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An integrative model of waste management

An integrative model of waste management: situational, normative, attitudinal and self-related determinants of household's food waste separation intention and habits, and waste deposit at disposal centers.

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1 **Abstract.**

2
3 Faced with increasing waste production, authorities are seeking to encourage better household
4 waste-management and need to identify levers for change. We propose a model integrating the
5 major determinants of pro-environmental behavior assumed in prominent theoretical models.
6 Based on meta-analytical evidence, we incorporated situational, normative, attitudinal and self-
7 processes and tested this integrative model to predict intentions to perform two overlooked
8 behaviors: food waste separation and deposit at waste disposal centers. To go beyond intention
9 we also investigated habits to sort food waste. An online survey was administered to two
10 samples ($N_{\text{total}} = 2'814$) and data were analyzed using structural equation modeling. The results
11 showed a good fit of an integrative model (CFIs > 0.917; TLIs > 0.910; RMSEAs < 0.043;
12 SRMRs < 0.071). Waste management intentions and habits are directly predicted mainly by
13 personal norms and perceived behavioral control. The latter is predicted by facilitating
14 conditions and pro-environmental identity. Personal norms are predicted by social norms, pro-
15 environmental identity and perceived behavioral control. Our results confirm the relevance of
16 a model integrating situational, normative, attitudinal and self-processes to explain waste
17 management intentions, and provide a basis for the development of waste-management
18 interventions.

19 **Keywords:** waste management, integrative model, environmental psychology, intention,
20 structural equation modeling

21

22 Since the beginning of this century, the serious and growing international issue of waste
23 management has led to many studies of recycling behavior, which have been widely reported
24 in the behavioral science literature (littering, Chaudhary et al., 2021; household waste
25 separation, Roustae et al., 2020; recycling of packaging materials, Miafodzyeva & Brandt, 2013).
26 Research has highlighted several determinants of waste management behaviors, all articulated
27 in four robust models: the theory of planned behavior (Strydom, 2018), the norm activation
28 model (Wang et al., 2019), the value-belief-norm model (Dursun et al., 2017), and the
29 comprehensive action determination model (Ofstad et al., 2017). A recent meta-analysis of 91
30 studies on household waste management identified numerous predictors of recycling behavior
31 in general, helping policymakers design effective strategies for waste prevention actions
32 (Geiger et al., 2019).

33 The purpose of the present study is to advance the understanding of household waste
34 management by integrating the contributions of historical models of behavioral change and
35 more recent research into a unified model, to predict intention and habits related to two
36 understudied types of waste management behaviors. The first is the source separation of food
37 waste, which makes up around 30% of the contents of a household's waste bin. European Union
38 foresees the obligation to treat it separately from January 2024, implying the individual
39 adoption of this new sorting behavior. The second behavior is the deposit at waste recycling
40 and disposal centers of various household waste types, such as bulky, toxic, electrical, or
41 electronic waste. Collected properly, the largest part of this waste volume can be recovered
42 through the resale of materials or through reuse. Some waste, however, contains hazardous
43 materials, such as toxic liquids and electronic waste, which can generate environmental
44 pollution. Therefore, it is essential to treat each waste type accordingly after it has been
45 deposited in appropriate facilities, such as a community's waste recycling and disposal center.
46 In this study, we propose a model incorporating the main determinants of recycling behaviors

47 (identified from the meta-analysis by Geiger et al., 2019) and we test its ability to account
48 for intention towards two specific behaviors: separation of food waste and deposits at waste
49 disposal centers.

50 **Models of Pro-Environmental Behavior**

51 Research in environmental psychology has fruitfully developed and tested models to
52 explain pro-environmental behavior. However, the parallel development of multiple models has
53 revealed a large diversity of potential determinants of pro-environmental behavior. The present
54 study is in line with recent attempts to integrate models and the most important determinants of
55 pro-environmental behavior (see e.g., Gkargkavouzi et al., 2019; Klöckner & Blöbaum, 2010).
56 Our approach is to integrate prominent theoretical models by relying on empirical meta-
57 analytical evidence. In what follows, we provide an overview of four prominent theoretical
58 models.

59 ***Theory of Planned Behavior***

60 In 1991, Ajzen proposed a theory of planned behavior to explain any deliberate
61 behavior, including deliberate pro-environmental behavior (e.g., choice of travel mode,
62 Bamberg et al., 2003; food consumption, Ajzen, 2016; implication in pro-environmental
63 education, de Leeuw et al., 2015). As shown in Figure 1a, this rational choice model assumes
64 that behavioral intention is the main predictor of deliberate behaviors. Intention reflects the will
65 to exert effort to perform a behavior and is guided by three types of beliefs. First, an individual's
66 intention is guided by attitudes in terms of a favorable or unfavorable evaluation of the behavior,
67 derived from beliefs about the possible consequences of the behavior and the rational evaluation
68 of those consequences. Second, intention is guided by subjective norms—perceived social
69 pressure resulting from beliefs about what relevant others approve or disapprove (injunctive

70 norm) or do (descriptive norm)—and the motivation to fulfill those social expectations. Third,
71 intention is guided by perceived behavioral control (Ajzen, 1991), which results from beliefs
72 about one's ability to perform the target behavior (i.e., self-efficacy) and about control over that
73 behavior (Kraft et al., 2005). According to this model, individuals form a rational intention to
74 act, weighing the three types of behavioral beliefs. The determinants modeled in the theory of
75 planned behavior have been associated with a wide range of recycling behaviors (Aguilar-
76 Luzón et al., 2012; Tonglet et al., 2004).

77 *The Norm Activation Model*

78 The norm activation model developed by Schwartz (1973, 1977), shown in Figure 1b,
79 proposes that individuals act in a pro-social and pro-environmental way because they feel
80 morally obligated to do so (Bamberg et al., 2003; Steg & Groot, 2010). The sense of moral
81 obligation, also referred to as personal norms, arises from the internalization of social
82 expectations. Indeed, social learning about what is and what is not valued by significant others
83 forms a solid basis for the moral principles that individuals embrace (Thøgersen, 2006).
84 However, the influence of personal norms on behavior differs from the influence arising from
85 social norms, as it primarily results from implications for the self. First, sanctions following
86 personal norm violations differ from those that follow the violation of social norms—violating
87 personal norms calls into question one's self-concept, whereas violating social norms has
88 consequences for social interactions (Bamberg et al., 2007). Second, the feeling of moral
89 obligation to comply exerts a stronger influence than social norms on individual decisions .
90 Behaviors consistent with personal norms protect the self, whereas inconsistent behaviors lead
91 to self-criticism. Personal norms play a role in behavioral decisions because individuals
92 anticipate and compare the cost of their behavior (in effort or time, for example) with the cost

93 of the violation for the self. People do not enact the behavior if doing so is more costly than
94 violating personal norms.

95 The norm activation model further suggests that personal norms are not always active.
96 Their activation depends on awareness of the need to act and of the consequences, for the
97 environment, of performing or not performing the action, and of the individual's ascription of
98 responsibility in the situation. Thus, the higher the awareness of the need for action and of the
99 impact of the solution, and the higher the self-ascribed responsibility, the stronger the personal
100 norms. In the domain of pro-environmental behavior, the norm activation model has proven
101 useful in explaining energy conservation (van der Werff & Steg, 2015), food waste reduction
102 (Kim et al., 2022), and recycling (Wang et al., 2019). Numerous other studies have shown that
103 the impact of personal norms on behavior is mediated by behavioral intention (for meta-
104 analyses, see Bamberg & Möser, 2007; Onwezen et al., 2013).

105 *The Value-Belief-Norm Model*

106 Stern (2000) proposed an extended version of the norm activation model by integrating
107 the new environmental paradigm (Stern, Dietz, et al., 1995) and the values-based theory (Stern,
108 Kalof, et al., 1995). According to Schwartz (1992), values are the most stable beliefs
109 transcending any situation to guide decisions and behaviors, such that they match what is
110 important to individuals. The different types of values classified by Schwartz (1994) constitute
111 a priority system for the individual. If an individual's value system prioritizes self-transcendent
112 values, such as biospheric values (concerns about nature) and altruistic values (concerns about
113 other humans), at the expense of self-enhancement values (egoistic values, concerns about self-
114 interest), then that person will be more inclined to adopt environmentally friendly behaviors
115 (Steg et al., 2005).

116 The value-belief-norm model, presented in Figure 1c, postulates a causal chain in which
117 self-transcendent values predict the new environmental paradigm – a general ecological
118 worldview measured through individuals’ beliefs about human-nature interactions. This belief,
119 in turn, affects awareness of adverse and beneficial consequences. Awareness of consequences
120 influences beliefs about one’s personal responsibility in those consequences, which then
121 activates personal norms. Activated personal environmental norms act as a general
122 predisposition to pro-environmental actions. The value-belief-norm model has shown a good
123 predictive validity for pro-environmental behaviors (Jakovcevic & Reyna, 2016) and
124 specifically for recycling behaviors (Dursun et al., 2017).

125 *The Comprehensive Action Determination Model*

126 Klöckner and Blöbaum (2010) proposed a comprehensive model, presented in figure 1d,
127 that integrates the main determinants from both the theory of planned behavior and the norm
128 activation model, and adds constructs from the ipsative theory of behavior (Tanner, 1999;
129 Tanner et al., 2004). The comprehensive action determination model aims to explain a wide
130 range of pro-environmental behaviors by modeling three direct sources of influence on pro-
131 environmental behaviors: intentional processes, habitual processes and situational processes. A
132 fourth indirect source of influence is also proposed—the normative processes.

133 Intentional processes designate reflexive processes leading to the formation of a will to
134 make an effort to produce the behavior. They comprise attitudes and behavioral intentions. In
135 the case of uncommon or new practices, intentional processes are the proximal antecedent of
136 the behavior.

137 Habitual processes are the results of the automation of a gesture or practice through its
138 frequent repetition over time. Habits can be in line with or in conflict with the expected

139 behavior. They will therefore moderate—positively or negatively—the link between intentional
140 processes and behavior, and the strength of the moderation increases with the degree of
141 automaticity (Triandis, 1980).

142 Situational processes involve the context and how it facilitates the correct
143 implementation of the behavior. These include subjective constraints, namely perceived
144 behavioral control, and objective constraints. The objective constraints are the physical,
145 material and informational characteristics of the situation in which the behavior occurs (e.g.,
146 access to a recycling bin, knowledge of the deposit center location). These conditions can hinder
147 or facilitate the behavior depending on the situation. Therefore, objective constraints influence
148 the perceived control that the individual has over the expected behavior.

149 Normative processes refer to the influence of standards related to the behavior. These
150 norms can be conveyed by others - social norms - or internalized - personal norms. Their
151 influence on behavior is mediated by intentional and habitual processes. The personal norms
152 held the strongest normative influence on behavioral intention and habits, and this influence
153 must be activated by beliefs about the behavior (Schwartz, 1977; Thøgersen, 2006). Therefore,
154 the normative processes include awareness of a need to fix an issue and awareness of
155 consequences of the targeted behavior.

156 Lastly, although situational processes directly influence behavior, they also do so
157 indirectly via intentional, habitual and normative processes. Indeed, the situation must provide
158 individuals with a subjective sense of ability to produce the behavior in order for their personal
159 norms to be activated, the intention to act to be evaluated and the habit pattern to be triggered.
160 Furthermore, the objective conditions in the environment must allow the habit to take place.

161 The comprehensive action determination model has been used to explain pro-
162 environmental behavior such as clothing consumption (Joanes et al., 2020), sustainable
163 purchase (Jovarauskaitė et al., 2020) and recycling (Klößner & Oppedal, 2011; Ofstad et al.,
164 2017).

165 - Insert figure 1 about here -

166 **Identifying the Main Determinants**

167 Recently, a meta-analysis classified the most important factors predicting waste
168 management across different contexts (e.g., households, employees) and types of waste (e.g.,
169 plastic, general recycling, Geiger et al., 2019). The authors conducted their analyses on the
170 effect sizes from 91 studies that tested the link between the determinants of a large variety of
171 models and behavioral intention, self-reported behavior or observed behavior.

172 The results showed the predictive importance of most of the determinants included in
173 the comprehensive action determination model. The meta-analysis confirmed the influence of
174 normative processes, including social norms ($r = .33$), personal norms ($r = .42$), and awareness
175 of consequences ($r \approx .19^1$). The results also supported the importance of attitudes ($r = .34$) and
176 of situational processes (i.e., perceived behavioral control, $r = .39$; contextual factors, $-.17 \leq rs$
177 $\geq .26$).

178 In line with the value-belief-norm model, and a broader version of the Comprehensive
179 action determination model (Klößner, 2013), the meta-analysis also showed that values are
180 related to recycling ($r = .24$). Furthermore, Geiger et al. (2019)'s meta-analysis highlights the

¹ The exact effect size for awareness of consequences is not provided

181 importance of another factor that we have not mentioned so far: environmental self-identity (r
182 = .30), defined as the degree to which individuals see themselves as eco-friendly (van der Werff
183 & Steg, 2016). Environmental self-identity and values refer to self- processes—general beliefs
184 linking the self to the domain in which behavior takes place (e.g., the environment). Many
185 studies have shown a link between pro-environmental behavior and general beliefs related to
186 the self (De Groot & Steg, 2007), such as biospheric values and environmental self-identity
187 (Carmona-Moya et al., 2017).

