastepaper recycling: kerbside collection
Cheung et al. (1999)	+,1 (specific attitude) <sup>cm</sup>	+,2 (referents) <sup>cm</sup>	+,3 (control, difficulty) <sup>cm</sup>	Wastepaper recycling: not clearly specified
Tonglet et al. (2004)	+,1 (specific attitude) <sup>d</sup>	NS (referents) <sup>d</sup>	+,2 (inconvenience, facilities, knowledge) <sup>d</sup>	Household waste recycling: kerbside collection
Mannetti et al. (2004)	+,3 (specific attitude) <sup>d</sup>	+,3 (referents) <sup>d</sup>	+,1 (difficulty) <sup>d</sup>	Household waste recycling: differentiated collection
Chan (1998)	+, 1 (specific attitude) <sup>d</sup>	+,3 (referents, media) <sup>d</sup>	+,2 (difficulty) <sup>d</sup>	Household waste recycling: waste receptacles
Nigbur et al. (2010)	+,1 (specific attitude) <sup>cm</sup>	+,3 (descriptive SN) <sup>d</sup>	+,2 (control, difficulty) <sup>cm</sup>	Household waste recycling: kerbside collection
<b>Chu and Chiu (2003)</b>	<b>+,2 (specific attitude)<sup>d</sup></b>	<b>+,3 (referents)<sup>d</sup></b>	<b>+,1 (control)<sup>d</sup></b>	<b>Household waste recycling: dump into disposal trucks</b>
Do Valle (2005) <sup>a</sup>	-,3 (specific attitude) <sup>cm</sup>	+,2 (referents) <sup>cm</sup>	1,+ (control, difficulty) <sup>d</sup>	Household waste recycling: selective collection
Knussen et al. (2004)	+,1 (specific attitude) <sup>d</sup>	NS (referents) <sup>d</sup>	NS (opportunity, difficulty) <sup>d</sup>	Household waste recycling: kerbside collection
<b>Chen and Tung (2010)</b>	<b>NS (specific attitude)<sup>d</sup></b>	<b>-,1 (referents)<sup>d</sup></b>	<b>+,2 (inconvenience, facilities, knowledge)<sup>d</sup></b>	<b>Household waste recycling: bring to recycling facility</b>
<b>Hansmann et al. (2006)<sup>ab</sup></b>	<b>NS (general attitude)<sup>d</sup></b>	<b>NI</b>	<b>NI</b>	<b>Battery recycling: drop-off at collection points</b>
Ramayah et al. (2012) <sup>a</sup>	+,2 (benefits) <sup>d</sup>	+,1 (referents) <sup>d</sup>	NS (convenience, cost) <sup>d</sup>	Household waste recycling: recycling facility
Davis et al. (2006)	NS (specific attitude) <sup>d</sup>	NS (referents) <sup>d</sup>	NS (inconvenience, facilities, knowledge) <sup>d</sup>	Household waste recycling: kerbside collection
Chan and Bishop (2013)	NI (specific attitude) <sup>d</sup>	+,2 (referents) <sup>d</sup>	+,1 (inconvenience, facilities, knowledge) <sup>d</sup>	Household waste recycling: not clearly specified
<b>Tang et al. (2011)<sup>a</sup></b>	<b>+,3 (specific attitude)<sup>d</sup></b>	<b>+,2 (referents)<sup>d</sup></b>	<b>+,1 (self-efficacy, situational factors)<sup>d</sup></b>	<b>Household waste recycling: bring to collection depot</b>
Aguilar-Luzón et al. (2012)	+,1 (specific attitude) <sup>d</sup>	NS (referents) <sup>cm</sup>	+,2 (difficulty, control) <sup>d</sup>	Household waste recycling: glass sorting
<b>Botetzagias et al. (2015)</b>	<b>+,2 (specific attitude)<sup>d</sup></b>	<b>NS (referents)<sup>d</sup></b>	<b>+,1 (inconvenience, facilities, knowledge)<sup>d</sup></b>	<b>Household waste recycling: drop-off in recycle bins</b>
<b>Wan et al. (2014b)</b>	<b>NS (specific attitude)<sup>d</sup></b>	<b>+,2 (referents)<sup>d</sup></b>	<b>+,1 (inconvenience, facilities, knowledge)<sup>d</sup></b>	<b>Household waste recycling: bring to recycling facility</b>
White and Hyde (2012)	+,2 (specific attitude) <sup>d</sup>	+,1 (referents) <sup>d</sup>	NS (control, difficulty) <sup>d</sup>	Household waste recycling: kerbside recycling
<b>Rhodes et al. (2015)</b>	<b>+,1 (specific attitude)<sup>d</sup></b>	<b>+,3 (referents)<sup>d</sup></b>	<b>+,2 (control)<sup>d</sup></b>	<b>Household waste recycling: bring to recycling depot</b>
<b>Wan et al. (2014a)</b>	<b>NS (specific attitude)<sup>d</sup></b>	<b>+,2 (referents)<sup>d</sup></b>	<b>+,1 (inconvenience, facilities, knowledge)<sup>d</sup></b>	<b>Household waste recycling: bring to recycling facility</b>

Legend: NS = not significant; NI= not included; + = positive relationship; - = negative relationship; 1,2,3 = order of importance amongst ATT, SN, and PBC with 1 being more important than 3; () = how the measurement is operationalized; <sup>a</sup> Misses the intention-behaviour relationship and hence investigates the predictors of self-reported behaviour; <sup>d</sup> stands for direct measurement; <sup>cm</sup> stands for composite measurement; <sup>b</sup> Should have been excluded due to the non-compliance with the standard TPB framework, but was kept due to its importance regarding the topic

319 As recommended, additional variables are included in our model to be able to more adequately explain  
320 intentions. Hence, an integrative model is estimated (Bamberg and Möser, 2007). Firstly, past behaviour has  
321 often been hypothesized to affect recycling intention and behaviour, resulting in mixed evidence. Boldero (1995)  
322 failed to establish a significant relationship between past behaviour, measured by a self-report indicating whether  
323 the majority of newspapers (quantity) was recycled in the past (yes/no), and intention to recycle newspapers. On  
324 the other hand Cheung et al. (1999) found a positive relationship between past behaviour, indicated by the  
325 percentage of time (frequency) they performed the target behaviour within the 1-month period prior to the study,  
326 and intention. The same relationship applies for Terry et al. (1999), White and Hyde (2012) who used a quantity-  
327 based measurement of past behaviour. Tonglet et al. (2004) also concur, but use both questions on quantity and  
328 frequency to form past behaviour. Consequently, hypothesis 2 (H2) says we expect a positive relationship  
329 between past behaviour and intention. Still, it should be noted that, while past behaviour has in some cases -  
330 which might reflect the influence of the operationalization- been found to be a powerful predictor of intention  
331 and future behaviour (e.g. see Conner and Armitage (1998)), it does not add to the theoretical understanding of  
332 what is driving that behaviour. It merely shows there is stability across time (Ajzen, 1991). In our study we have  
333 assumed that there might be a spill-over from the past recycling behaviour of other battery types on the intention  
334 to recycle battery packs in the future. Dispute has also arisen concerning whether past behaviour directly affects  
335 future actual behaviour or whether it is mediated by intention. This debate is interwoven with the habit issue  
336 discussed earlier (see section 1.2). If pro-environmental behaviour is thought to be reasoned, then the frequency of  
337 prior behaviour should have only an indirect link to later behaviour, i.e. its effect should be mediated by  
338 intention. However, when added to the model, past behaviour is often found to significantly improve the  
339 prediction of later behaviour over and above the effects of intentions. Consequently, the behaviour might not be  
340 completely reasoned after all, but in part under the control of certain stimuli (Bamberg et al., 2003), which might  
341 reflect its semi-automatic nature.

342

343 Secondly, going into the debate evoked by the issues habits create for TPB models, Knussen et al. (2004) picked  
344 up on the use of past behaviour, operationalized by measuring its frequency, as a proxy for a habit. The reason  
345 for doing so was twofold. Reason number one was the disbelief in the frequency of past behaviour being a good

346 proxy on its own for the strength of a habit. Reason number two was the finding that the attitude–intention  
347 relationship was stronger -and not weaker, which would actually match the findings of Ouellette and Wood  
348 (1998)- for those who had recycled most of their recyclable waste, compared to those who had recycled little or  
349 none of their recyclable waste. The latter found in a meta-analysis of TPB studies that if behaviour is classified  
350 as habitual it decreases the strength of the attitude-intention relationship and increases the strength of the past  
351 behaviour-intention relationship. Therefore, Knussen et al. (2004) reckoned that those who were not recycling  
352 were those displaying habitual behaviour, which gave rise to the conception of a “lack of habit” construct.  
353 Consequently, they aimed at verifying whether: (i) the attitude–intention relationship was weaker for those with  
354 high scores on the lack of habit variable than for those with low lack of habit scores and (ii) the past behavior–  
355 intention relationship was stronger for those with high lack of habit scores than for those with low lack of habit  
356 scores. In other words, they expected the intention of those without a recycling habit to be strongly related to  
357 past behavior and weakly related to attitudes. We will verify these hypotheses for a recycling practice which  
358 requires the person to bring the waste to a collection point. The lack of habit construct is considered appealing  
359 for our study as from the low collection levels of battery packs, it can be deduced that most Belgians have  
360 adopted the custom of not bringing back their battery packs (to a Bebat collection point), but in spite might have  
361 adopted a more prevailing alternative habit. Accordingly, the construct “lack of habit” is hypothesized to  
362 moderate the relationship between attitude and intention and between past behaviour and intention (Ouellette  
363 and Wood, 1998, Knussen et al., 2004). This will be tested in hypothesis 7 and 8 (H7 and H8).

364

365



366 Table 2: Hypotheses

Nr	Hypothesis	Expected sign
H1	The more positive one's <u>attitude</u> , the higher the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H2	The more one has recycled electronic waste streams in the <u>past</u> , the higher the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H3	The more one feels <u>morally obliged</u> to recycle battery packs, the higher the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H4	The more one perceives recycling battery packs as a <u>socially desirable</u> action by peers, the higher the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H5	The more one perceives positive <u>consequences</u> of recycling battery packs as being present, the higher the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H6	The more one perceived to be in <u>able to</u> carry out battery pack recycling, the higher the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H7	The <u>lack of a habit</u> of dropping off battery packs at a Bebat collection point <u>moderates</u> the influence of <u>attitude</u> on the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	-
H8	The <u>lack of a habit</u> of dropping off battery packs at a Bebat collection point <u>moderates</u> the influence of <u>past behaviour</u> on the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	+
H9	The more people think that Bebat is highly <u>effective</u> in stimulating people to recycle battery packs, the lower the influence of being aware of the positive <u>consequences</u> of recycling battery packs on the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	-
H10	The more people think that Bebat is highly <u>effective</u> in stimulating people to recycle battery packs, the lower the influence of <u>subjective norms</u> on the intention of dropping off used, removable battery packs at a Bebat collection point as soon as possible.	-

368 Thirdly, moral or personal norms have often been added to the TPB. Tonglet et al. (2004) hypothesized moral  
369 norms, measured by 7 7-point rating scales containing items such as “it would be wrong of me not to recycle  
370 waste”, had a direct effect on intention to recycle household. No significant relationship was found. On the other  
371 hand, Nigbur et al. (2010) showed that personal norms, measured by 5 items adapted from Hopper and Nielsen  
372 (1991), had a positive direct effect on the intention to participate in a kerbside recycling program. Chu and Chiu  
373 (2003), Chen and Tung (2010), Chan and Bishop (2013), and Botetzagias et al. (2015) corroborate such findings.  
374 Hence, personal moral norms are expected to have a positive relationship with the intention to bring back battery  
375 packs (H3).

376  
377 Fourthly, inspired by Schwartz’s model of altruistic behaviour (Schwartz, 1970), the awareness of consequences  
378 has been added to a TPB model. Tonglet et al. (2004) unexpectedly found a negative relationship between  
379 consequences as distinct from community concern and outcomes, measured using 7-point rating scales using  
380 statements after Davies et al. (2002) capturing both personal and social benefits, and intention. The authors argue  
381 to capture the subjective knowledge-based (cognitive/instrumental) component of attitude. The anticipated  
382 positive relationship has been confirmed by Davis et al. (2006), Chen and Tung (2010), and Wan et al. (2014a,  
383 2014b). Accordingly, hypothesis 5 (H5) says we expect a positive relationship between the awareness of  
384 consequences and intention.

385  
386 Finally, the effectiveness of the recycling scheme and by consequence its organizer has been hypothesized to  
387 effect the intention to recycle. Such exploration goes back to Boldero (1995) who argued that the program’s  
388 perceived inadequateness can be used to justify non-participation. The latter author, using a single 5-point rating  
389 scale ranging from a very bad to a very good evaluation, established a positive relationship between program  
390 evaluation and intention. Later, it has been picked up by Wan et al. (2014a, 2014b). Here, perceived policy  
391 effectiveness (PPE) captured an individual’s favourable or unfavourable evaluation on the clarity, adequacy and  
392 facilitation of policy measures. It was measured using 5 7-point rating scales using statements such as “The  
393 government provides clear guidelines on recycling”. They found that PPE not only has a direct effect on

394 intention, but also that it negatively moderates subjective norms and the awareness of consequences (H9). An  
395 overview of the structural model and related hypothesis can be found in Figure 2.