188 The results of this meta-analytical work reveal the main determinants of recycling
189 behavior that are only partially included in the current models. To move away from the
190 multiplication of separate models, we propose to integrate these determinants in a unified
191 framework. Hence, we offer a model that includes the normative, attitudinal, and situational
192 processes from Klöckner and Blöbaum's comprehensive model (2010). Importantly, we add a
193 fourth source of influence: the self-processes (from the meta-analysis by Geiger, 2019). The
194 first objective of the present research is to test the new integrative model and document the
195 relative predictive strength of the main determinants of recycling behavior and how they relate
196 to each other. This should contribute to scientific knowledge by providing cumulative evidence
197 about previously observed relations between psychological determinants and pro-
198 environmental intentions or habits. An integrative model however provides a stricter test of
199 those relations, as the effect of each determinant on the outcome (i.e., intention or habit) is
200 estimated beyond the influence of the other determinants, and while the relations between the
201 determinants are also simultaneously estimated. The proposed integrative model should further
202 widen our understanding of pro-environmental intentions and habits by considering the
203 upstream influence values and identity. The second contribution of the present research is to
204 use this integrative model to foster our understanding of two waste management behaviors that
205 are overlooked, although they are at high stake considering the prospect of regulation changes:

206 sorting food waste and dropping off waste at a disposal center. This should bring knowledge
207 about whether the influence of determinants widely documented in the literature transfers to
208 those specific behaviors. This is also important, in the prospect of policy-making, as it could
209 inform about the most relevant levers for behavioral change.

210 **Integrative Model**

211 Our model first integrates the attitudinal, situational, and normative processes identified
212 in the comprehensive action determination model (Figure 2). Given that we could not measure
213 behavior, the main outcome predicted in our study was intention to act. We assume that
214 behavioral intention is *directly* predicted by four determinants: attitudes (**H1**), perceived
215 behavioral control (**H2**), social norms (**H3**), and personal norms (**H4**) (Ajzen, 1991; Bamberg
216 et al., 2007; Klöckner, 2010, 2013).

217 As for situational processes, perceived behavioral control should be influenced by
218 facilitating conditions (**H5**). The more facilitating the conditions, the more individuals will
219 perceive that they have control over their behavior. Regarding normative processes, personal
220 norms should be activated by awareness of need (**H6**), awareness of consequences (**H7**), and
221 social norms (**H8**) (Schwartz, 1977). We expect that the more people are aware that there is a
222 problem and that the targeted behavior is a means to solve it, the higher the sense of moral
223 obligation. Further, the more individuals perceive that the behavior is valued and/or generally
224 adopted by significant others, the more they should feel a moral obligation. Personal norms
225 should mediate the relationship between social norms and intention (**H9**) (Helferich et al.,
226 2023). Moreover, normative processes should be influenced by situational processes, such that
227 personal norms will be predicted by the level of perceived behavioral control (**H10**) (Klöckner
228 et al., 2010): the less individuals feel able to perform the behavior, the less they feel obliged to

229 do so. We expect the influence of perceived control on intention to be mediated by personal
230 norms (**H11**).

231 The main innovation of our model is the integration of self-processes as a new source
232 of influence. These processes refer to self-identity and values. Self-processes provide an overall
233 framework of conduct for individuals; thus, we propose that they act at the early stages of the
234 behavioral performance decision. This idea is supported by the value identity personal norm
235 model, which indicates that values predict identity, which in turn predicts personal norms (Steg
236 & Van der Werff, 2016). Support for this view also comes from the value-belief-norm model,
237 which shows that values are the antecedents of beliefs (Stern, 1999). Recent work has further
238 shown that biospheric values and self-identity are antecedents of social norms, perceived
239 behavioral control, and attitudes (Ateş, 2020; Carfora et al., 2017; Gkargkavouzi et al., 2019).
240 Therefore, we hypothesize that self-processes have an upstream influence on the set of the
241 previously mentioned proximal determinants of behavioral intention. Values should impact the
242 level of awareness individuals have regarding the need to act (**H12**) and the consequences of
243 the solution behavior (**H13**). We expect that the more individuals endorse biospheric values,
244 the stronger their awareness of the problem and the solution's relevance. Values should also
245 affect pro-environmental self-identity (**H14**), which will directly affect personal norms (**H15**),
246 social norms (**H16**), perceived behavioral control (**H17**), and attitudes (**H18**). The stronger the
247 pro-environmental identity, the higher the sense of moral obligation to act, the higher the
248 perception of social norms, the higher the perceived ability to perform the behavior and the
249 more favorable the evaluation of the behavior. The influence of environmental self-identity on
250 personal norms should also be mediated by social norms (**H19**).

251 Lastly, besides intention, we measured habits as an outcome for food waste separation.
252 Habits refer to past behaviors that, through repetition over time, have become automatic,

253 frequent, and non-conscious (Ouellette & Wood, 1998). Habits are a strong proximal predictor
254 when the behavior is frequent (Klößner, 2013). With respect to the two behaviors investigated
255 here, habits do not apply to dropping off waste at a disposal center as this behavior is not
256 frequent. It can apply to food waste separation, although this specific behavior is not yet
257 required from the population and is therefore not widely enforced. In the prospect of
258 enforcement planned in 2024 in the present country, it is important to know what is related to
259 the development of this habit. We hypothesize that habits will be directly predicted by perceived
260 behavioral control (H20), facilitating conditions (H21), and personal norms (H22) (Klößner,
261 2013; Klößner & Blöbaum, 2010). The more individuals feel able to perform, the more the
262 conditions facilitate the performance, and the more individuals feel obliged to do so, the
263 stronger the habit formation. Furthermore, habits should also be influenced indirectly by
264 perceived behavioral control via personal norms (H23) and by facilitating conditions via
265 perceived behavioral control (H24).

266 - Insert figure 2 about here -

267 **Methods**

268 *Sample Size*

269 According to Kline (2011), structural equation models need to have at least 5 to 1 ratio
270 of observations to estimated parameters. We estimated 169 parameters in the model addressing
271 food waste sorting and 164 parameters in the model for deposit at waste disposal centers,
272 leading to minimal sample sizes of 845 and 820 observations, respectively.

273 *Participants*

274 Participants voluntarily filled in an online questionnaire that took approximately 30
275 minutes to complete and asked about one of the two targeted behaviors. The final samples

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276 consisted of 1,198 usable observations for the food waste sorting questionnaire and 1,616
277 observations for the (deposit at) waste disposal centers questionnaire. Table 1 and 2 provides
278 an overview of the socio-demographic characteristics of the participants included in the data
279 analyses for both samples. Participants mostly identified as women, and the distribution of their
280 level of education and income was skewed to the right. Moreover, half of the respondents lived
281 in peri-urban areas (49% and 52% for food waste and waste disposal center questionnaires,
282 respectively), and about a quarter in rural areas (28% and 19%, respectively) or urban areas
283 (23% and 26%, respectively).

284 -Insert Table 1 and 2 about here-

285 *Measures*

286 All variables in the study were latent variables with multiple indicators. All items were
287 adapted from previous studies and translated into French. Unless otherwise specified,
288 respondents rated each item on a seven-point scale, ranging from 1 (*totally disagree*) to 7
289 (*totally agree*). Negatively worded items were reverse-scored. Analyses were conducted on
290 the basis of all items related to the construct mean score.

291 A first block of items measured general beliefs about waste:

292 *Awareness of need* about waste in general was measured with four items (e.g., “Our society
293 produces too much waste”).

294 *Awareness of consequences* about general waste management on the environment was
295 measured with four items (e.g., “If I manage my waste properly, my local quality of life will
296 improve”).

297 In the second block, participants answered questions about one of the two specific behaviors.

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298 *Social norms* about the specific waste management were measured on both injunctive and
299 descriptive sides. *Social injunctive norms* were measured with three items (e.g., “Dropping off
300 waste at disposal centers is encouraged by people whose opinion I value”). *Social descriptive*
301 *norms* were measured with three items (e.g., “Everyone in my neighborhood deposits waste at
302 disposal centers”). A mean score of the six items has been calculated.

303 Participants’ *personal norms* about specific waste management were measured with three
304 items, for example, “I feel morally obliged to sort my food waste”, translated from van der
305 Werff et al., (2013) and Klöckner & Blöbaum (2010).

306 Participants’ *perceived behavioral control* about specific waste management was assessed with
307 four items, for example, “It is up to me to deposit my waste at disposal centers,” adapted from
308 Kraft et al. (2005).

309 Participants’ *attitudes* about specific waste management were assessed by asking them to
310 respond to the statement, “Dropping off my waste at the disposal center/Sorting my food waste
311 is....” on six pairs of bidimensional components of instrumental attitude, for example,
312 “pointless–useful,” adapted from Graham-Rowe et al. (2019).

313 *Facilitating conditions* related to specific waste management were measured with 10 items for
314 food waste, for example, “I know where to find information to sort my food waste” and 15
315 items for bulky waste, for example, “I know where to find the closest disposal center”, adapted
316 from Klöckner and Oppedal (2011).

317 Participants’ *habits* were only assessed for food waste separation, with four items (e.g., “Sorting
318 my food waste is something I do without thinking” from the self-report habits index,
319 Verplanken & Orbell, 2003).

320 *Behavioral intention* to manage the specific waste was assessed with four items, for example,
321 “Over the next twelve months, I intend to sort, or to continue to sort, my food waste.”

322 In the last block, participants were asked about their *values*, *environmental self-identity*, and
323 *socio-demographic* variables. *Biospheric values* were measured with four items, for example,
324 “Being close to nature is important to me,” translated into French from Steg et al., (2014).
325 *Environmental self-identity* was measured with three items, for example, “I consider myself to
326 be a waste management sensitive person”, adapted from Nigbur et al., (2010).

327 We collected six socio-demographic variables: age, gender, highest diploma, annual income,
328 familial status and type of habitation (Table 1 and 2).

329 ***Procedure***

330 An online survey was distributed via social networks and mailing lists of local
331 associations. Participants over 18 years old were invited to fill in a questionnaire about 30
332 minutes long. After consenting to participate, they answered the first block of questions on
333 general beliefs about waste management: awareness of need and consequences. Participants
334 were then pseudo-randomly assigned to two out of three behaviors (60% for waste disposal
335 centers and 40% for food waste separation). Indeed, data collection was performed in the
336 context of collaboration with local authorities initially interested in fostering their
337 understanding of three specific behaviors: food waste separation, deposit at waste disposal
338 centers, and green waste reuse in situ. The last behavior was not included in the present paper
339 because we did not reach an acceptable sample size. The second block of questions randomly
340 assessed determinants specifically referring to the targeted behavior, namely, social norms,
341 personal norms, perceived behavioral control, facilitating conditions, attitudes, and habits.
342 Participants then filled in the intention measure at the end of the block. The last block measured

343 pro-environmental values and identity, and participants filled in socio-demographic
344 information on an optional basis. Within each block, the items measuring each determinant
345 were counterbalanced.

346 *Analysis Strategy*

347 Two correlation matrices, reported in Tables 3 and 4, present the zero-order correlations
348 between each determinant and behavioral intention (i) to sort food waste and (ii) to deposit
349 waste at disposal centers.

350 To test each model, analyses were run using the R package lavaan (Rosseel, 2012).
351 Structural equation modeling (SEM) with robust maximum likelihood estimation was applied
352 with a two-stage procedure to test the fitness of the proposed model with the gathered data. In
353 the first step, the reliability and validity of the measurement instruments were determined by
354 confirmatory factor analyses. In the second step, the fitness of the proposed model and the
355 relationships between variables were evaluated by structural equation modeling tests. The
356 model fit was examined based on the following indices: items saturation with related construct
357 (std. str) greater than .40 (Stevens, 2012), robust comparative fit index (Robust CFI), robust
358 Tucker-Lewis index (Robust TLI) equal or greater than .92, robust root mean square error of
359 approximation (Robust RMSEA) lower than .08 and robust standardized root mean squared
360 error (Robust SRMR), lower than .08 (Hair, 2019).

361 **Results**

362 *Food Waste Separation*

363 *Descriptive Results*

364 -Insert Table 3 about here-

411 *Deposit at a Disposal Center*

412 *Descriptive Results*

413 -Insert Table 6 about here-

414 *Measurement model analysis*

415 Due to poor standardized factor loadings, we deleted two items referring to the
416 facilitating conditions. The modification indices suggested correlating ten error terms within
417 the same latent constructs to improve the model fit. The final CFA results revealed an
418 acceptable fit for the proposed model, Robust $\chi^2 = 3042.374$; $df = 978$; $p < .001$; $df/\chi^2 = 3.111$;
419 Robust CFI = .937, Robust TLI = .931, Robust RMSEA = .038 90% CI [.037; .040];
420 SRMR = .044. All standardized factor loadings are significant at $p < .001$ (factor loadings and
421 Cronbach's alphas are presented in Table 7).

422 -Insert Table 7 about here-

423 *Structural Equation Modeling*

424 The results from the SEM analysis showed that the proposed model had an acceptable
425 fit to the data: Robust $\chi^2 = 3557.990$; $df = 963$; $p < .001$; $df/\chi^2 = 3.695$; Robust CFI = .917,
426 Robust TLI = .910, Robust RMSEA = .043 90% CI [.042; .045]; SRMR = .071. The model
427 accounted for 52.8% of the variance in intention to deposit waste at a disposal center.