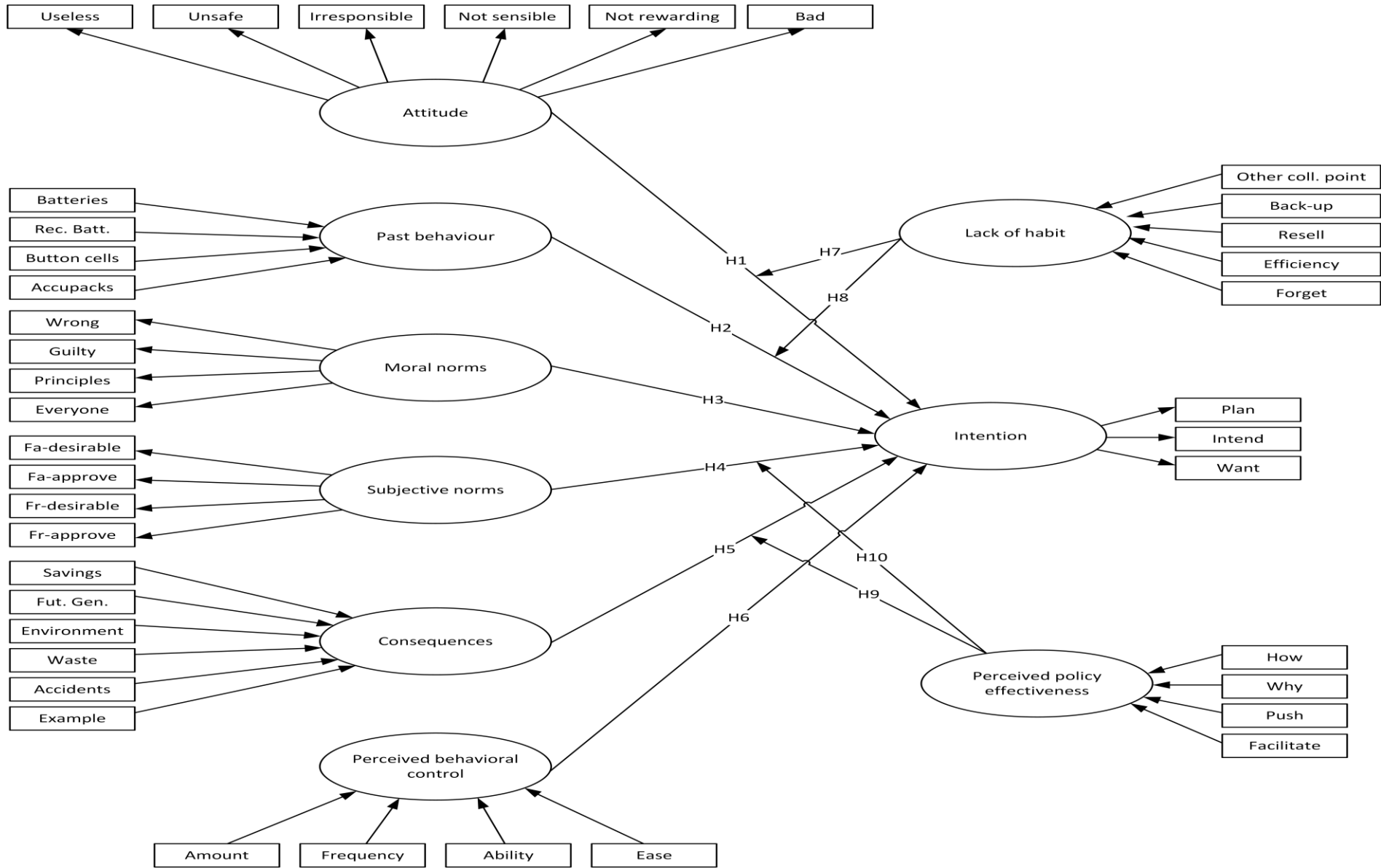


Figure 2. The structural equations model

397 **2.2. Questionnaire design, measurement, and sampling**

398 To gather the necessary data an online survey was designed in both Dutch and French. The survey consisted of  
399 an opening page, which introduced the topic and five survey sections. In the first section the respondents were  
400 profiled based on socio-demographic characteristics. In a second section the respondents were carefully  
401 explained what the desired behaviour entails. It was defined as: “dropping off spent, removable battery packs to  
402 a Bebat collection point as soon as possible”. To assure full understanding, it was verified whether the provided  
403 definitions of ‘spent’ and ‘removable’ were memorized by the respondents. Spent signals that either the device  
404 or battery pack does not function properly anymore, or that the device has been replaced by a newer one. As we  
405 also strongly expected that respondents were unfamiliar with the word “battery packs”, it was defined and  
406 examples of battery packs were presented. In case respondents did not reveal full understanding of the desired  
407 behaviour, the definitions provided earlier were repeated, before being able to continue.

408  
409 In a third section the respondents were asked to fill in several 7-point semantic differentials or rating scales, see  
410 Table 3. *Italic statements are changes to existing scales.* The obtained scores give rise to the indicator variables  
411 (the rectangular shapes in Figure 2) that measure the latent variables under revision (the circles in Figure 2).  
412 Besides determining the measurement indicators, we also need to define the relationship between the latent  
413 variables and their indicators. Formative indicators are multidimensional in nature, whereas reflective indicators  
414 are unidimensional. In our study, the latent variables ‘Past behaviour’, ‘Consequences’, ‘Perceived behavioural  
415 control’, ‘Perceived policy effectiveness’, and ‘Lack of habit’ are measured on a formative scale, whereas the  
416 latent variables ‘Attitude’, ‘Subjective norm’, ‘Moral norm’, and ‘Intention’ are defined as being measured on a  
417 reflective scale. Using a test, based on principal component analysis of the correlation matrix, detailed in Sahmer  
418 et al. (2006) it could be verified that the reflective indicators are indeed unidimensional. An overview of the  
419 characteristics of reflective and formative latent variables is provided by Jarvis et al. (2003). It is important to  
420 correctly define the relationship between the latent variables and its indicators in order to avoid biased parameter  
421 and standard error estimates for the structural model and inflated type II errors (MacKenzie et al., 2005).

422

423 In a fourth section, respondents' objective knowledge on recycling batteries was verified. Here, respondents  
424 objective knowledge was tested regarding legal requirements, what they can bring to a Bebat collection point,  
425 where they can find Bebat collection points, and in what devices they can find removable battery packs. In the  
426 fifth and final section, respondents' pro-ecological worldview was assessed based on the scale developed by  
427 Dunlap et al. (2000).

428 Table 3: Measurement of latent variables

Latent variable	Tag	Indicator (mean – standard deviation)	Reference
<b>Attitude</b> (semantic differentials, reflective)	Useless	It is (useless-useful) to ... (6.23 - 1.50)	Tonglet et al. (2004)
	<i>Unsafe</i>	<i>It is (unsafe-safe) to ...</i> (6.20 - 1.51)	
	Irresponsible	It is (irresponsible-responsible) to ... (6.22 - 1.51)	
	Not sensible	It is (not sensible-sensible) to ... (6.22 - 1.53)	
	Not rewarding	It is (not rewarding-rewarding) to ... (5.80 - 1.56)	
	Bad	It is (bad-good) to ... (6.24 - 1.53)	
<b>Past behaviour</b> (rating scales: never-always, formative)	Batteries	How often do you recycle the typical non-rechargeable batteries (6.16 - 1.32)	Own work, inspired by Cheung et al. (1999)
	Rec. Batt.	How often do you recycle rechargeable batteries (5.66 - 1.75)	
	Button cells	How often do you recycle button cells (5.61 - 1.72)	
	Accupacks	How often do you recycle battery packs (5.31 - 1.85)	
<b>Moral norms</b> (rating scales: totally disagree-totally agree, reflective)	Wrong	It would be wrong of me not to ... (5.80 - 1.48)	Tonglet et al. (2004)
	Guilty	I would feel guilty if I did not ... (5.50 - 1.63)	
	Principles	It goes against my principles not to ... (5.61 - 1.63)	
	Everyone	Everyone should share the responsibility to ... (6.12 - 1.24)	
<b>Subjective norms</b> (rating scales: totally disagree-totally agree, reflective)	Fa-desirable	My family thinks it is desirable to ... (5.53 - 1.68)	Taylor and Todd (1995) and Tonglet et al. (2004)
	Fa-approve	My family would approve of me ... (5.93 - 1.33)	
	Fr-desirable	My friends think it is desirable to ... (5.24 - 1.62)	
	Fr-approve	My friends would approve of me ... (5.68 - 1.40)	
<b>Awareness of consequences</b> (rating scales: totally disagree-totally agree, formative)	Savings	I save money by ... (4.15 - 1.85)	Tonglet et al. (2004)
	Fut. gen.	I create a better environment for future generations by ... (6.20 - 1.18)	
	Environment	I protect the environment by ... (6.35 - 1.09)	
	Waste	I reduce the amount of waste by ... (6.05 - 1.30)	
	Accidents	<i>I reduce the likelihood of accidents in my house by ...</i> (5.22 - 1.63)	
	Example	<i>I am an example for my kids by ...</i> (6.17 - 1.24)	
<b>Perceived behavioural control</b> (semantic differentials and rating scales, formative)	Amount	How much control do you have over ... (very few-a lot) (5.15 - 1.89)	Aguilar-Luzón et al. (2012) and Nigbur et al. (2010)
	Frequency	How many events out of your control could prevent you from (very few-a lot) (4.48 - 1.81)	
	Ability	If I want to, I can easily ... (totally disagree-totally agree) (5.76 - 1.36)	
	Ease	It is (very hard-very easy) to ... (5.65 - 1.48)	
<b>Lack of habit</b> (rating scales: totally disagree-totally agree, formative)	Other coll. point	I bring back electronic devices including battery pack, to the waste electric and electronic equipment recycling point (3.73 - 1.97)	Own work, inspired by Knussen et al. (2004)
	Back-up	I save the device as a spare before I ... (4.51 - 1.80)	
	Resell	I try to salvage some economic value from my device before I ... (3.73 - 1.97)	
	Efficiency	The organization of battery pack collection could be more efficient (3.85 - 1.87)	
	Forget	I often forget to ... even if battery packs have been removed from the devices (3.08 - 1.90)	
<b>Perceived policy effectiveness</b> (rating scales: totally disagree-totally agree, formative)	How	Bebat offers clear guidelines on ... (5.31 - 1.47)	Wan et al. (2014a, 2014b)
	Why	Bebat clearly shows the benefits of ... (5.38 - 1.45)	
	Push	Bebat stimulate me to ... (5.23 - 1.52)	
	Facilitate	Bebat offers sufficient facilities in order for me to ... (5.20 - 1.53)	
<b>Intention</b> (rating scales: totally disagree-totally agree, reflective)	Plan	I plan to ... (5.93 - 1.26)	Cheung et al. (1999) and Chu and Chiu (2003)
	Intend	I intend to ... (5.99 - 1.25)	
	Want	I want to ... (5.87 - 1.28)	

429 The data was collected by a market research company. An online survey was taken from a panel of Belgian  
430 respondents during the 11/2014-01/2015 period. In total 1638 respondents aged between 18 and 64 participated  
431 in the survey. The primary sampling goal was to collect data that would subsequently allow investigating  
432 whether heterogeneity was an issue. We hypothesized that heterogeneity could be caused by the following self-  
433 reports: (1) whether the majority of battery packs was brought back to a Bebat collection point in the past  
434 (yes/no), (2) whether the living area is a rural or urban environment, and (3) what lifestage the respondent is in  
435 (young adult; family -12; family +12; medior; senior). As guidelines dictate that the minimum sample size is  
436 obtained by multiplying the maximum amount of arrowheads pointing at a latent variable times ten, 80  
437 respondents are required per subgroup in our study (Barclay et al., 1995). Moreover, minimum sample size  
438 requirements based on power analysis also indicate that a sample of 1638 is sufficiently large. For example,  
439 given an  $\alpha$  of 0.05 we need at least 174 respondents to achieve a statistical power of 80% for detecting  $R^2$  values  
440 of at least 0.10 (and the number decreases as higher  $R^2$  can be detected) (Hair et al., 2016). An overview of the  
441 obtained subgroup sample sizes is given in Table 4. Note that every categorization using only a single observed  
442 characteristic exceeds these requirements.

443

444 The descriptive statistics for the full sample ( $n=1638$ ) can be found in Table 5. We can see that the sample is  
445 representative concerning gender, but is slightly dominated by older, more highly educated people having less  
446 kids compared to the Belgian population. The life stage variables were defined as follows: (1) “young adults”  
447 are people under 45 being single or in a relationship without kids (living at home); (2) “family -12” are families  
448 of which their oldest child has not reached the age of 12; (3) “family +12” are families of which their oldest  
449 child has passed the age of 12; (4) “mediors” are people falling in the age group of 45-60 being single or in a  
450 relationship without kids (living at home); (5) “seniors” are people having reached the age of 61 or older being  
451 single or in a relationship without kids (living at home). This categorization was maintained for reasons of  
452 consistency with prior research.

453



454 Table 4: Subgroup sample sizes (# respondents)

<b>Battery pack = No</b>			<b>Battery pack = Yes</b>		
	<b>Living area</b>			<b>Living area</b>	
<b>Lifestage</b>	<i>City</i>	<i>Rural</i>	<b>Lifestage</b>	<i>City</i>	<i>Rural</i>
<i>Young adult</i>	98	85	<i>Young adult</i>	69	73
<i>Family -12</i>	73	87	<i>Family -12</i>	54	67
<i>Family +12</i>	102	87	<i>Family +12</i>	100	94
<i>Medior</i>	86	88	<i>Medior</i>	93	91
<i>Senior</i>	50	62	<i>Senior</i>	89	90

455

456

457 Table 5: Descriptive statistics

<b>Descriptive</b>	<b>Category</b>	<b>Proportion</b>	<b>Population<sup>f</sup></b>
Primary language	Dutch-speaking	57.39%	NA
	French-speaking	42.61%	NA
Region <sup>a</sup>	Flanders	59.77%	57.18%
	Walloon	32.30%	31.92%
	Brussels capital	7.94%	10.90%
Age <sup>a</sup>	18-24	13.61%	15.12%
	25-34	17.09%	12.79%
	35-44	15.32%	23.75%
	45-54	17.70%	25.73%
	55-64	36.26%	22.61%
Gender <sup>a</sup>	Male	50.18%	50.18%
	Female	49.82%	49.82%
Family size <sup>b</sup>	1	18.99%	16.70%
	2	41.64%	32.90%
	3	17.64%	20.50%
	4	13.92%	18.50%
	5	5.62%	7.40%
	>5	2.20%	4.00%
Life stage	Young adult	19.84%	NA
	Family -12	17.16%	NA
	Family +12	23.38%	NA
	Medior	21.86%	NA
	Senior	17.77%	NA
Education <sup>c</sup>	Primary and lower secondary	17.58%	29.50%
	Upper secondary	37.06%	37.80%
	Tertiary	45.36%	32.60%
Monthly net family income <sup>d</sup>	0-1499	20.52%	NA
	1500-2499	25.09%	NA
	2500-3499	19.78%	NA
	3500-4499	11.48%	NA
	4500-6000	3.24%	NA
	>6000	0.92%	NA
Living area <sup>e</sup>	Missing	18.97%	NA
	City	49.69%	NA
Battery pack	Rural	50.31%	NA
	Majority yes	49.94%	NA
	Majority no	50.06%	NA

458 <sup>a</sup> population data from Statbel (<http://statbel.fgov.be/nl/statistieken/cijfers/>) counted on 01/01/2015 for 18-64 years; <sup>b</sup> population data  
459 obtained from Generation and Gender Program Belgium (<http://www.ggps.be/>); <sup>c</sup> population data from Eurostat  
460 (<http://ec.europa.eu/eurostat/data/database>) counted on 01/01/2014 for 15-64 years; <sup>d</sup> the average net-adjusted monthly (yearly/12)  
461 income in € (using a 0.95\$/€ conversion rate) is about €2485 according to the 2015 OECD Economic Survey of Belgium  
462 (<http://www.oecdbetterlifeindex.org/countries/belgium/>); <sup>e</sup> based on classification used by market research company, which is dependent  
463 of both the Eurostat and OECD classification; <sup>f</sup> NA = Not available for comparison..

### 464 **2.3. Estimation**

465 Using structural equations modelling (SEM) the underlying relationships between latent variables, measured  
466 indirectly by indicator variables can be assessed. The term "structural equations model" generally refers to a  
467 combination of a "measurement model" that defines latent variables being measured by one or more observed  
468 indicator variables, and a "structural model" that links the latent variables together. The two parts of a structural  
469 equation model are linked together by a system of simultaneous regression equations. Within SEM one of two  
470 approaches can be chosen depending on the objectives of the research. Covariance based SEM is used to confirm  
471 or reject theories, whereas partial least squares structural equations modelling (PLS-SEM) is used when theory  
472 is less developed.

473

474 In this research, PLS-SEM is chosen, because no former socio-psychological study has been executed for our  
475 case and context. Additionally, PLS-SEM offers the following advantages: (1) it can handle formative,  
476 reflective, and single-item measurement scales, (2) it makes virtually no assumptions about the distribution of  
477 the data, (3) it does not require large sample sizes, (4) it allows for estimating higher order models, and (5) it  
478 works better for complex models, i.e. when the focus is on the interrelationships among a large set of factors  
479 and in case of many manifest variables (Chin and Newsted, 1999, Chin, 2010). PLS-SEM is an ordinary least  
480 squares (OLS) regression based method. The estimation procedure estimates the structural path coefficients that  
481 maximize the  $R^2$  values of the target endogenous latent variables while accounting for measurement error. The  
482 effects of the perceived policy effectiveness of Bebat on the awareness of consequences and subjective norms  
483 and of a lack of habit on attitudes and past behaviour and attitude were investigated by means of the two-stage  
484 approach. Besides continuous moderators, PLS-SEM also allows testing for differences between identical  
485 models for different subsamples divided using a categorical variable (Hair et al., 2016). Hence, the goal of this  
486 research is not only to find out the latent drivers and barriers to battery pack drop-off intention, but also to reveal  
487 if and where heterogeneity in relationships is present. All SEM estimations are performed using the software  
488 program SmartPLS 2.0.

489 **3. Results**

490 **3.1. PLS-SEM estimation results**

491 Before being able to present the estimation results, the measurement models need to be evaluated. The full  
492 results of this evaluation can for brevity be found in Appendix A. For the reflective measurement models, all  
493 relevant criteria were met. For the formative measurement models it was found that the savings and efficiency  
494 indicator of the consequences and lack of habit construct do not meaningfully contribute and hence were  
495 dropped. Before proceeding with presenting the results of the regressions, we also demonstrate that the  
496 estimation is not biased due to multicollinearity. In order to verify whether this could be an issue, the tolerance  
497 and variance inflation factors (VIFs) are calculated as they do take indirect correlation into account. Tolerance  
498 levels below 0.2 or VIFs over 5 are considered to be indicative of multicollinearity (Hair et al., 2016). Using  
499 the latent variable scores, resulting from the previously validated measurement models, as input for a linear  
500 regression, we get the results shown in Table 6. Based on these results we conclude it is safe to proceed. The  
501 results of the estimation are shown in Figure 3. Path coefficients between round brackets are negative values.