428 The four hypothesized direct influences on intention were observed. The intention to
429 deposit waste at disposal centers was predicted by personal norms, $\beta = .51$, $p < .001$, indicating
430 that the more participants feel morally obliged to drop off their waste at a disposal center, the
431 more they intend to do so. Perceived behavioral control, social norms and attitude were also
432 significantly linked with intention, $\beta = 0.23$, $p < .001$, $\beta = 0.10$, $p = .003$, and $\beta = 0.16$, $p < .001$,

455 to deposit waste at a disposal center. All five models demonstrated an acceptable fit based on
456 the goodness-of-fit indices. While the two integrative models did not perform as well as the
457 more parsimonious models, our model showed comparable performance to the previous
458 integrative model (i.e., comprehensive action determination model) for both behaviors. The
459 value-belief-norm model had the best comparative fit indices (AIC and BIC). Nevertheless, our
460 model explained more variance in intention and personal norms, and therefore provides a more
461 comprehensive explanation of the data.

462 -Insert Table 9 and 10 about here-

463 **Discussion**

464 The first objective of this study was to test an integrative model that relies on the three—
465 normative, attitudinal, and situational—processes of the comprehensive action determination
466 model (Klößner et al., 2010) and includes an additional process based on a recent meta-
467 analysis (Geiger et al., 2019): self-processes. Our model is supported by the results of structural
468 equation modeling which are consistent with 21 out of the 24 hypotheses. The indices showed
469 a good fit of the model, accounting for 52.8% and 54.7% of the variance in intentions and 65.5%
470 of the variance in habits. As expected, each of the four processes included in the model had a
471 significant direct or indirect impact on the outcomes studied here. This finding shows the value
472 of including all identified sources of influence to achieve a more complete and detailed
473 understanding of the intention (or habit) to produce the target behaviors.

474 Analyses confirmed our proposal that self-processes have an upstream influence on all
475 other processes (Gkargkavouzi et al., 2019; Steg et al., 2014). By proposing both values and
476 pro-environmental identity as early antecedents, the present integrative model showed that
477 attitudes and social norms – only treated as antecedents in the other models – are predicted by

478 self-processes ($.10 < R^2 < .23$). The comparison with more classical models showed that
479 adding these early antecedents increased the explanation of personal norms, reaching 46% and
480 75% of explained variance. This suggests that self-processes are a promising venue for better
481 understanding how a personal sense of moral obligation emerges and is activated. These
482 findings are consistent with recent work showing that self-processes (i.e., values) predict
483 attitudes, social norms, personal norms and perceived behavioral control (Ateş, 2020). Overall,
484 the observed influence of self-processes on the attitudinal, normative and situational processes
485 is consistent with previous claims that values and self-identity indirectly affect behavioral
486 intentions by providing a general orientation for the perception and evaluation of any specific
487 situation (Bamberg et al., 2003; Udall et al., 2021).

488 This study focused on two specific waste management behaviors: food waste separation
489 and deposit at disposal centers. The results revealed a common basis of understanding for both
490 behaviors. The main common finding is that the intention and habit to manage one's waste are
491 related to two proximal determinants: personal norms and perceived behavioral control. This
492 suggests that, across two types of waste, individuals who feel a strong moral obligation to
493 manage their waste in an environmentally friendly manner and who are highly confident in their
494 ability to do so, are more likely to have a positive intention to engage in proper waste
495 management. Another result observed for both behaviors in our integrative model is that
496 attitudes and social norms are weakly linked to intention. This finding is consistent with a recent
497 study on residential households' waste behavior, that similarly showed the influence of
498 perceived behavioral control and personal norms on waste separation, while attitudes and social
499 norms had no significant relationship with the behavior (Goh et al., 2022). The weaker or
500 absence of influence of attitudes has been observed in other studies when normative influences
501 are included in the models (Oehman et al., 2022; Wu et al., 2022). This may indicate that the
502 presence of personal norms in the model absorbs much of the predictive power of attitudes. The

503 weak and even non-significant effect of social norms in the case of food waste separation may
504 be due to the private nature of the behaviors. Managing food waste, bulky, toxic, or electronic
505 waste mostly takes place in private contexts (e.g., one's own home), which may explain the
506 lower importance of the influence of others' behavior (Aguilar-Luzón et al., 2012).

507 Regarding the path of influence of the proposed model, the results show that the first
508 proximal determinant of intention –personal norms– is predicted by the perception of high
509 levels of social norms and environmental self-identity, but also by a strong sense of control over
510 the behavior. For both behaviors, the more people perceive that those around them value
511 (injunctive norms) or practice (descriptive norms) good waste management, the more people
512 perceive themselves as pro-environmental persons, the more they feel able to perform the waste
513 behavior, and the more they develop a sense of moral obligation to do so. However, contrary to
514 our prediction, the results did not show a significant relationship between personal norms and
515 awareness of consequences. A possible explanation for this null result, which contradicts many
516 studies (Klößner, 2013), is that the measure we used referred to the consequences of waste
517 management in general and not of the target behavior.

518 As for the second stable and proximal determinant of waste management intention –
519 perceived behavioral control – it is strongly predicted by facilitating conditions. The more
520 supportive the material and informational conditions are in individuals' performance
521 environment, the stronger their sense of performance ability. Our findings, along with others
522 (e.g., Cheng et al., 2022; Concari et al., 2022b; Vijayan et al., 2023; Zaikova et al., 2022; Zhang
523 et al., 2022), outline the importance of access to information and material conditions that
524 facilitate the production of waste management behaviors. Such facilitating conditions enrich
525 psychological models with contextual factors that contribute to alleviate constraints.

526 Although the results revealed a common core for understanding both targeted behaviors,
527 they also highlighted specificities in the determinants of food waste sorting and deposit at waste
528 disposal centers. In the case of food waste separation, situational processes appear to be the
529 most influential of the four sources of influence. In fact, the key-predictor of the intention to
530 sort food waste is perceived behavioral control, directly and indirectly through personal norms.
531 That is, when individuals feel control over their behavior, their sense of moral obligation is
532 likely to be activated, which in turn changes their intention to behave accordingly. The results
533 concerning habits also support the predominance of situational processes, as facilitating
534 conditions are strongly related to the presence of sorting habits, both directly and indirectly via
535 perceived behavioral control. The more favorable the material and informational conditions for
536 the act of sorting, the easier the behavior is perceived to be and the higher the habits are. The
537 model predicting intention towards waste disposal emphasizes normative processes over
538 situational and attitudinal processes. Personal norms showed the strongest association with
539 intention. The stronger the principle of depositing toxic or bulky waste at the disposal center,
540 the higher the intention to do so. However, it is interesting to note that the variance of personal
541 norms explained by the antecedents included in the model is lower when the target behavior is
542 depositing at waste disposal centers ($R^2 = .46$) than when it is food waste separation ($R^2 = .74$).
543 Moreover, in the waste disposal model, the awareness that waste generation is a problem that
544 needs to be addressed does not have a significant effect on personal norms. This suggests that
545 the sense of moral obligation to deposit waste at disposal centers is influenced by factors other
546 than those we identified in the pro-environmental literature. This raises the question of the
547 perception of this behavior as being strictly pro-environmental. It is possible that people are not
548 fully aware of how waste is treated and reused in these infrastructures, which have long been
549 perceived as mere landfills.

550 Our second objective was to use our integrative model to promote an understanding of
551 two overlooked waste management behaviors: food waste separation and waste deposit at
552 disposal centers. The behaviors studied in this paper are of practical relevance, with food waste
553 responding to regulatory developments in Europe, and the deposit of waste in a disposal center
554 enabling the reuse of materials (e.g., metal, wood, electronic components), in a context of
555 accelerating resource depletion. This study also contributes to the advancement of the research
556 field on the identification of factors related to waste sorting behavior. Recent bibliometric
557 research suggests that the study of waste sorting behavior is generating a growing literature
558 (Concari et al., 2022). Research on waste management focuses on different types of waste,
559 sometimes grouped under the umbrella term recycling. Our study addresses the need to
560 differentiate and clarify the waste management behaviors studied by identifying both common
561 factors and differentiating elements for understanding two specific behaviors.

562 **Limitations**

563 The main limitation of our study is the absence of measurement of actual behavior. As
564 in many other studies, we measured intention, as a key determinant of behavior (Sheeran &
565 Webb, 2016). Meta-analytic findings on pro-environmental behavior have shown a moderate to
566 strong relationship between intention and behavioral enactment (Morren & Grinstein, 2016). In
567 a longitudinal study, Passafaro et al. (2019) showed that intentions predicted self-reported waste
568 sorting behavior one month later. Despite these strong associations, people do not always do
569 what they intend to do, and thus there is a gap between stated intention and action (Hassan,
570 2016; Rhodes & Dickau, 2012). Indeed, meta-analyses of the impact of interventions aimed at
571 changing health-related behaviors have shown greater intervention-induced changes in
572 intentions than in measured behaviors (Rhodes & Dickau, 2012; Webb & Sheeran, 2006).
573 However, the gap between intentions and behavior depends on the context, particularly whether

574 the behavior is habitual or not. Specifically, the link between change in intention and change in
575 behavior is stronger for nonhabitual behaviors ($d = .74$) than for habitual behaviors ($d = .22$,
576 Webb & Sheeran, 2006). It is worth noting that the behaviors examined in the present study
577 were unlikely to be habitual. The behavior of dropping off food waste at a waste disposal center
578 does not meet the criteria of regularity and frequency that constitute a habit and is therefore a
579 nonhabitual behavior. As for the sorting of food waste, this is a new behavior that is not yet
580 required in the study area. Therefore, the habitual nature of food waste sorting can vary from
581 zero, or very low, to strong. In addition to intentions, we also studied the habit of sorting food
582 waste. This allowed us to establish the relevance of our integrative model to understand what
583 is associated with the emergence of this behavioral variable. Indeed, it appears that regular
584 sorting performance is related to performance conditions, perceived control, and sense of moral
585 obligation, and that these processes, both situational and normative, are not independent since
586 perceived control predicts personal norms. However, habits remain a measure of self-reported
587 behavior that was realized at the same time as the measures of determinants tested in the model.
588 In future work, it would be critical to test the influence of the determinants proposed here in a
589 longitudinal study that would include measures of self-reported or observed waste management
590 behavior (e.g., trash can weighing). We recognize that the explanatory power of the model for
591 actual behavior will be certainly less than that reported here for intention (see e.g., Yuriev et
592 al., 2020). Nevertheless, from an intervention perspective, our study provides a broader
593 understanding of the articulation of the determinants of sorting intentions, which may help in
594 the design of research or interventions targeting the actual realization of these behaviors.
595 Considering the intention-behavior gap, interventions must include complementary elements
596 that strengthen the transformation of intentions into actual actions, such as planning of the
597 action, monitoring progress, or information and conditions that facilitate the production of the
598 behavior (e.g., Rosenthal, 2018; Schwarzer, 2008; Sheeran & Webb, 2016).

599 A second limitation of this study pertains to the representativeness of the samples.
600 Women, highly educated, and high-income individuals are overrepresented in both samples.
601 This may be due first to the recruitment strategy, which relied in part on the social network of
602 the researchers. In addition, a self-selection of respondents is highly likely, as participants
603 completed the questionnaire without retribution, and studies consistently show that women and
604 highly educated people are more concerned about the environment (e.g., Diamantopoulos et al.,
605 2003; Franzen & Meyer, 2009). It is important to replicate this study with a more diverse sample
606 to improve the generalizability of the findings.

607 From an intervention perspective, proposing a comprehensive model may have practical
608 implications. A model that allows for the testing of a wide range of determinants can enable
609 stakeholders and public policymakers to conduct comprehensive diagnostic studies to identify
610 the most important determinants of target behaviors in the population and then develop fine-
611 tuned interventions. For example, in this study, we found that environmental self-identity is a
612 common and early source of influence. Thus, to encourage better waste management, it may be
613 relevant to design general incentive strategies based on the identity lever. However, the model
614 also highlights specificities related to each behavior that suggest more specific strategies. For
615 example, if the goal of a public policy is to specifically encourage the sorting of food waste, the
616 strategy should focus on increasing the sense of control, the key predictor, in particular by
617 providing the conditions that facilitate the practices.

618 In conclusion, this research supports a model that integrates the main determinants of
619 behavior identified in the recycling literature into four sources of influence: normative,
620 attitudinal, situational and self-processes. It adds to our knowledge of the main determining
621 factors of two overlooked behaviors of greatest concern to local authorities: food waste
622 separation and deposits at waste disposal centers. It appears that normative and situational

623 processes are consistently directly related to intentions and habits, while attitudinal processes
624 show weak links. The study also supports the idea that self-processes – values and identity –
625 should be integrated, as they have an upstream influence on the other processes. We believe
626 that the present research contributes to the efforts to move from multiplicity of specific models
627 to a more integrative approach applicable to a wide range of pro-environmental behaviors.

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An integrative model of waste management

|

1 **Abstract.**

2
3 Faced with increasing waste production, authorities are seeking to encourage better household
4 waste-management and need to identify levers for change. We propose a model integrating the
5 major determinants of pro-environmental behavior assumed in prominent theoretical models.
6 Based on meta-analytical evidence, we incorporated situational, normative, attitudinal and self-
7 processes and tested this integrative model to predict intentions to perform two overlooked
8 behaviors: food waste separation and deposit at waste disposal centers. To go beyond intention
9 we also investigated habits to sort food waste. An online survey was administered to two
10 samples ($N_{\text{total}} = 2'814$) and data were analyzed using structural equation modeling. The results
11 showed a good fit of an integrative model (CFIs > 0.917; TLIs > 0.910; RMSEAs < 0.043;
12 SRMRs < 0.071). Waste management intentions and habits are directly predicted mainly by
13 personal norms and perceived behavioral control. The latter is predicted by facilitating
14 conditions and pro-environmental identity. Personal norms are predicted by social norms, pro-
15 environmental identity and perceived behavioral control. Our results confirm the relevance of
16 a model integrating situational, normative, attitudinal and self-processes to explain waste
17 management intentions, and provide a basis for the development of waste-management
18 interventions.