502 Table 6: Checking for multicollinearity

<b>Latent variable</b>	<b>VIF</b>	<b>Tolerance</b>
Attitude	1.40	0.72
Subjective norms	2.46	0.41
Perceived behavioural control	1.76	0.57
Awareness of consequences	2.28	0.44
Moral norms	1.73	0.58
Past behaviour	1.55	0.65

503

504 The main focus in PLS-SEM analysis is on the predictive power in terms of variance explained, as well as on  
505 the significance of all path coefficients, while assuming that the model is correctly specified due to its grounding  
506 in theory. The structural model's predictive accuracy is evaluated using the R<sup>2</sup> values of the endogenous  
507 construct (i.e. intention), whereas its predictive relevance can be computed with Stone-Geisser's Q<sup>2</sup> which  
508 assesses the predictive relevance. According to Chin (1998) R<sup>2</sup> values of 0.67, 0.33 and 0.19 can be considered  
509 as respectively substantial, moderate and weak for social studies. Hence, the R<sup>2</sup> value of about 0.64 found by  
510 our study is considered to be moderate yet close to substantial. To test the R<sup>2</sup>'s significance, a bootstrap  
511 confidence interval is calculated by using the equation described in Tenenhaus et al. (2005). The R<sup>2</sup> 90%

512 bootstrap confidence interval amounts to [0.39,0.74]. To assess the hypotheses accompanying the structural  
513 model's path coefficients, again a bootstrapping procedure with 5000 draws is used to obtain their standard  
514 errors. From Figure 3 we can see that all direct effects are significant and have the anticipated sign, except for  
515 the relationship between attitude and intention. Hence, hypotheses H2 to H6 could be confirmed. Moreover, in  
516 diminishing order perceived behavioural control and moral norms are found to have the largest direct effect.  
517 The moderating effects of lack of habit and of perceived policy effectiveness on consequences are not  
518 significant, hence we disprove H7, H8 and H9. A negative moderating effect of perceived policy effectiveness  
519 on subjective norms was found, hence we can confirm H10. Additionally, it was found that the direct effects of  
520 lack of habit (-) and perceived policy effectiveness (+) perform as expected. A blindfolding procedure was used  
521 to assess the predictive relevance, of the structural model. The Q<sup>2</sup> value for intention amounts to +0.54 which  
522 signals that the model has predictive relevance for intention (Geisser, 1974). Finally, f<sup>2</sup> and q<sup>2</sup> effect sizes, which  
523 signal the importance of a single latent variable on the R<sup>2</sup> and Q<sup>2</sup> of an endogenous construct respectively, were  
524 found to be lacking (<0.02) or weak ([0.02-0.15]). An overview of the findings is provided in Table 7.

525 Table 7: Hypotheses: findings

<b>Hypothesis</b>	<b>H1</b>	<b>H2</b>	<b>H3</b>	<b>H4</b>	<b>H5</b>	<b>H6</b>	<b>H7</b>	<b>H8</b>	<b>H9</b>	<b>H10</b>
Expectation	+	+	+	+	+	+	-	-	-	-
Findings	NS	+	+	+	+	+	NS	NS	NS	-

\*NS = not significant; sample size: n=1638

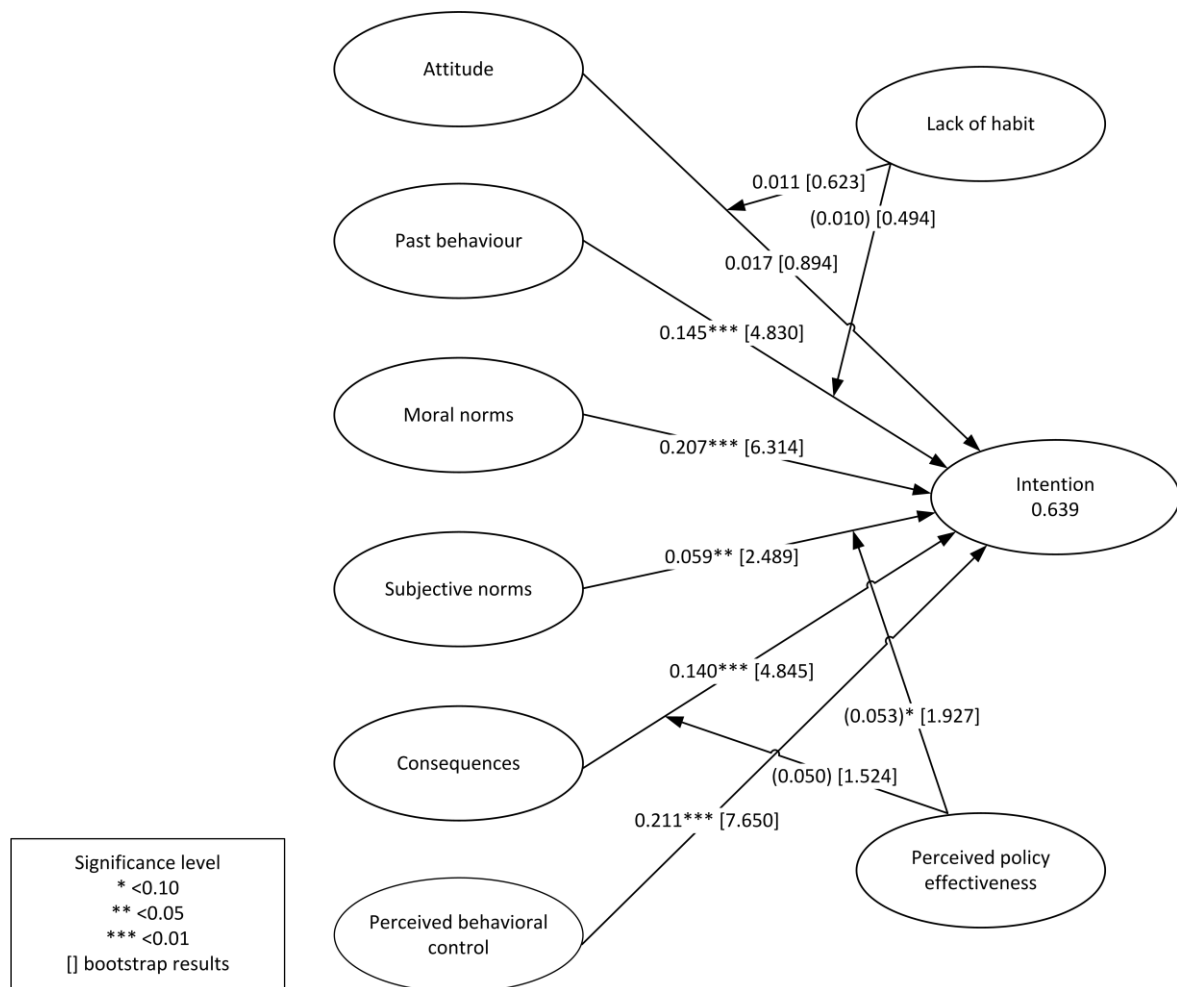


Figure 3: PLS-SEM estimation results

### 3.2 Evaluation of observed heterogeneity

A multi-group analysis (MGA) was used to assess the impact of observed (categorical) variables, such as lifestage, living area, and past drop-off behaviour, on the estimated path coefficients. Observed heterogeneity exists when significant differences are found between path coefficients when dividing the dataset into subgroups based on observed features. Seeing that PLS-SEM does not make any distributional assumptions, a non-parametric approach is used to test for differences between the strengths of the relationships amongst subgroups (Henseler, 2012). Such an analysis is meant to reveal the pitfalls of relying solely on the full sample's average results, which are presented in Figure 3. In Table 8 we show the results of the MGAs when dividing the dataset in subgroups based on a single feature. The p-values express the probability that the second subgroup has a larger population parameter than the first subgroup. Hence, if the path coefficient is positive, a p-value smaller than 0.10 signals that the first subgroup has the largest impact, whereas a value larger than 0.90 indicates the

539 opposite. In case the path coefficient is negative, a p-value smaller than 0.10 signals that the first subgroup has  
540 the smallest absolute impact, whereas a value larger than 0.90 indicates the opposite.

541

542 From Table 8 the following conclusions can be derived. First, there are only 2 groups without significant  
543 differences, being city-rural and young adult-family+12. The latter may be due to ambiguity in answering the  
544 profiling questions and resulting sorting, causing young adults to be sorted in the family + 12 and vice versa.  
545 Second, differences are most common in the susceptibility towards subjective norms, the lack of habit, moral  
546 norms, and awareness of consequences. Third, the characteristics causing most heterogeneity are: the pro-  
547 ecological worldview and the lifestage the respondent is in. Especially, respondents in a family with the oldest  
548 kid under the age of 12 are heterogeneous. Fourth, only the lower educated respondents display a positive  
549 relationship between attitude and intention, whereas the other display an insignificant relationship. Fifth,  
550 subjective norms have a stronger impact on intention for people bringing back less than half of their battery  
551 packs they have available for recycling to a Bebat collection point, for Dutch-speaking people, and for young  
552 adults and families with the oldest child over 12 compared to families with kids younger than 12. Sixth, lack of  
553 habit has a stronger impact on intention for people bringing back less than half of their battery packs they have  
554 available for recycling to a Bebat collection point, for people with a low pro-ecological worldview, and for  
555 mediors compared to young adults, families with the oldest child older than 12, and families with kids younger  
556 than 12. Seventh, moral norms have a stronger impact on intention for people having a high pro-ecological  
557 worldview, for females, and for young adults, families with the oldest child aged above 12, and seniors compared  
558 to families with kids younger than 12. Eighth, consequences have a stronger impact on intention for families  
559 with kids younger than 12 compared to all other lifestage categories. Ninth, the influence of perceived  
560 behavioural control on intention is larger for mediors than for seniors. This heterogeneity shows the importance  
561 of segmentation prior to behavioural change interventions as it has been argued that interventions should be  
562 tailored to the target group to avoid resistance (Klößner, 2015).

563 Table 8: MGA test results

Observed variable	Subgroup <sup>a</sup>	Size	Significant difference	Sign <sup>b</sup>	p-value
Battery pack	Minority	818	Subjective norm -> Intention	+/NS	0.004
	Majority	820	Lack of habit -> Intention	NS/-	0.015
Education	Low	895	Attitude -> Intention	+/NS	0.049
	High	743			
Ecological world view	Low	835	Moral norm -> Intention	+/+	0.991
	High	803	Past behaviour -> Intention	+/+	0.082
				Lack of habit -> Intention	-/NS
Gender	Female	822	Moral norm -> Intention	+/+	0.090
	Male	816			
Language	Dutch	940	Subjective norm -> Intention	+/NS	0.025
	French	698	Past behaviour -> Intention	+/+	0.092
Living area	City	814	/	/	/
	Rural	824			
Lifestage	Young adult	325	Subjective norm -> Intention	+/NS	0.081
	Family -12	281	Moral norm -> Intention	+/+	0.042
				Consequences -> Intention	+/+
Lifestage	Young adult	325	/	/	/
	Family +12	383			
Lifestage	Young adult	325	Subjective norm -> Intention	+/NS	0.066
	Medior	358	Lack of habit -> Intention	NS/-	0.019
Lifestage	Young adult	325	Subjective norm -> Intention	+/NS	0.014
Lifestage	Senior	291			
	Family -12	281	Subjective norm -> Intention	NS/+	0.926
				Moral norm -> Intention	+/+
Lifestage	Family +12	383	Consequences -> Intention	+/+	0.044
				Consequences -> Intention	+/+
Lifestage	Family -12	281	Consequences -> Intention	+/+	0.037
	Medior	358	Lack of habit -> Intention	NS/-	0.075
Lifestage	Family -12	281	Moral norm -> Intention	+/+	0.965
	Senior	291	Consequences -> Intention	+/+	0.025
Lifestage	Family +12	383	Subjective norm -> Intention	+/NS	0.059
	Medior	358	Lack of habit -> Intention	NS/-	0.010
Lifestage	Family +12	383	Subjective norm -> Intention	+/NS	0.007
Lifestage	Senior	291			
	Medior	358	PBC -> Intention	+/+	0.090
Lifestage	Senior	291	Lack of habit -> Intention	-/NS	0.952

564 <sup>a</sup>The first subgroup being the one first mentioned when reading from top to bottom; <sup>b</sup> NS = not significant.

565



## 566 **4. Discussion**

### 567 **4.1. Reflection on the findings**

568 In this study we have verified the drivers and barriers to battery pack drop-off intention using an integrative  
569 model based on the TPB. Seeing the  $R^2$  our results support the use of such frameworks in understanding battery  
570 pack recycling intention for cases and contexts similar to ours. Yet, we expected attitude towards the specific  
571 pro-environmental behaviour to be a significant factor in driving battery pack recycling intention. However, our  
572 study points to the opposite conclusion, which can be considered surprising seeing the large empirical evidence  
573 on its role in predicting intentions. Chan and Bishop (2013), however, have previously found that moral norms  
574 and attitude, operationalized in the same way as in our study, exhibit convergent validity which signals that the  
575 constructs are not distinct, even if the indicators “bad” and “not responsible” are removed. Consequently, in  
576 accordance with Chen and Tung (2010) and Wan et al. (2014b), the additional constructs, awareness of  
577 consequences and moral norms, take over the predictive power from attitude seeing that in a basic TPB model  
578 attitude has the expected positive relationship with intention.

579

580 For past behaviour we have independently confirmed the findings of Knussen et al. (2004) to also be valid for  
581 battery pack recycling intention. Like for kerbside collection, the frequency of past behaviour (+) and lack of  
582 habit (-) made significant independent contributions to the intention to recycle. Consequently, past behaviour  
583 alone, operationalized using frequency measurements, does not confer habit. More recently, it became evident  
584 that there are three primary antecedents to habit development being: (i) frequent repetition of the behaviour in  
585 question, (ii) the extent of satisfaction with the outcomes of the repeated behaviour, and (iii) relatively stable  
586 contexts (Limayem et al., 2007). Unlike Knussen et al. (2004) we do not obtain evidence of significant  
587 moderation by lack of habit on the relationship between attitude and intention, most likely due to the above.  
588 Like Knussen et al. (2004) we do not find support for significant moderation by lack of habit on the relationship  
589 between past behaviour and intention, which is most likely signalling that the consistency between past  
590 behaviour and intention was not more marked for those presumed to have a strong alternative habit, than for  
591 those having the desired habit. The latter is supported by the fact that past behaviour is not identified as a latent  
592 variable with much heterogeneity.

593

594 Perceived behavioural control, moral norms and awareness of consequences were found to be significant factors  
595 in explaining intention, hence reconfirming the results found by Wan et al. (2014b) and Chen and Tung (2010).  
596 From the wider survey, however, some evidence was found supporting that perceived behavioural control is not  
597 a good proxy for actual behavioural control. Whereas people think to be quite able to bring back battery packs,  
598 they were found much less competent in identifying the devices containing them. Consequently, its effect on  
599 actual behaviour might be questionable (Carrington et al., 2010). Also, we did not add a mediating effect of  
600 moral norms on subjective norms. However, Nigbur et al. (2010) and have shown such an effect to be significant.  
601 Subjective (injunctive) norms were found to be least important in explaining intention. This is not surprising  
602 seeing that there is ample evidence showing that social pressure can become internalized over time Botetzagias  
603 et al. (2015). Furthermore, recycling battery packs is not a visible type of behaviour so there is few incentive to  
604 uphold such norms. Indeed, it has been argued that for social norms full impact to be revealed one should  
605 investigate both injunctive (i.e. what people approve) and descriptive (i.e. what people actually do in a given  
606 context) norms (Cialdini et al., 1990). For perceived policy effectiveness, we could not find statistical evidence  
607 of a moderating role on the awareness of consequences (Wan et al., 2014b). This signals that promotional  
608 campaigns in Belgium should not stop reminding people of the avoided costs and benefits of recycling batteries  
609 in spite of the good reputation Bebat maintains. On the other hand, we could establish a moderating role on  
610 subjective norms. This points out that for those with a weak perceived policy effectiveness a stronger, positive  
611 relationship exists between subjective norms and intention.

612

613 Besides offering the average results based on the full sample of 1638 respondents, we also performed a multi-  
614 group analysis (MGA) to assess the impact of observed demographical variables and pro-ecological worldview.  
615 Such an analysis is useful as empirical evidence on the effect of demographics is inconclusive (Arbués and  
616 Villanúa, 2016) and it allows nuancing the full sample's average results by serving as a means to create target  
617 groups that can be addressed using the same communication channel(s) and message(s). A downside of MGA  
618 is that it presumes measurement invariance, i.e. we suppose that the subgroups do not require a different

619 measurement model. However, ways to test this assumption empirically have yet to be further developed  
620 (Henseler et al., 2016).

621

622 From the wider survey it was also found that on average respondents: (i) report to bring 7 to 8 used portable  
623 batteries to a collection point 4-5 times per year, (ii) do not plan on changing this frequency, and (iii) agree the  
624 least with the statement saying that they often forget to take battery packs to a collection point. Consequently,  
625 we feel Bebat is facing the situation where people recycle batteries on a low frequency basis and do not perceive  
626 any (easy) opportunity to bring back more of them. This lack in perceived opportunity is in contrast to reality.  
627 Past research showed that people store used battery packs longer than they do other types of batteries. At the  
628 root of the difference in recycling rates between types of batteries we presume, lies that that (Belgian) people  
629 are more attached to higher-end electronics devices, which are more likely to contain battery packs. Such devices  
630 are typical examples of up-to-date products. Consequently, people are more hesitant to recycle such devices and  
631 their batteries (Jacoby et al., 1977) perhaps caused by anticipated feelings of regret (Tsiros and Mittal, 2000)  
632 which then over time evolves into forgetting the devices are there. For instance, in a follow-up qualitative study  
633 respondents noted not to have parted from a mobile phone because it contained pictures of good times they once  
634 had. If they do part from their devices, our respondents preferred to look for other interesting options, such as  
635 reselling or returning them for rebates, or to gift it to someone or donate it to a charity, which is similar to  
636 American behaviour (Staples, 2014).