19 **Keywords:** waste management, integrative model, environmental psychology, intention,
20 structural equation modeling

21

22 Since the beginning of this century, the serious and growing international issue of waste
23 management has led to many studies of recycling behavior, which have been widely reported
24 in the behavioral science literature (littering, Chaudhary et al., 2021; household waste
25 separation, Roustae et al., 2020; recycling of packaging materials, Miafodzyeva & Brandt, 2013).
26 Research has highlighted several determinants of waste management behaviors, all articulated
27 in four robust models: the theory of planned behavior (Strydom, 2018), the norm activation
28 model (Wang et al., 2019), the value-belief-norm model (Dursun et al., 2017), and the
29 comprehensive action determination model (Ofstad et al., 2017). A recent meta-analysis of 91
30 studies on household waste management identified numerous predictors of recycling behavior
31 in general, helping policymakers design effective strategies for waste prevention actions
32 (Geiger et al., 2019).

33 The purpose of the present study is to advance the understanding of household waste
34 management by integrating the contributions of historical models of behavioral change and
35 more recent research into a unified model, to predict intention and habits related to two
36 understudied types of waste management behaviors. The first is the source separation of food
37 waste, which makes up around 30% of the contents of a household's waste bin. European Union
38 foresees the obligation to treat it separately from January 2024, implying the individual
39 adoption of this new sorting behavior. The second behavior is the deposit at waste recycling
40 and disposal centers of various household waste types, such as bulky, toxic, electrical, or
41 electronic waste. Collected properly, the largest part of this waste volume can be recovered
42 through the resale of materials or through reuse. Some waste, however, contains hazardous
43 materials, such as toxic liquids and electronic waste, which can generate environmental
44 pollution. Therefore, it is essential to treat each waste type accordingly after it has been
45 deposited in appropriate facilities, such as a community's waste recycling and disposal center.
46 In this study, we propose a model incorporating the main determinants of recycling behaviors

47 (identified from the meta-analysis by Geiger et al., 2019) and we test its ability to account
48 for intention towards two specific behaviors: separation of food waste and deposits at waste
49 disposal centers.

50 **Models of Pro-Environmental Behavior**

51 Research in environmental psychology has fruitfully developed and tested models to
52 explain pro-environmental behavior. However, the parallel development of multiple models has
53 revealed a large diversity of potential determinants of pro-environmental behavior. The present
54 study is in line with recent attempts to integrate models and the most important determinants of
55 pro-environmental behavior (see e.g., Gkargkavouzi et al., 2019; Klöckner & Blöbaum, 2010).
56 Our approach is to integrate prominent theoretical models by relying on empirical meta-
57 analytical evidence. In what follows, we provide an overview of four prominent theoretical
58 models.

59 ***Theory of Planned Behavior***

60 In 1991, Ajzen proposed a theory of planned behavior to explain any deliberate
61 behavior, including deliberate pro-environmental behavior (e.g., choice of travel mode,
62 Bamberg et al., 2003; food consumption, Ajzen, 2016; implication in pro-environmental
63 education, de Leeuw et al., 2015). As shown in Figure 1a, this rational choice model assumes
64 that behavioral intention is the main predictor of deliberate behaviors. Intention reflects the will
65 to exert effort to perform a behavior and is guided by three types of beliefs. First, an individual's
66 intention is guided by attitudes in terms of a favorable or unfavorable evaluation of the behavior,
67 derived from beliefs about the possible consequences of the behavior and the rational evaluation
68 of those consequences. Second, intention is guided by subjective norms—perceived social
69 pressure resulting from beliefs about what relevant others approve or disapprove (injunctive

70 norm) or do (descriptive norm)—and the motivation to fulfill those social expectations. Third,
71 intention is guided by perceived behavioral control (Ajzen, 1991), which results from beliefs
72 about one’s ability to perform the target behavior (i.e., self-efficacy) and about control over that
73 behavior (Kraft et al., 2005). According to this model, individuals form a rational intention to
74 act, weighing the three types of behavioral beliefs. The determinants modeled in the theory of
75 planned behavior have been associated with a wide range of recycling behaviors (Aguilar-
76 Luzón et al., 2012; Tonglet et al., 2004).

77 *The Norm Activation Model*

78 The norm activation model developed by Schwartz (1973, 1977), shown in Figure 1b,
79 proposes that individuals act in a pro-social and pro-environmental way because they feel
80 morally obligated to do so (Bamberg et al., 2003; Steg & Groot, 2010). The sense of moral
81 obligation, also referred to as personal norms, arises from the internalization of social
82 expectations. Indeed, social learning about what is and what is not valued by significant others
83 forms a solid basis for the moral principles that individuals embrace (Thøgersen, 2006).
84 However, the influence of personal norms on behavior differs from the influence arising from
85 social norms, as it primarily results from implications for the self. First, sanctions following
86 personal norm violations differ from those that follow the violation of social norms—violating
87 personal norms calls into question one’s self-concept, whereas violating social norms has
88 consequences for social interactions (Bamberg et al., 2007). Second, the feeling of moral
89 obligation to comply exerts a stronger influence than social norms on individual decisions .
90 Behaviors consistent with personal norms protect the self, whereas inconsistent behaviors lead
91 to self-criticism. Personal norms play a role in behavioral decisions because individuals
92 anticipate and compare the cost of their behavior (in effort or time, for example) with the cost

93 of the violation for the self. People do not enact the behavior if doing so is more costly than
94 violating personal norms.

95 The norm activation model further suggests that personal norms are not always active.
96 Their activation depends on awareness of the need to act and of the consequences, for the
97 environment, of performing or not performing the action, and of the individual's ascription of
98 responsibility in the situation. Thus, the higher the awareness of the need for action and of the
99 impact of the solution, and the higher the self-ascribed responsibility, the stronger the personal
100 norms. In the domain of pro-environmental behavior, the norm activation model has proven
101 useful in explaining energy conservation (van der Werff & Steg, 2015), food waste reduction
102 (Kim et al., 2022), and recycling (Wang et al., 2019). Numerous other studies have shown that
103 the impact of personal norms on behavior is mediated by behavioral intention (for meta-
104 analyses, see Bamberg & Möser, 2007; Onwezen et al., 2013).

105 *The Value-Belief-Norm Model*

106 Stern (2000) proposed an extended version of the norm activation model by integrating
107 the new environmental paradigm (Stern, Dietz, et al., 1995) and the values-based theory (Stern,
108 Kalof, et al., 1995). According to Schwartz (1992), values are the most stable beliefs
109 transcending any situation to guide decisions and behaviors, such that they match what is
110 important to individuals. The different types of values classified by Schwartz (1994) constitute
111 a priority system for the individual. If an individual's value system prioritizes self-transcendent
112 values, such as biospheric values (concerns about nature) and altruistic values (concerns about
113 other humans), at the expense of self-enhancement values (egoistic values, concerns about self-
114 interest), then that person will be more inclined to adopt environmentally friendly behaviors
115 (Steg et al., 2005).

116 The value-belief-norm model, presented in Figure 1c, postulates a causal chain in which
117 self-transcendent values predict the new environmental paradigm – a general ecological
118 worldview measured through individuals’ beliefs about human-nature interactions. This belief,
119 in turn, affects awareness of adverse and beneficial consequences. Awareness of consequences
120 influences beliefs about one’s personal responsibility in those consequences, which then
121 activates personal norms. Activated personal environmental norms act as a general
122 predisposition to pro-environmental actions. The value-belief-norm model has shown a good
123 predictive validity for pro-environmental behaviors (Jakovcevic & Reyna, 2016) and
124 specifically for recycling behaviors (Dursun et al., 2017).

125 *The Comprehensive Action Determination Model*

126 Klöckner and Blöbaum (2010) proposed a comprehensive model, presented in figure 1d,
127 that integrates the main determinants from both the theory of planned behavior and the norm
128 activation model, and adds constructs from the ipsative theory of behavior (Tanner, 1999;
129 Tanner et al., 2004). The comprehensive action determination model aims to explain a wide
130 range of pro-environmental behaviors by modeling three direct sources of influence on pro-
131 environmental behaviors: intentional processes, habitual processes and situational processes. A
132 fourth indirect source of influence is also proposed—the normative processes.

133 Intentional processes designate reflexive processes leading to the formation of a will to
134 make an effort to produce the behavior. They comprise attitudes and behavioral intentions. In
135 the case of uncommon or new practices, intentional processes are the proximal antecedent of
136 the behavior.

137 Habitual processes are the results of the automation of a gesture or practice through its
138 frequent repetition over time. Habits can be in line with or in conflict with the expected

139 behavior. They will therefore moderate—positively or negatively—the link between intentional
140 processes and behavior, and the strength of the moderation increases with the degree of
141 automaticity (Triandis, 1980).

142 Situational processes involve the context and how it facilitates the correct
143 implementation of the behavior. These include subjective constraints, namely perceived
144 behavioral control, and objective constraints. The objective constraints are the physical,
145 material and informational characteristics of the situation in which the behavior occurs (e.g.,
146 access to a recycling bin, knowledge of the deposit center location). These conditions can hinder
147 or facilitate the behavior depending on the situation. Therefore, objective constraints influence
148 the perceived control that the individual has over the expected behavior.

149 Normative processes refer to the influence of standards related to the behavior. These
150 norms can be conveyed by others - social norms - or internalized - personal norms. Their
151 influence on behavior is mediated by intentional and habitual processes. The personal norms
152 held the strongest normative influence on behavioral intention and habits, and this influence
153 must be activated by beliefs about the behavior (Schwartz, 1977; Thøgersen, 2006). Therefore,
154 the normative processes include awareness of a need to fix an issue and awareness of
155 consequences of the targeted behavior.

156 Lastly, although situational processes directly influence behavior, they also do so
157 indirectly via intentional, habitual and normative processes. Indeed, the situation must provide
158 individuals with a subjective sense of ability to produce the behavior in order for their personal
159 norms to be activated, the intention to act to be evaluated and the habit pattern to be triggered.
160 Furthermore, the objective conditions in the environment must allow the habit to take place.

161 The comprehensive action determination model has been used to explain pro-
162 environmental behavior such as clothing consumption (Joanes et al., 2020), sustainable
163 purchase (Jovarauskaitė et al., 2020) and recycling (Klößner & Oppedal, 2011; Ofstad et al.,
164 2017).

165 - Insert figure 1 about here -

166 **Identifying the Main Determinants**

167 Recently, a meta-analysis classified the most important factors predicting waste
168 management across different contexts (e.g., households, employees) and types of waste (e.g.,
169 plastic, general recycling, Geiger et al., 2019). The authors conducted their analyses on the
170 effect sizes from 91 studies that tested the link between the determinants of a large variety of
171 models and behavioral intention, self-reported behavior or observed behavior.

172 The results showed the predictive importance of most of the determinants included in
173 the comprehensive action determination model. The meta-analysis confirmed the influence of
174 normative processes, including social norms ($r = .33$), personal norms ($r = .42$), and awareness
175 of consequences ($r \approx .19^1$). The results also supported the importance of attitudes ($r = .34$) and
176 of situational processes (i.e., perceived behavioral control, $r = .39$; contextual factors, $-.17 \leq rs$
177 $\geq .26$).

178 In line with the value-belief-norm model, and a broader version of the Comprehensive
179 action determination model (Klößner, 2013), the meta-analysis also showed that values are
180 related to recycling ($r = .24$). Furthermore, Geiger et al. (2019)'s meta-analysis highlights the

¹ The exact effect size for awareness of consequences is not provided

181 importance of another factor that we have not mentioned so far: environmental self-identity (r
182 = .30), defined as the degree to which individuals see themselves as eco-friendly (van der Werff
183 & Steg, 2016). Environmental self-identity and values refer to self- processes—general beliefs
184 linking the self to the domain in which behavior takes place (e.g., the environment). Many
185 studies have shown a link between pro-environmental behavior and general beliefs related to
186 the self (De Groot & Steg, 2007), such as biospheric values and environmental self-identity
187 (Carmona-Moya et al., 2017).

188 The results of this meta-analytical work reveal the main determinants of recycling
189 behavior that are only partially included in the current models. To move away from the
190 multiplication of separate models, we propose to integrate these determinants in a unified
191 framework. Hence, we offer a model that includes the normative, attitudinal, and situational
192 processes from Klöckner and Blöbaum's comprehensive model (2010). Importantly, we add a
193 fourth source of influence: the self-processes (from the meta-analysis by Geiger, 2019). The
194 first objective of the present research is to test the new integrative model and document the
195 relative predictive strength of the main determinants of recycling behavior and how they relate
196 to each other. This should contribute to scientific knowledge by providing cumulative evidence
197 about previously observed relations between psychological determinants and pro-
198 environmental intentions or habits. An integrative model however provides a stricter test of
199 those relations, as the effect of each determinant on the outcome (i.e., intention or habit) is
200 estimated beyond the influence of the other determinants, and while the relations between the
201 determinants are also simultaneously estimated. The proposed integrative model should further
202 widen our understanding of pro-environmental intentions and habits by considering the
203 upstream influence values and identity. The second contribution of the present research is to
204 use this integrative model to foster our understanding of two waste management behaviors that
205 are overlooked, although they are at high stake considering the prospect of regulation changes:

206 sorting food waste and dropping off waste at a disposal center. This should bring knowledge
207 about whether the influence of determinants widely documented in the literature transfers to
208 those specific behaviors. This is also important, in the prospect of policy-making, as it could
209 inform about the most relevant levers for behavioral change.

210 **Integrative Model**

211 Our model first integrates the attitudinal, situational, and normative processes identified
212 in the comprehensive action determination model (Figure 2). Given that we could not measure
213 behavior, the main outcome predicted in our study was intention to act. We assume that
214 behavioral intention is *directly* predicted by four determinants: attitudes (**H1**), perceived
215 behavioral control (**H2**), social norms (**H3**), and personal norms (**H4**) (Ajzen, 1991; Bamberg
216 et al., 2007; Klöckner, 2010, 2013).

217 As for situational processes, perceived behavioral control should be influenced by
218 facilitating conditions (**H5**). The more facilitating the conditions, the more individuals will
219 perceive that they have control over their behavior. Regarding normative processes, personal
220 norms should be activated by awareness of need (**H6**), awareness of consequences (**H7**), and
221 social norms (**H8**) (Schwartz, 1977). We expect that the more people are aware that there is a
222 problem and that the targeted behavior is a means to solve it, the higher the sense of moral
223 obligation. Further, the more individuals perceive that the behavior is valued and/or generally
224 adopted by significant others, the more they should feel a moral obligation. Personal norms
225 should mediate the relationship between social norms and intention (**H9**) (Helferich et al.,
226 2023). Moreover, normative processes should be influenced by situational processes, such that
227 personal norms will be predicted by the level of perceived behavioral control (**H10**) (Klöckner
228 et al., 2010): the less individuals feel able to perform the behavior, the less they feel obliged to

229 do so. We expect the influence of perceived control on intention to be mediated by personal
230 norms (**H11**).

231 The main innovation of our model is the integration of self-processes as a new source
232 of influence. These processes refer to self-identity and values. Self-processes provide an overall
233 framework of conduct for individuals; thus, we propose that they act at the early stages of the
234 behavioral performance decision. This idea is supported by the value identity personal norm
235 model, which indicates that values predict identity, which in turn predicts personal norms (Steg
236 & Van der Werff, 2016). Support for this view also comes from the value-belief-norm model,
237 which shows that values are the antecedents of beliefs (Stern, 1999). Recent work has further
238 shown that biospheric values and self-identity are antecedents of social norms, perceived
239 behavioral control, and attitudes (Ateş, 2020; Carfora et al., 2017; Gkargkavouzi et al., 2019).
240 Therefore, we hypothesize that self-processes have an upstream influence on the set of the
241 previously mentioned proximal determinants of behavioral intention. Values should impact the
242 level of awareness individuals have regarding the need to act (**H12**) and the consequences of
243 the solution behavior (**H13**). We expect that the more individuals endorse biospheric values,
244 the stronger their awareness of the problem and the solution's relevance. Values should also
245 affect pro-environmental self-identity (**H14**), which will directly affect personal norms (**H15**),
246 social norms (**H16**), perceived behavioral control (**H17**), and attitudes (**H18**). The stronger the
247 pro-environmental identity, the higher the sense of moral obligation to act, the higher the
248 perception of social norms, the higher the perceived ability to perform the behavior and the
249 more favorable the evaluation of the behavior. The influence of environmental self-identity on
250 personal norms should also be mediated by social norms (**H19**).

251 Lastly, besides intention, we measured habits as an outcome for food waste separation.
252 Habits refer to past behaviors that, through repetition over time, have become automatic,

253 frequent, and non-conscious (Ouellette & Wood, 1998). Habits are a strong proximal predictor
254 when the behavior is frequent (Klößner, 2013). With respect to the two behaviors investigated
255 here, habits do not apply to dropping off waste at a disposal center as this behavior is not
256 frequent. It can apply to food waste separation, although this specific behavior is not yet
257 required from the population and is therefore not widely enforced. In the prospect of
258 enforcement planned in 2024 in the present country, it is important to know what is related to
259 the development of this habit. We hypothesize that habits will be directly predicted by perceived
260 behavioral control (H20), facilitating conditions (H21), and personal norms (H22) (Klößner,
261 2013; Klößner & Blöbaum, 2010). The more individuals feel able to perform, the more the
262 conditions facilitate the performance, and the more individuals feel obliged to do so, the
263 stronger the habit formation. Furthermore, habits should also be influenced indirectly by
264 perceived behavioral control via personal norms (H23) and by facilitating conditions via
265 perceived behavioral control (H24).

266 - Insert figure 2 about here -

267 **Methods**

268 *Sample Size*

269 According to Kline (2011), structural equation models need to have at least 5 to 1 ratio
270 of observations to estimated parameters. We estimated 169 parameters in the model addressing
271 food waste sorting and 164 parameters in the model for deposit at waste disposal centers,
272 leading to minimal sample sizes of 845 and 820 observations, respectively.

273 *Participants*

274 Participants voluntarily filled in an online questionnaire that took approximately 30
275 minutes to complete and asked about one of the two targeted behaviors. The final samples

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276 consisted of 1,198 usable observations for the food waste sorting questionnaire and 1,616
277 observations for the (deposit at) waste disposal centers questionnaire. Table 1 and 2 provides
278 an overview of the socio-demographic characteristics of the participants included in the data
279 analyses for both samples. Participants mostly identified as women, and the distribution of their
280 level of education and income was skewed to the right. Moreover, half of the respondents lived
281 in peri-urban areas (49% and 52% for food waste and waste disposal center questionnaires,
282 respectively), and about a quarter in rural areas (28% and 19%, respectively) or urban areas
283 (23% and 26%, respectively).

284 -Insert Table 1 and 2 about here-

285 *Measures*

286 All variables in the study were latent variables with multiple indicators. All items were
287 adapted from previous studies and translated into French. Unless otherwise specified,
288 respondents rated each item on a seven-point scale, ranging from 1 (*totally disagree*) to 7
289 (*totally agree*). Negatively worded items were reverse-scored. Analyses were conducted on
290 the basis of all items related to the construct mean score.

291 A first block of items measured general beliefs about waste:

292 *Awareness of need* about waste in general was measured with four items (e.g., “Our society
293 produces too much waste”).

294 *Awareness of consequences* about general waste management on the environment was
295 measured with four items (e.g., “If I manage my waste properly, my local quality of life will
296 improve”).

297 In the second block, participants answered questions about one of the two specific behaviors.

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298 *Social norms* about the specific waste management were measured on both injunctive and
299 descriptive sides. *Social injunctive norms* were measured with three items (e.g., “Dropping off
300 waste at disposal centers is encouraged by people whose opinion I value”). *Social descriptive*
301 *norms* were measured with three items (e.g., “Everyone in my neighborhood deposits waste at
302 disposal centers”). A mean score of the six items has been calculated.

303 Participants’ *personal norms* about specific waste management were measured with three
304 items, for example, “I feel morally obliged to sort my food waste”, translated from van der
305 Werff et al., (2013) and Klöckner & Blöbaum (2010).

306 Participants’ *perceived behavioral control* about specific waste management was assessed with
307 four items, for example, “It is up to me to deposit my waste at disposal centers,” adapted from
308 Kraft et al. (2005).

309 Participants’ *attitudes* about specific waste management were assessed by asking them to
310 respond to the statement, “Dropping off my waste at the disposal center/Sorting my food waste
311 is....” on six pairs of bidimensional components of instrumental attitude, for example,
312 “pointless–useful,” adapted from Graham-Rowe et al. (2019).

313 *Facilitating conditions* related to specific waste management were measured with 10 items for
314 food waste, for example, “I know where to find information to sort my food waste” and 15
315 items for bulky waste, for example, “I know where to find the closest disposal center”, adapted
316 from Klöckner and Oppedal (2011).

317 Participants’ *habits* were only assessed for food waste separation, with four items (e.g., “Sorting
318 my food waste is something I do without thinking” from the self-report habits index,
319 Verplanken & Orbell, 2003).

320 *Behavioral intention* to manage the specific waste was assessed with four items, for example,
321 “Over the next twelve months, I intend to sort, or to continue to sort, my food waste.”

322 In the last block, participants were asked about their *values*, *environmental self-identity*, and
323 *socio-demographic* variables. *Biospheric values* were measured with four items, for example,
324 “Being close to nature is important to me,” translated into French from Steg et al., (2014).
325 *Environmental self-identity* was measured with three items, for example, “I consider myself to
326 be a waste management sensitive person”, adapted from Nigbur et al., (2010).

327 We collected six socio-demographic variables: age, gender, highest diploma, annual income,
328 familial status and type of habitation (Table 1 and 2).

329 ***Procedure***

330 An online survey was distributed via social networks and mailing lists of local
331 associations. Participants over 18 years old were invited to fill in a questionnaire about 30
332 minutes long. After consenting to participate, they answered the first block of questions on
333 general beliefs about waste management: awareness of need and consequences. Participants
334 were then pseudo-randomly assigned to two out of three behaviors (60% for waste disposal
335 centers and 40% for food waste separation). Indeed, data collection was performed in the
336 context of collaboration with local authorities initially interested in fostering their
337 understanding of three specific behaviors: food waste separation, deposit at waste disposal
338 centers, and green waste reuse in situ. The last behavior was not included in the present paper
339 because we did not reach an acceptable sample size. The second block of questions randomly
340 assessed determinants specifically referring to the targeted behavior, namely, social norms,
341 personal norms, perceived behavioral control, facilitating conditions, attitudes, and habits.
342 Participants then filled in the intention measure at the end of the block. The last block measured

343 pro-environmental values and identity, and participants filled in socio-demographic
344 information on an optional basis. Within each block, the items measuring each determinant
345 were counterbalanced.

346 *Analysis Strategy*

347 Two correlation matrices, reported in Tables 3 and 4, present the zero-order correlations
348 between each determinant and behavioral intention (i) to sort food waste and (ii) to deposit
349 waste at disposal centers.

350 To test each model, analyses were run using the R package lavaan (Rosseel, 2012).
351 Structural equation modeling (SEM) with robust maximum likelihood estimation was applied
352 with a two-stage procedure to test the fitness of the proposed model with the gathered data. In
353 the first step, the reliability and validity of the measurement instruments were determined by
354 confirmatory factor analyses. In the second step, the fitness of the proposed model and the
355 relationships between variables were evaluated by structural equation modeling tests. The
356 model fit was examined based on the following indices: items saturation with related construct
357 (std. str) greater than .40 (Stevens, 2012), robust comparative fit index (Robust CFI), robust
358 Tucker-Lewis index (Robust TLI) equal or greater than .92, robust root mean square error of
359 approximation (Robust RMSEA) lower than .08 and robust standardized root mean squared
360 error (Robust SRMR), lower than .08 (Hair, 2019).

361 **Results**

362 *Food Waste Separation*

363 *Descriptive Results*

364 -Insert Table 3 about here-

365 *Measurement Model Analysis*

366 The initial CFA results indicated that several items should be deleted due to poor
367 standardized factor loadings ($< .40$). We deleted one item from the personal norms scale, and
368 two items measuring facilitating conditions. The modification indices suggested correlating
369 nine error terms within the same latent constructs to improve the model fit. The final CFA
370 results revealed an acceptable fit for the proposed model: Robust $\chi^2 = 2172.742$; $df = 972$;
371 $p = .000$; $df/\chi^2 = 1.141$; Robust CFI = .961; Robust TLI = .957; Robust RMSEA = .034; 90% CI
372 [.032; .036]; SRMR = .045. All standardized factor loadings were significant at $p < .001$. Factor
373 loadings and Cronbach's alphas are presented in Table 4.

374 -Insert Table 4 about here-

375 *Structural Equation Modeling*

376 The results from the SEM analysis showed that the proposed model yielded a good fit
377 to the data: $\chi^2 = 2666.302$; $df = 1006$; $p < .001$; $df/\chi^2 = 1.144$; Robust CFI = .946, Robust
378 TLI = .942, Robust RMSEA = .039 90% CI [.038; .041]; SRMR = .075. The model accounted
379 for 54.7% of the variance in intention to sort food waste and 65.5% of variance in habits to sort
380 food waste.

381 We observed three out of the four hypothesized direct influences on intention. Intention
382 to sort food waste had a strong relationship with both personal norms, $\beta = .35$, $p < .001$, and
383 perceived behavioral control, $\beta = .43$, $p < .001$, suggesting that the stronger the moral obligation
384 and ability individuals feel, the higher their intention to sort food waste. Attitudes were
385 significantly but more weakly linked with intention, $\beta = .08$, $p = .005$. Contrary to expectations,
386 social norms were not significantly related to intention, $\beta = 0.06$, $p = .072$.

411 *Deposit at a Disposal Center*

412 *Descriptive Results*

413 -Insert Table 6 about here-

414 *Measurement model analysis*

415 Due to poor standardized factor loadings, we deleted two items referring to the
416 facilitating conditions. The modification indices suggested correlating ten error terms within
417 the same latent constructs to improve the model fit. The final CFA results revealed an
418 acceptable fit for the proposed model, Robust $\chi^2 = 3042.374$; $df = 978$; $p < .001$; $df/\chi^2 = 3.111$;
419 Robust CFI = .937, Robust TLI = .931, Robust RMSEA = .038 90% CI [.037; .040];
420 SRMR = .044. All standardized factor loadings are significant at $p < .001$ (factor loadings and
421 Cronbach's alphas are presented in Table 7).