#### 637 **4.2. Recommendations for national producer responsibility organisations**

638 From our findings the following recommendations can be drawn to reinforce the desired behaviour. National  
639 producer responsibility organisations are advised to (continue) stress(ing) the added value of dropping-off even  
640 a single battery (pack) in information campaigns. Also, if financially feasible, they are advised to reward loyalty  
641 for instance by organising collection races, preferably asking for some form of prior commitment to actually  
642 perform the behaviour (Burn and Oskamp, 1986). For instance, schools or companies could register to  
643 participate in a local collection race of which the results are made public. Such activities help to prevent bad  
644 habit formation or to relapse into them. The desired behaviour can be (re)activated by making consumers aware  
645 of the consequences (or need) of assuming their responsibility of recycling all batteries. We do not advocate

646 raising awareness on recycling being a legal requirement in the top-performing countries as it might crowd out  
647 intrinsic motivation (Frey, 1994). Without any type of personal or public awareness, no norms can be activated  
648 whose defiance challenge both the ideal self-image and the ideal concept others have of me, which induces self-  
649 discrepancy (Higgins, 1987) and stimulates people to do what is right instead of what is economically rational.

650

651 Having touched ethics, it is also worth mentioning that a message intended to guilt someone into recycling in  
652 the future is expected to be less lasting than announcements that induce feelings of pride (Bissing-Olson et al.,  
653 2016). Hence, the message to persuade people to start recycling battery packs and to motivate others that have  
654 already started, should be framed in a positive and understandable manner. For more detail on how to design  
655 effective behaviour change interventions we refer to Bator and Cialdini (2000) for a thorough overview of  
656 general insights. Essential is that changing behaviour does not stop at making sure the message is well-received,  
657 it also involves making sure it is retrievable and that people are kept committed to the message. For literature  
658 investigating battery recycling slogans' most effective content we refer to Hansmann et al. (2009). In brief, they  
659 found that a factual slogan is more effective than a humorous one.

660

661 Increasing only the awareness of consequences is insufficient. Just because one provides ample reasons of why  
662 to adopt a new behaviour or continue the desired behaviour, does not mean one does not simply forget over time  
663 or is able or willing to. To avoid forgetting we recommend to use additional, more visible cues than the currently  
664 widely used battery collection bags. For instance national producer responsibility organisations could team up  
665 with apps for making grocery shopping lists to remind them of their recycling intention when they add new  
666 batteries or electric or electronic equipment containing battery packs to their shopping lists. The creation of a  
667 proper habit then still needs to be facilitated in order to avoid the feeling of learned helplessness and hence to  
668 generate satisfaction. Satisfactory experiences are key in developing new habitual behaviour (Aarts et al., 1997).  
669 Moreover, increasing people's feeling of competence and ease may contribute to an increase in the level of  
670 satisfaction which is experienced as behaviour is performed (Ronis et al., 1989). However, the battery collection  
671 process differs in difficulty across battery types and consequently so will the perceived (and actual) behavioural  
672 control. Note that, in the case of portable batteries, the difference in difficulty in Belgium is not caused by how

673 the system is organized as all portable batteries can be brought to the same Bebat drop-off point. One reason we  
674 suspect to be an issue is that people are unable to tell the difference between a removable battery pack and a  
675 built-in one. To remedy this barrier, people have to learn how to tell the difference. Only showing them how to  
676 do it in a commercial or on a website is expected to be less effective in the long run. A joint collection point  
677 having an instructor for separating wireless electrical and electronical waste and batteries could provide in a  
678 practical solution to help people by providing them with instructions while they do it. In a second stage  
679 collection campaigns targeting battery pack collection in specific target groups can be initiated to stimulate  
680 knowledge transfer further and to make learning a fun, social activity. It has been shown that people might  
681 induce themselves to carry out a mundane task by creating ways to perceive the task as more interesting and fun  
682 (Sansone and Harackiewicz, 1996). Intuitively, in the context of household chores a hedonic goal-frame is less  
683 expected. Indeed, our results confirm that in this context a normative goal-frame is most likely to be dominant  
684 without intervention (Miao and Wei, 2013).

685

686 For this approach to work the collection campaign needs to last long enough to allow unfreezing the old,  
687 unwanted and reinforcing or freezing the new, desired habit. These latter steps are important as information  
688 campaigns may stimulate a behavioral change, but tend to devote too little effort to feedback to support behavior  
689 repetition and the desired pro-environmental habit establishment (Dahlstrand and Biel, 1997). Respondents also  
690 indicated that a logo on the device would prove to be useful cue in stimulating the drop-off of battery packs. A  
691 stable context, which requires identical or similar situational cues, is alongside with satisfaction and frequent  
692 repetition conducive to habit development (Limayem et al., 2007).

693

694 We end with a word of caution as experimental studies would be required to validate these recommendations  
695 for our context. Such experimental studies are moreover important given that the costs of infomercials and  
696 collection campaigns vary significantly because they are a function of their length, quality, and coverage.

### 697 **4.3. Limitations and routes for further research**

698 The main limitation of our results is that they are based on self-reported intention statements, which are  
699 correlated with findings about self-reported behaviour. However, the latter do not necessarily have a high

700 correlation with observed, actual behaviour. The strength of the relationship between actual and self-reported  
701 behaviour has been found to depend on the product under study, but typically one overestimates the degree to  
702 which one displays the desired behaviour when self-reporting (Huffman et al., 2014). Hence, further study based  
703 on objective measurements of actual behaviour of a representative sample is needed to verify whether our  
704 findings hold in such a context. These measurements would then allow to empirically verify whether a (lack of)  
705 habit significantly moderates the relationship between intention and actual behaviour and hence limits the  
706 predictive power of intentions on actual behaviour.

707

708 Based on the insights gained, we feel it would also be interesting to investigate the role of emotions, control,  
709 (lack of) habits and self-identity within the frame of the interlinkage between WEEE and battery packs using a  
710 multilevel structural equations model such as the one presented in Klöckner and Oppedal (2011) once before  
711 and once after interventions have taken place. This would allow to empirically quantify the existence and impact  
712 on spill-over effects in a context where recycling is normalized if the study were to take place in Belgium again.  
713 Previously, it has been argued that, due to normalization, positive spill-overs to other pro-environmental  
714 behaviours are less likely to occur, unless such conduct results from a pro-environmental identity (Thomas and  
715 Sharp, 2013). Still, the findings of Reams et al. (1996) who found that a positive effect might be limited to  
716 closely related behaviour, cause us to expect a positive spill-over. Nevertheless, such an effect is not guaranteed.  
717 Thøgersen (1999) found evidence of negative spill-over between pro-environmental behaviours. Most likely this  
718 is because people chose to act pro-environmentally in the domain where the costs are lowest, which is also  
719 known as limited behaviour (Gifford, 2011). In order to explain these mixed findings Truelove et al. (2014)  
720 developed a unifying theoretical framework which could be tested in such a follow-up study.

721

722 An interesting starting point is provided by Triandis' (1977) theory of interpersonal behaviour (TIB) and  
723 Klöckner and Blöbaum's (2010) comprehensive action determination model. Triandis' theory, although similar  
724 to TPB in that intention is a direct antecedent of actual behaviour, recognised the key role played by (i) social  
725 factors, which include norms, roles, and the self-concept, and emotions in forming intentions, (ii) the mediating  
726 influence of habits on actual behaviour, and (iii) the moderating influence by facilitating conditions on the

727 influence of both intention and habits on actual behaviour. Consequently, actual behaviour is considered to be  
728 predicted by intention, habits, and situational constraints, whereas intention is formed by rational, social and  
729 affective antecedents. In a study by Bamberg and Schmidt (2003) it was shown that the TIB outperforms the  
730 TPB in terms of explanatory power of self-reported car use. Similarly, Klöckner and Blöbaum's comprehensive  
731 action determination model (CADM) incorporates intentional, normative, situational, and habitual influences on  
732 environmentally friendly behaviour based on the assumptions made respectively in the TPB, the norm activation  
733 model (NAM), the ipsative theory of behaviour (Tanner, 1999), and the definition of the concept of habit. A test  
734 of the comprehensive model showed that the CADM explained the greatest degree of variation as compared  
735 with the TPB and the NAM.