422 -Insert Table 7 about here-

423 *Structural Equation Modeling*

424 The results from the SEM analysis showed that the proposed model had an acceptable
425 fit to the data: Robust $\chi^2 = 3557.990$; $df = 963$; $p < .001$; $df/\chi^2 = 3.695$; Robust CFI = .917,
426 Robust TLI = .910, Robust RMSEA = .043 90% CI [.042; .045]; SRMR = .071. The model
427 accounted for 52.8% of the variance in intention to deposit waste at a disposal center.

428 The four hypothesized direct influences on intention were observed. The intention to
429 deposit waste at disposal centers was predicted by personal norms, $\beta = .51$, $p < .001$, indicating
430 that the more participants feel morally obliged to drop off their waste at a disposal center, the
431 more they intend to do so. Perceived behavioral control, social norms and attitude were also
432 significantly linked with intention, $\beta = 0.23$, $p < .001$, $\beta = 0.10$, $p = .003$, and $\beta = 0.16$, $p < .001$,

455 to deposit waste at a disposal center. All five models demonstrated an acceptable fit based on
456 the goodness-of-fit indices. While the two integrative models did not perform as well as the
457 more parsimonious models, our model showed comparable performance to the previous
458 integrative model (i.e., comprehensive action determination model) for both behaviors. The
459 value-belief-norm model had the best comparative fit indices (AIC and BIC). Nevertheless, our
460 model explained more variance in intention and personal norms, and therefore provides a more
461 comprehensive explanation of the data.

462 -Insert Table 9 and 10 about here-

463 **Discussion**

464 The first objective of this study was to test an integrative model that relies on the three—
465 normative, attitudinal, and situational—processes of the comprehensive action determination
466 model (Klöckner et al., 2010) and includes an additional process based on a recent meta-
467 analysis (Geiger et al., 2019): self-processes. Our model is supported by the results of structural
468 equation modeling which are consistent with 21 out of the 24 hypotheses. The indices showed
469 a good fit of the model, accounting for 52.8% and 54.7% of the variance in intentions and 65.5%
470 of the variance in habits. As expected, each of the four processes included in the model had a
471 significant direct or indirect impact on the outcomes studied here. This finding shows the value
472 of including all identified sources of influence to achieve a more complete and detailed
473 understanding of the intention (or habit) to produce the target behaviors.

474 Analyses confirmed our proposal that self-processes have an upstream influence on all
475 other processes (Gkargkavouzi et al., 2019; Steg et al., 2014). By proposing both values and
476 pro-environmental identity as early antecedents, the present integrative model showed that
477 attitudes and social norms – only treated as antecedents in the other models – are predicted by

478 self-processes ($.10 < R^2 < .23$). The comparison with more classical models showed that
479 adding these early antecedents increased the explanation of personal norms, reaching 46% and
480 75% of explained variance. This suggests that self-processes are a promising venue for better
481 understanding how a personal sense of moral obligation emerges and is activated. These
482 findings are consistent with recent work showing that self-processes (i.e., values) predict
483 attitudes, social norms, personal norms and perceived behavioral control (Ateş, 2020). Overall,
484 the observed influence of self-processes on the attitudinal, normative and situational processes
485 is consistent with previous claims that values and self-identity indirectly affect behavioral
486 intentions by providing a general orientation for the perception and evaluation of any specific
487 situation (Bamberg et al., 2003; Udall et al., 2021).

488 This study focused on two specific waste management behaviors: food waste separation
489 and deposit at disposal centers. The results revealed a common basis of understanding for both
490 behaviors. The main common finding is that the intention and habit to manage one's waste are
491 related to two proximal determinants: personal norms and perceived behavioral control. This
492 suggests that, across two types of waste, individuals who feel a strong moral obligation to
493 manage their waste in an environmentally friendly manner and who are highly confident in their
494 ability to do so, are more likely to have a positive intention to engage in proper waste
495 management. Another result observed for both behaviors in our integrative model is that
496 attitudes and social norms are weakly linked to intention. This finding is consistent with a recent
497 study on residential households' waste behavior, that similarly showed the influence of
498 perceived behavioral control and personal norms on waste separation, while attitudes and social
499 norms had no significant relationship with the behavior (Goh et al., 2022). The weaker or
500 absence of influence of attitudes has been observed in other studies when normative influences
501 are included in the models (Oehman et al., 2022; Wu et al., 2022). This may indicate that the
502 presence of personal norms in the model absorbs much of the predictive power of attitudes. The

503 weak and even non-significant effect of social norms in the case of food waste separation may
504 be due to the private nature of the behaviors. Managing food waste, bulky, toxic, or electronic
505 waste mostly takes place in private contexts (e.g., one's own home), which may explain the
506 lower importance of the influence of others' behavior (Aguilar-Luzón et al., 2012).

507 Regarding the path of influence of the proposed model, the results show that the first
508 proximal determinant of intention –personal norms– is predicted by the perception of high
509 levels of social norms and environmental self-identity, but also by a strong sense of control over
510 the behavior. For both behaviors, the more people perceive that those around them value
511 (injunctive norms) or practice (descriptive norms) good waste management, the more people
512 perceive themselves as pro-environmental persons, the more they feel able to perform the waste
513 behavior, and the more they develop a sense of moral obligation to do so. However, contrary to
514 our prediction, the results did not show a significant relationship between personal norms and
515 awareness of consequences. A possible explanation for this null result, which contradicts many
516 studies (Klößner, 2013), is that the measure we used referred to the consequences of waste
517 management in general and not of the target behavior.

518 As for the second stable and proximal determinant of waste management intention –
519 perceived behavioral control – it is strongly predicted by facilitating conditions. The more
520 supportive the material and informational conditions are in individuals' performance
521 environment, the stronger their sense of performance ability. Our findings, along with others
522 (e.g., Cheng et al., 2022; Concari et al., 2022b; Vijayan et al., 2023; Zaikova et al., 2022; Zhang
523 et al., 2022), outline the importance of access to information and material conditions that
524 facilitate the production of waste management behaviors. Such facilitating conditions enrich
525 psychological models with contextual factors that contribute to alleviate constraints.

526 Although the results revealed a common core for understanding both targeted behaviors,
527 they also highlighted specificities in the determinants of food waste sorting and deposit at waste
528 disposal centers. In the case of food waste separation, situational processes appear to be the
529 most influential of the four sources of influence. In fact, the key-predictor of the intention to
530 sort food waste is perceived behavioral control, directly and indirectly through personal norms.
531 That is, when individuals feel control over their behavior, their sense of moral obligation is
532 likely to be activated, which in turn changes their intention to behave accordingly. The results
533 concerning habits also support the predominance of situational processes, as facilitating
534 conditions are strongly related to the presence of sorting habits, both directly and indirectly via
535 perceived behavioral control. The more favorable the material and informational conditions for
536 the act of sorting, the easier the behavior is perceived to be and the higher the habits are. The
537 model predicting intention towards waste disposal emphasizes normative processes over
538 situational and attitudinal processes. Personal norms showed the strongest association with
539 intention. The stronger the principle of depositing toxic or bulky waste at the disposal center,
540 the higher the intention to do so. However, it is interesting to note that the variance of personal
541 norms explained by the antecedents included in the model is lower when the target behavior is
542 depositing at waste disposal centers ($R^2 = .46$) than when it is food waste separation ($R^2 = .74$).
543 Moreover, in the waste disposal model, the awareness that waste generation is a problem that
544 needs to be addressed does not have a significant effect on personal norms. This suggests that
545 the sense of moral obligation to deposit waste at disposal centers is influenced by factors other
546 than those we identified in the pro-environmental literature. This raises the question of the
547 perception of this behavior as being strictly pro-environmental. It is possible that people are not
548 fully aware of how waste is treated and reused in these infrastructures, which have long been
549 perceived as mere landfills.

550 Our second objective was to use our integrative model to promote an understanding of
551 two overlooked waste management behaviors: food waste separation and waste deposit at
552 disposal centers. The behaviors studied in this paper are of practical relevance, with food waste
553 responding to regulatory developments in Europe, and the deposit of waste in a disposal center
554 enabling the reuse of materials (e.g., metal, wood, electronic components), in a context of
555 accelerating resource depletion. This study also contributes to the advancement of the research
556 field on the identification of factors related to waste sorting behavior. Recent bibliometric
557 research suggests that the study of waste sorting behavior is generating a growing literature
558 (Concari et al., 2022). Research on waste management focuses on different types of waste,
559 sometimes grouped under the umbrella term recycling. Our study addresses the need to
560 differentiate and clarify the waste management behaviors studied by identifying both common
561 factors and differentiating elements for understanding two specific behaviors.

562 **Limitations**

563 The main limitation of our study is the absence of measurement of actual behavior. As
564 in many other studies, we measured intention, as a key determinant of behavior (Sheeran &
565 Webb, 2016). Meta-analytic findings on pro-environmental behavior have shown a moderate to
566 strong relationship between intention and behavioral enactment (Morren & Grinstein, 2016). In
567 a longitudinal study, Passafaro et al. (2019) showed that intentions predicted self-reported waste
568 sorting behavior one month later. Despite these strong associations, people do not always do
569 what they intend to do, and thus there is a gap between stated intention and action (Hassan,
570 2016; Rhodes & Dickau, 2012). Indeed, meta-analyses of the impact of interventions aimed at
571 changing health-related behaviors have shown greater intervention-induced changes in
572 intentions than in measured behaviors (Rhodes & Dickau, 2012; Webb & Sheeran, 2006).
573 However, the gap between intentions and behavior depends on the context, particularly whether

574 the behavior is habitual or not. Specifically, the link between change in intention and change in
575 behavior is stronger for nonhabitual behaviors ($d = .74$) than for habitual behaviors ($d = .22$,
576 Webb & Sheeran, 2006). It is worth noting that the behaviors examined in the present study
577 were unlikely to be habitual. The behavior of dropping off food waste at a waste disposal center
578 does not meet the criteria of regularity and frequency that constitute a habit and is therefore a
579 nonhabitual behavior. As for the sorting of food waste, this is a new behavior that is not yet
580 required in the study area. Therefore, the habitual nature of food waste sorting can vary from
581 zero, or very low, to strong. In addition to intentions, we also studied the habit of sorting food
582 waste. This allowed us to establish the relevance of our integrative model to understand what
583 is associated with the emergence of this behavioral variable. Indeed, it appears that regular
584 sorting performance is related to performance conditions, perceived control, and sense of moral
585 obligation, and that these processes, both situational and normative, are not independent since
586 perceived control predicts personal norms. However, habits remain a measure of self-reported
587 behavior that was realized at the same time as the measures of determinants tested in the model.
588 In future work, it would be critical to test the influence of the determinants proposed here in a
589 longitudinal study that would include measures of self-reported or observed waste management
590 behavior (e.g., trash can weighing). We recognize that the explanatory power of the model for
591 actual behavior will be certainly less than that reported here for intention (see e.g., Yuriev et
592 al., 2020). Nevertheless, from an intervention perspective, our study provides a broader
593 understanding of the articulation of the determinants of sorting intentions, which may help in
594 the design of research or interventions targeting the actual realization of these behaviors.
595 Considering the intention-behavior gap, interventions must include complementary elements
596 that strengthen the transformation of intentions into actual actions, such as planning of the
597 action, monitoring progress, or information and conditions that facilitate the production of the
598 behavior (e.g., Rosenthal, 2018; Schwarzer, 2008; Sheeran & Webb, 2016).

599 A second limitation of this study pertains to the representativeness of the samples.
600 Women, highly educated, and high-income individuals are overrepresented in both samples.
601 This may be due first to the recruitment strategy, which relied in part on the social network of
602 the researchers. In addition, a self-selection of respondents is highly likely, as participants
603 completed the questionnaire without retribution, and studies consistently show that women and
604 highly educated people are more concerned about the environment (e.g., Diamantopoulos et al.,
605 2003; Franzen & Meyer, 2009). It is important to replicate this study with a more diverse sample
606 to improve the generalizability of the findings.

607 From an intervention perspective, proposing a comprehensive model may have practical
608 implications. A model that allows for the testing of a wide range of determinants can enable
609 stakeholders and public policymakers to conduct comprehensive diagnostic studies to identify
610 the most important determinants of target behaviors in the population and then develop fine-
611 tuned interventions. For example, in this study, we found that environmental self-identity is a
612 common and early source of influence. Thus, to encourage better waste management, it may be
613 relevant to design general incentive strategies based on the identity lever. However, the model
614 also highlights specificities related to each behavior that suggest more specific strategies. For
615 example, if the goal of a public policy is to specifically encourage the sorting of food waste, the
616 strategy should focus on increasing the sense of control, the key predictor, in particular by
617 providing the conditions that facilitate the practices.

618 In conclusion, this research supports a model that integrates the main determinants of
619 behavior identified in the recycling literature into four sources of influence: normative,
620 attitudinal, situational and self-processes. It adds to our knowledge of the main determining
621 factors of two overlooked behaviors of greatest concern to local authorities: food waste
622 separation and deposits at waste disposal centers. It appears that normative and situational

623 processes are consistently directly related to intentions and habits, while attitudinal processes
624 show weak links. The study also supports the idea that self-processes – values and identity –
625 should be integrated, as they have an upstream influence on the other processes. We believe
626 that the present research contributes to the efforts to move from multiplicity of specific models
627 to a more integrative approach applicable to a wide range of pro-environmental behaviors.

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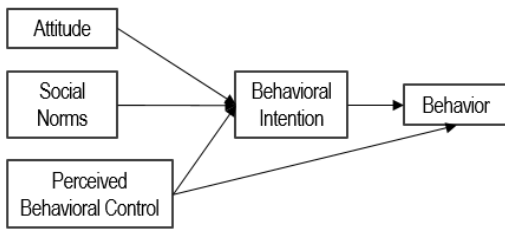
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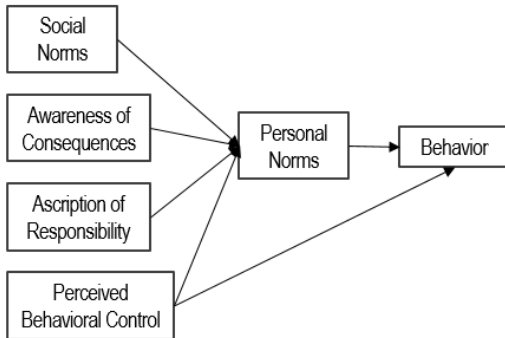
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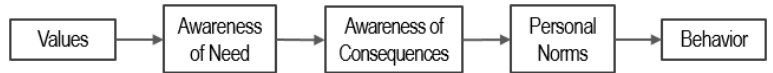
a. The theory of planned behavior (Ajzen, 1991)



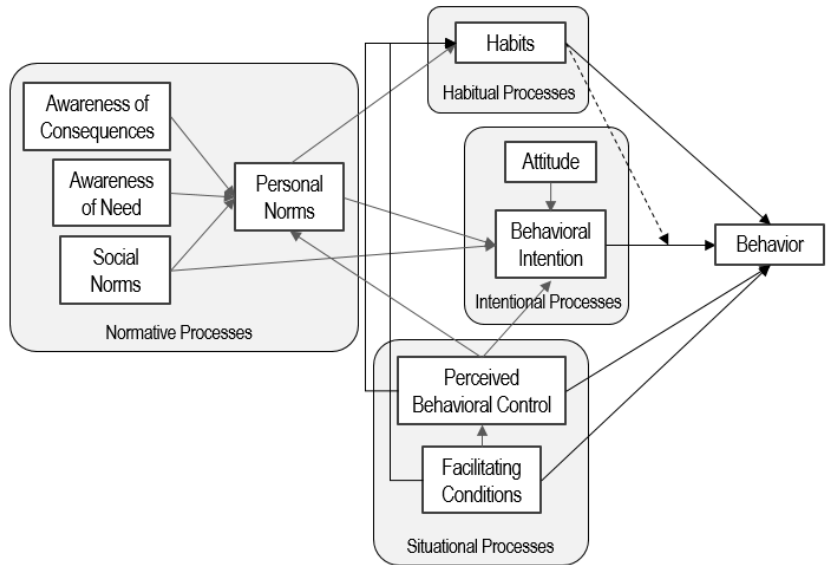
b. The norm activation theory (1977)



c. The value-belief-norm model (Stern, 1999)



d. The comprehensive action determination model (Klöckner, 2010)

**Figure 1.** Four prominent models in environmental psychology

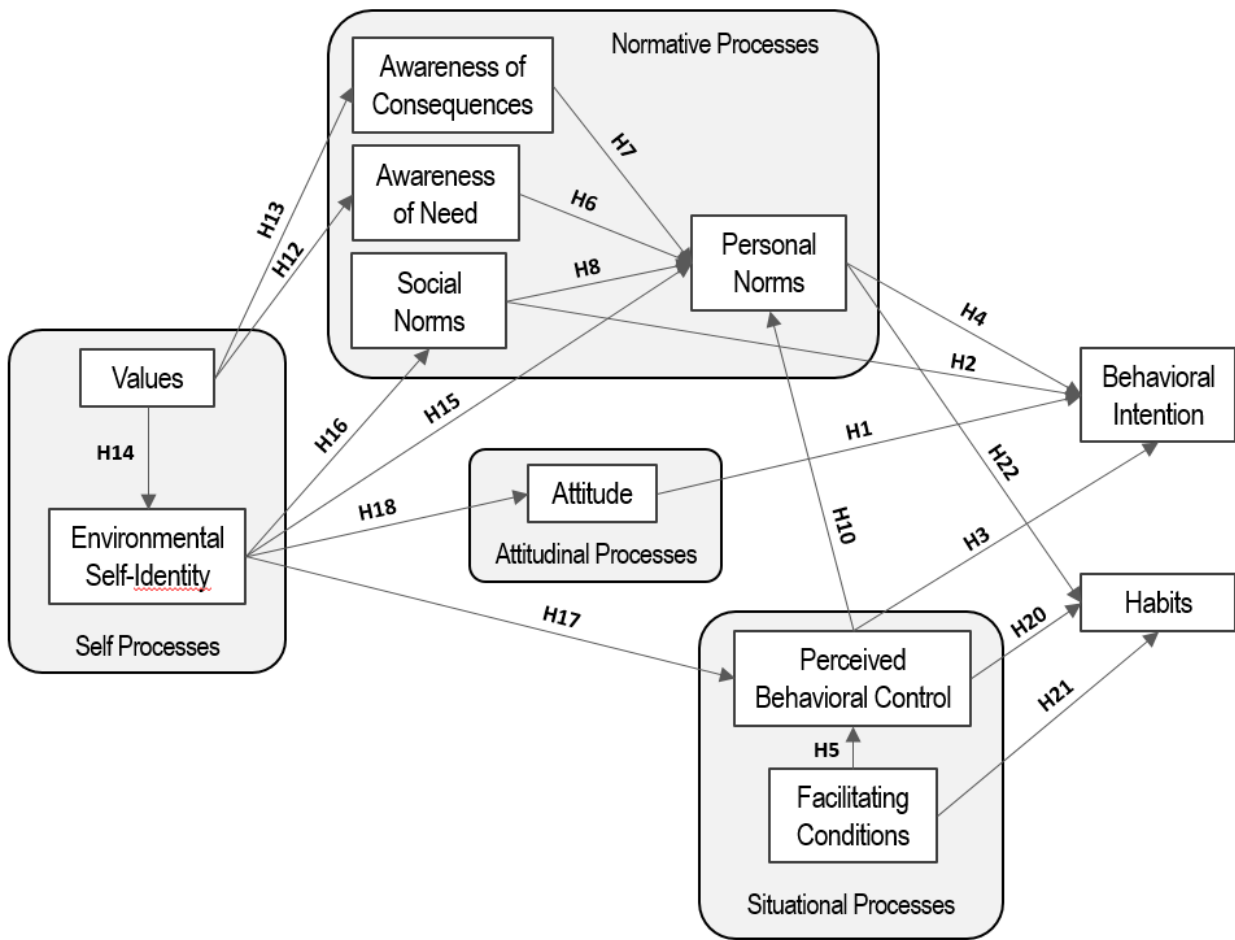


Figure 2. Integrative model.

Table 1. Description of the socio-demographic profile of participants of the food waste sub sample ($N = 1198$)

Gender	Age	Educational attainment	Familial Status	Income per year	Housing type					
Women	74.00% (757)	41.77 (XX)	no diploma	1.48% (13)	Single without children	23.80% (239)	Lowest bracket	6.67% (65)	Room	0.33% (4)
Men	25.71% (263)		Lower secondary education / vocational secondary education	11.36% (100)	Single with children	7.07% (71)	2 nd bracket	7.28% (71)	Studio	4.39% (53)
Other	0.29% (3)		Upper secondary education - General	19.32% (170)	Couple without children	29.68% (298)	3 rd bracket	6.36% (62)	Flat with separated kitchen	15.82% (191)
			Short-cycle tertiary education/ Bachelor's degree or equivalent	36.93% (325)	Couple with children	39.44% (396)	4 th bracket	4.82% (47)	House	76.97% (929)
			Master's degree or equivalent and higher	30.91% (272)			5 th bracket	5.74% (56)	Farm	1.57% (19)
							6 th bracket	7.18% (70)	Other	0.91% (11)
							7 th bracket	7.08% (69)		
							8 th bracket	8.72% (85)		
							9 th bracket	14.46% (141)		
							10 th bracket	24.00% (234)		
							Highest bracket	7.69% (75)		

Table 2. Description of the socio-demographic profile of participants of the disposal center subsample ($N = 1616$)

Gender	Age	Educational attainment		Familial Status		Income per year		Housing type		
Women	65.51 (870)	46.07 (XX)	no diploma	1.30 (17)	Single without children	36.00 (459)	Lowest bracket	7.73% (98)	Room	0.31% (5)
Men	34.04 (452)		Lower secondary education / vocational secondary education	9.78 (128)	Single with children	5.80 (74)	2 nd bracket	5.84% (74)	Studio	9.05% (146)
Autre	0.45 (6)		Upper secondary education - General	15.58 (204)	Couple without children	29.96 (382)	3 rd bracket	5.60% (71)	Flat with separated kitchen	22.81% (368)
			Short-cycle tertiary education/ Bachelor's degree or equivalent	35.75 (468)	Couple with children	28.24 (360)	4 th bracket	4.26% (54)	House	66.27% (1069)
			Master's degree or equivalent and higher	37.59 (492)			5 th bracket	4.50% (57)	Farm	0.68% (11)
							6 th bracket	6.39% (81)	Other	0.87% (14)
							7 th bracket	6.71% (85)		
							8 th bracket	8.29% (105)		
							9 th bracket	14.68% (186)		
							10 th bracket	24.78% (314)		
							Highest bracket	11.21% (142)		

Table 3. Correlation matrix and descriptive statistics of latent variables: food waste separation.

Correlation Matrix											
	1	2	3	4	5	6	7	8	9	10	11
1.Biospheric values	-										
2.Awareness of need	.480***	-									
3.Awareness of consequences	.377***	.470***	-								
4.Environmental self-identity	.664***	.460***	.347***	-							
5.Social norms	.232***	.106***	.180***	.328***	-						
6.Personal norms	.462***	.353***	.277***	.561***	.375***	-					
7.Attitude	.360***	.285***	.225***	.354***	.169***	.313***	-				
8.Facilitating Conditions	.339***	.188***	.218***	.422***	.385***	.447***	.258***	-			
9.Perceived behavioral control	.323***	.215***	.226***	.346***	.352***	.444***	.261***	.618***	-		
10.Habits	.320***	.180***	.193***	.461***	.453***	.556***	.247***	.663***	.614***	-	
11.Behavioral intention	.472***	.294***	.271***	.495***	.396***	.568***	.342***	.570***	.580***	.666***	-
Mean (SD)	6.36 (0.76)	6.28 (0.76)	5.78 (0.89)	5.64 (1.08)	4.04 (1.10)	5.55 (1.32)	6.34 (1.05)	4.94 (1.18)	5.60 (1.32)	5.02 (2.04)	5.91 (1.34)

Note. * $p > .05$, ** $p > .01$, *** $p > .001$

Table 4. Factor loadings and Cronbach's alphas: food waste separation.

Construct	Items	Standardized factor loadings	Cronbach's alpha
Biospheric values	BV1	.753	.89
	BV2	.879	
	BV3	.838	
	BV4	.829	
Environmental self-identity	ESI1	.792	.86
	ESI2	.818	
	ESI3	.756	
Awareness of need	AN1	.617	.76
	AN2	.727	
	AN3	.709	
	AN4	.670	
Awareness of consequences	AC1	.846	.81
	AC2	.798	
Attitude	ATT1	.741	.86
	ATT2	.719	
	ATT3	.795	
	ATT4	.812	
	ATT5	.699	
Social norms	SN1	.501	.83
	SN2	.672	
	SN3	.572	
	SN4	.768	
	SN5	.793	
	SN6	.636	
Facilitating conditions	FC1	.408	.79
	FC2	.462	
	FC3	.653	
	FC4	.452	
	FC5	.779	
	FC6	.546	
	FC7	.414	
	FC8	.710	
Perceived behavioral control	PBC1	.949	.79
	PBC2	.640	
	PBC3	.448	
	PBC4	.719	
Personal norms	PN1	.587	.64
	PN2	.849	
Behavioral intention	BI1	.932	.96
	BI2	.958	
	BI3	.956	
Habits	H1	.978	.98
	H2	.942	
	H3	.923	
	H4	.977	

Table 5. Evidence support for the hypothesized relations: food waste separation.