736

737 There is, however, a potential downside to the quest for socio-psychological models which explain more  
738 variation in the dependent variable(s). As more and more antecedents are added to such models there are  
739 diminishing increases in their predictive capacity while the increasing complexity renders them less easily  
740 amenable to practical application. If so, then perhaps one should consider turning to other methods. For instance,  
741 one could employ a method that operationalizes structuration theory (Giddens, 1984). The latter theory takes the  
742 middle ground in the debate on whether behaviour is driven by agency or by structure. Nevertheless, such an  
743 alternative has the potential downside of not being easily generalized across contexts. Alternatively, one could  
744 perform an experimental study. Although it has been said to evoke socially desirable responses due to the fact  
745 that respondents are aware of being in an experiment, the relative switch in behaviour displayed in experiments  
746 has been found to be consistent (Ariely et al., 2003).

747

748 Lastly, we admit that the proposed recommendations are mainly based on the average results and largely neglect  
749 the information provided by the multi-group analysis (MGA). This merely signals that our recommendations are  
750 more suited for mass media communication. We leave it to future studies to distinguish target groups that can  
751 be addressed using the same communication channel(s) and message(s).

## 752 **5. Conclusion**

753 Our results support the use of integrative, Theory of Planned based frameworks in understanding battery pack  
754 recycling intention, certainly for cases in which an actual, specific, desired habit has yet to be developed. Based  
755 on the size of the path coefficients we find that on average perceived behavioural control, moral norm, and the  
756 awareness consequences have the largest influence on the intention to drop-off battery packs as quickly as  
757 possible. Hence, national producer responsibility organisations are advised to (i) keep up with or start  
758 informational and promotional activities to familiarize people with the fact that this type of portable batteries is  
759 being collected by them and to decrease the (perceived) difficulty and banality of recycling battery packs in  
760 order to unfreeze the current lack of habit and (ii) to raise awareness on the need for and consequences of  
761 recycling battery packs in order to activate the ascription of responsibility and accordingly moral norms. Still, it  
762 should be taken into consideration that these findings and the derived recommendations are based on self-  
763 reported intention statements. Further study, using more comprehensive, integrative models which also  
764 incorporate objective measurements of actual behaviour of a representative sample, is needed to verify whether  
765 our findings hold in such a context. We recommend such a study to simultaneously investigate the presence of  
766 positive spill-overs or effect on spill-over of interventions using multilevel structural equation modelling.

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1070 **Appendices**

1071

1072 **Appendix A: Evaluation of the reflective and formative measurement models**

1073 When evaluating reflective measurement models, several aspects have to be tested. The indicator reliability  
 1074 specifies the part of an indicator's variance that can be explained by the underlying latent variable. At least 50%  
 1075 of an indicator's variance should be explained by the latent variable (i.e. loading above 0.70). For the construct  
 1076 reliability the composite reliability is used. Cronbach's alpha could also be used, but this measure is sensitive to  
 1077 the number of items in the scale and is more conservative. Values for the composite reliability above 0.60 are  
 1078 acceptable for exploratory research. The convergent validity measures the extent to which a measure correlates  
 1079 positively with alternative measures of the same construct. Both the outer loadings and average variance  
 1080 extracted (AVE) can be used to test this. The outer loadings should be higher than 0.70. The AVE is calculated  
 1081 as the sum of the squared loadings divided by the number of indicators. An AVE of less than 0.5 is considered  
 1082 insufficient, because more variance is due to error variance than to indicator variance. Finally, the discriminant  
 1083 validity represents the extent to which a construct is distinct from other constructs. The cross loadings may not  
 1084 exceed the indicators' outer loadings and the Fornell-Larcker criterion has to be met. The latter compares the  
 1085 square root of the AVE values with the latent variable correlations(Hair et al., 2016). It can be concluded that  
 1086 all criteria are met. An overview of the results of the reflective measurement models is provided in the Table  
 1087 A1.

1088 Table A1: Estimation results and psychometric properties of reflective measurement models

<b>Latent variable</b>	<b>Indicator</b>	<b>Loadings</b>	<b>Indicator reliability</b>	<b>Composite reliability</b>	<b>AVE</b>	<b>Discriminant validity</b>
Attitude	Useless	0.852	0.726	0.942	0.729	yes
	Unsafe	0.855	0.731			
	Irresponsible	0.883	0.780			
	Not sensible	0.884	0.781			
	Not rewarding	0.770	0.593			
	Bad	0.874	0.764			
Moral norm	Wrong	0.891	0.794	0.933	0.776	yes
	Guilty	0.892	0.796			
	Principles	0.863	0.745			
	Everyone	0.879	0.773			
Subjective norm	Fa-desirable	0.825	0.680	0.908	0.711	yes
	Fa-approve	0.871	0.759			
	Fr-desirable	0.801	0.642			
	Fr-approve	0.874	0.764			
Intention	Planned	0.948	0.898	0.958	0.885	yes
	Probable	0.941	0.886			
	Desire	0.933	0.870			

1089



1090 Formative latent variables require a different evaluation of the measurement model as indicators are not  
1091 supposed to be correlated. For formative measures we assessed the indicator reliability. Indicator reliability is  
1092 examined by verifying whether high correlations exists between indicators. The variance inflation factor (VIF)  
1093 is used to check whether multicollinearity poses a problem. The VIF did not exceed a value of 10. Using a  
1094 bootstrapping procedure with 5000 draws it is also evaluated which indicators are significant and relevant. The  
1095 null hypothesis, stating that an outer weight equals zero (i.e. has no significant effect), is rejected when the  
1096 interval does not include zero. When it seems that indicators are not significant, these are further investigated.  
1097 In case the outer loadings of these indicators are high (above 0.5), it was opted to keep the indicator in the model.  
1098 The results of the overall formative measurement models are provided in 0. Based on the results, it is decided to  
1099 keep all indicators in the measurement model, except for the savings indicator and efficiency indicator. In order  
1100 to check for convergent validity it is suggested to use a general question, which might be considered reflective,  
1101 related to each of the formative constructs in order to evaluate formative measurement model's validity.  
1102 However, no question is taken into account in our survey as the questionnaire is already perceived as being quite  
1103 long. As a consequence, the convergent validity of the formative constructs was not evaluated.  
1104

1105 Table A2: Results bootstrapping procedure formative measurement scales

Latent variable	Indicator	Outer weights (outer loadings)	Significance level (* .10 ** .05 ***.01)	Confidence interval (10%)
Past behaviour	Norm. batt.	0.580 (0.905)	***	[0.493;0.667]
	Rec. batt.	0.152 (0.732)	***	[0.072;0.232]
	Button cells	0.062 (0.733)	NS	[-0.023;0.147]
	Accupacks	0.396 (0.804)	***	[0.313;0.479]
Consequences	<b>Saving</b>	<b>0.010 (0.296)</b>	<b>NS</b>	<b>[-0.043;0.063]</b>
	Well-being	0.321 (0.925)	***	[0.196;0.446]
	Environment	0.305 (0.917)	***	[0.174;0.436]
	Waste	0.166 (0.795)	***	[0.079;0.253]
	Accident	0.164 (0.597)	***	[0.092;0.236]
	Example	0.228 (0.839)	***	[0.121;0.335]
Perceived behavioural control	Amount	0.136 (0.461)	***	[0.079;0.193]
	Frequency	0.053 (0.875)	*	[0.004;0.102]
	Ability	0.529 (0.868)	***	[0.446;0.612]
	Ease	0.537 (0.319)	***	[0.458;0.616]
Lack of habit	Other coll. Point	-0.390 (0.648)	***	[-0.472;-0.308]
	Back-up	0.269 (0.648)	***	[0.170;0.368]
	Resell	-0.108 (0.193)	**	[-0.191;-0.025]
	<b>Efficiency</b>	<b>0.091 (0.408)</b>	<b>NS</b>	<b>[-0.004;0.186]</b>
	Forget	0.760 (0.889)	***	[0.664;0.856]
Perceived policy effectiveness	How	0.223 (0.891)	**	[0.074;0.372]
	Why	0.244 (0.867)	***	[0.117;0.372]
	Push	0.355 (0.894)	***	[0.237;0.473]
	Facilitate	0.319 (0.853)	***	[0.223;0.415]

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