Paths	Coefficients	z-values	Hypothesis	Results
Attitude→ Intention	.08**	2.791	H1	Supported
Social norms→ Intention	.06, p = .07	1.797	H2	Not supported
Perceived control→ Intention	.43***	7.788	H3	Supported
Personal norms→ Intention	.35***	6.500	H4	Supported
Facilitating conditions→ Perceived control	.77***	11.588	H5	Supported
Awareness of need→ Personal norms	.14**	3.218	H6	Supported
Awareness of consequences→ Personal norms	-.05, p = .23	-1.212	H7	Not supported
Social norms→ Personal norms	.13**	2.699	H8	Supported
Social norms→ Personal norms→ Intention	.04*	2.304	H9	Supported
Perceived control→ Personal norms	.30***	6.873	H10	Supported
Perceived control→ Personal norms→ Intention	.11***	5.203	H11	Supported
Biospheric value→ Awareness of need	.64***	12.509	H12	Supported
Biospheric value→ Awareness of consequences	.52***	13.289	H13	Supported
Biospheric value→ Environmental self-identity	.82***	20.077	H14	Supported
Environmental self-Identity→ Personal norms	.58***	9.418	H15	Supported
Environmental self-Identity→ Social norms	.41***	8.206	H16	Supported
Environmental self-Identity→ Perceived control	.13***	3.598	H17	Supported
Environmental self-Identity→ Attitude	.48***	10.147	H18	Supported
Environmental self-Identity→ Social norms→ Personal norms	.09***	4.135	H19	Supported
Perceived control→ Habits	.36***	6.010	H20	Supported
Facilitating conditions→ Habits	.32***	5.340	H21	Supported
Personal norms→ habits	.25***	6.094	H22	Supported
Perceived control→ Personal norms→ habits	.08***	4.949	H23	Supported
Facilitating conditions→ Perceived control→ Habits	.28***	5.780	H24	Supported

Note. * p > .05, ** p > .01, *** p > .001

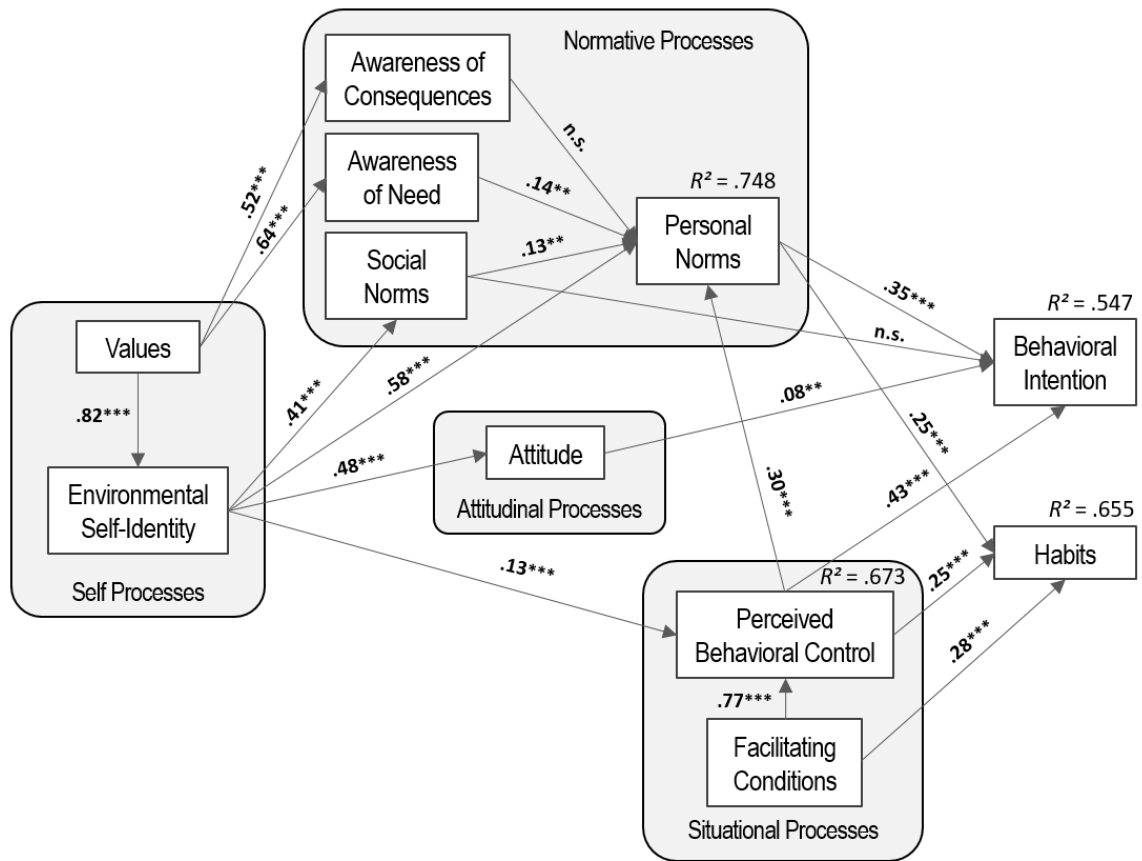


Figure 3. Results of the structural equation modeling: food waste separation.

Table 6. Correlation matrix and descriptive statistics of latent variables: the waste deposit at a disposal site.

Correlation Matrix										
	1	2	3	4	5	6	7	8	9	10
1.Biospheric values	-									
2.Awareness of need	.423***	-								
3.Awareness of consequences	.334***	.449***	-							
4.Environmental self-identity	.670***	.432***	.345***	-						
5.Social norms	.218***	.125***	.141***	.267***	-					
6.Personal norms	.353***	.264***	.250***	.413***	.333***	-				
7.Attitude	.180***	.148***	.173***	.197***	.156***	.325***	-			
8.Facilitating conditions	.123***	.032***	.131***	.195***	.287***	.201***	.218***	-		
9.Perceived behavioral control	.205***	.136***	.212***	.258***	.331***	.290***	.266***	.714***	-	
10.Behavioral intention	.326***	.217***	.220***	.367***	.372***	.540***	.379***	.361***	.444***	-
Mean (SD)	6.39 (0.76)	6.43 (0.66)	5.88 (0.87)	5.83 (1.01)	4.80 (1.02)	5.91 (1.14)	6.15 (0.99)	4.48 (1.08)	5.15 (1.18)	6.11 (1.10)

Note. * p > .05, ** p > .01, *** p > .001

Table 7. Factor loadings and Cronbach's alphas: the waste deposit at a disposal center.

Construct	Items	Standardized factor loadings	Cronbach's alpha
Biospheric values	BV1	.713	.88
	BV2	.896	
	BV3	.820	
	BV4	.834	
Environmental self-identity	ESI1	.778	.85
	ESI2	.824	
	ESI3	.719	
Awareness of need	AN1	.608	.73
	AN2	.728	
	AN3	.637	
	AN4	.648	
Awareness of consequences	AC1	.846	.81
	AC2	.806	
Attitude	ATT1	.761	.81
	ATT2	.679	
	ATT3	.533	
	ATT4	.754	
	ATT5	.776	
Social norms	SN1	.801	.82
	SN2	.542	
	SN3	.729	
	SN4	.618	
	SN5	.735	
	SN6	.477	
Facilitating conditions	FC1	.703	.86
	FC2	.745	
	FC3	.623	
	FC4	.454	
	FC5	.468	
	FC6	.484	
	FC7	.632	
	FC8	.545	
	FC9	.531	
	FC10	.646	
	FC11	.498	
	FC12	.522	
Perceived behavioral control	PBC1	.802	.83
	PBC2	.751	
	PBC3	.733	
	PBC4	.647	
Personal norms	PN1	.829	.63
	PN2	.555	
Behavioral intention	BI1	.877	.93
	BI2	.819	
	BI3	.926	
	BI4	.902	

Table 8. Evidence support for the hypothesized relations: the waste deposit at a disposal site.

Paths	Coefficients	z-values	Hypothesis	Results
Attitude→ Intention	.16***	4.963	H1	Supported
Social norms→ Intention	.10**	2.972	H2	Supported
Perceived control→ Intention	.23***	6.920	H3	Supported
Personal norms→ Intention	.51***	11.517	H4	Supported
Facilitating conditions→ Perceived control	.69***	16.321	H5	Supported
Awareness of need→ Personal norms	.04, p = .31	1.017	H7	Not supported
Awareness of consequences→ Personal norms	.03, p = .44	0.775	H8	Not supported
Social norms→ Personal norms	.19***	5.399	H6	Supported
Social norms→ Personal norms→ Intention	.10***	4.498	H11	Supported
Perceived control→ Personal norms	.23***	6.592	H9	Supported
Perceived control→ Personal norms→ Intention	.12***	5.895	H10	Supported
Biospheric values→ Awareness of need	.57***	8.916	H12	Supported
Biospheric values→ Awareness of consequences	.46***	12.012	H13	Supported
Biospheric values→ Environmental self-identity	.82***	20.401	H14	Supported
Environmental self-Identity→ Personal norms	.44***	8.533	H15	Supported
Environmental self-Identity→ Social norms	.37***	10.054	H16	Supported
Environmental self-Identity→ Perceived control	.23***	7.495	H17	Supported
Environmental self-Identity→ Attitude	.32***	8.481	H18	Supported
Environmental self-Identity→ Social norms→ Personal norms	.12***	7.318	H19	Supported

Note. * p > .05, ** p > .01, *** p > .001

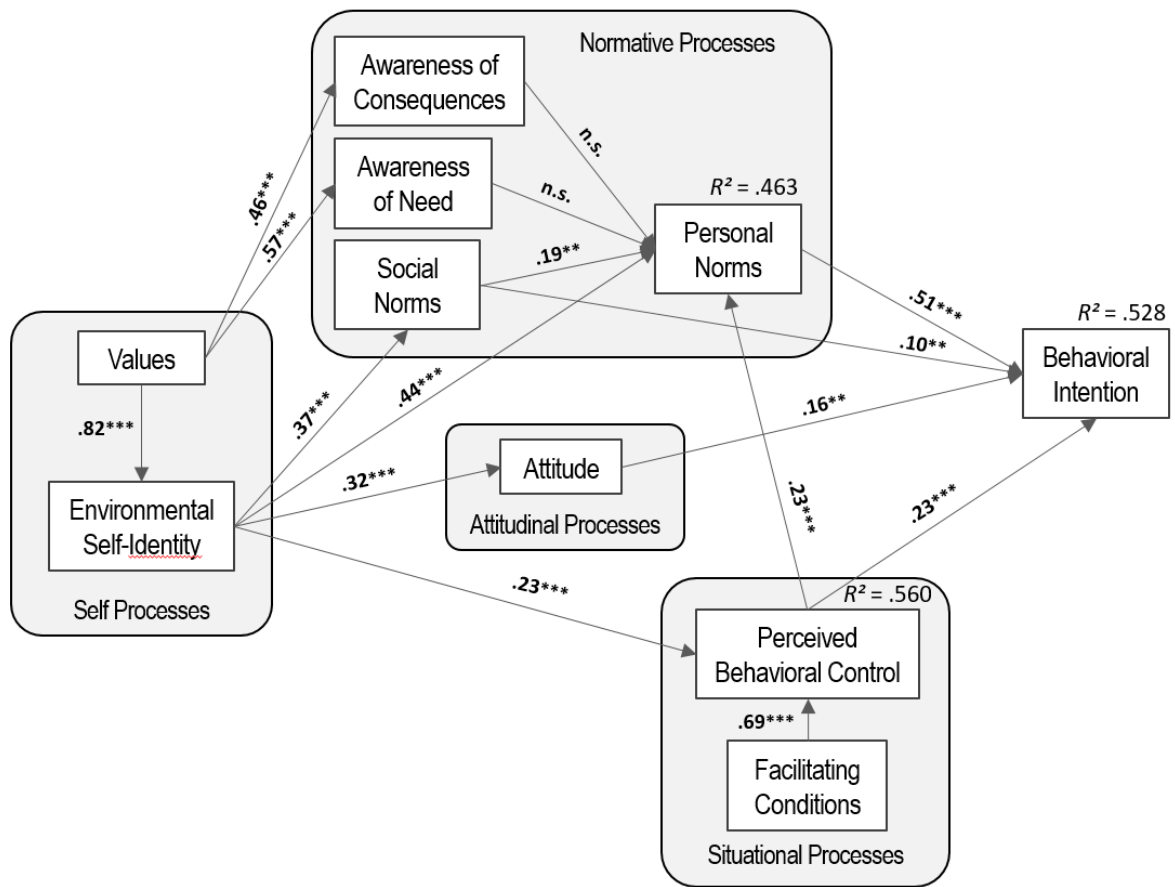


Figure 4. Results of the structural equation modeling: the waste deposit at a disposal site.

Table 9. Model comparison for food waste sorting intention.

Alternative Models explaining food waste sorting

Indices	TPB	NAM	VBN	CADM	Integrative Model
CFI	.971	.961	.957	.948	.946
TLI	.966	.955	.949	.943	.942
RMSEA	.047	.045	.060	.042	.039
SRMR	.036	.037	.106	.046	.075
AIC	65819	69693	49855	146135	162441
BIC	66125	70024	50135	146864	163302
R ² Intention	.52	.583	.472	.586	.547
R ² Personal Norms	NA	.626	.208	.64	.748
R ² Attitude	NA	NA	NA	NA	.227
R ² Perceived Control	NA	NA	NA	.711	.673
R ² Social Norms	NA	NA	NA	NA	.167
R ² Habits	NA	NA	NA	.674	.655

Note: TPB - Theory of Planned Behavior, NAM - Norm Activation Model, VBN - Value Belief Norm Model, CADM - Comprehensive Action Determination Model, NA - variable not present in the model or variable that does not have the status of an exogenous variable

Table 10. Model comparison for the intention to waste deposit at a disposal center

Alternative Models explaining desposit at a disposal centre

Indices	TPB	NAM	VBN	CADM	Integrative Model
CFI	.960	.968	.961	.902	.917
TLI	.953	.963	.954	.893	.910
RMSEA	.051	.039	.052	.052	.043
SRMR	.032	.028	.053	.053	.071
AIC	89581	102842	68903	173198	161939
BIC	89922	103281	69216	173841	162974
R ² Intention	.384	.559	.498	.542	.528
R ² Personal Norms	NA ¹	.390	.135	.354	.46
R ² Attitude	NA	NA	NA	NA	.103
R ² Perceived Control	NA	NA	NA	.535	.560
R ² Social Norms	NA	NA	NA	NA	.137

Note: TPB - Theory of Planned Behavior, NAM - Norm Activation Model, VBN - Value Belief Norm Model, CADM - Comprehensive Action Determination Model, NA - variable not present in the model or variable that does not have the status of an exogenous variable