To waste or not to waste? Empirical study of waste minimization behavior

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Abstract

This study explores the key variables that influence overall waste minimization behaviors of consumers by augmenting the theory of planned behavior (TPB) with additional variables, including environmental concern, perceived consumer effectiveness, and perceived lack of facilities. Further, subjective norm is replaced by injunctive norm and descriptive norm. A questionnaire was administered to 455 consumers from North America, a region that faces acute waste production challenges. The findings suggest that perceived consumer effectiveness (PCE) constitutes the most influential variable to predict zero waste behavior (ZWB) intentions ($\beta = 0.380$ $p < 0.001$), even surpassing perceived behavioral control (PBC) ($\beta = 0.232$ $p < 0.001$), PBC also directly influences ZWB ($\beta = 0.321$ $p < 0.001$), and injunctive norms ($\beta = 0.171$ $p < 0.05$) exert a slightly greater influence than attitudes ($\beta = 0.122$ $p < 0.001$). Importantly, environmental concern is a meaningful antecedent to all belief variables (i.e., control belief [$\beta = 0.689$ $p < 0.001$], normative belief [$\beta = 0.378$ $p < 0.001$], and behavioral belief [$\beta = 0.367$ $p < 0.001$]) while exerting an indirect effect on ZWB ($\beta = 0.474$ [.299, .523]), especially via attitudes and PBC. Albeit perceived lack of facilities negatively impacts intentions ($\beta = -0.073$ $p < 0.05$), it positively relates ZWB ($\beta = 0.189$ $p <$

0.001) or worsen the effect of intentions on ZWB (β = -0.033 [-0.102, 0.036]). The results deliver crucial insights to devise impactful strategies and formulate sound policies to nudge consumers' ZWB.

1. Introduction

Modern lifestyles centered around consumption activities generate substantial amounts of waste. About 2.01 billion metric tons of municipal solid waste (MSW) are generated each year worldwide, while less than 20% is recycled and 5.5% is composted (World Bank, 2018; Linnenkoper, 2019). If no corrective action is taken, overall waste generation is estimated to surge to 3.40 billion metric tons by 2050 (World Bank, 2018). For some time now, this state of affairs has had significant effects on the environment and has triggered rising public concern. Several solutions have been elaborated and implemented to minimize waste from consumption activities. Managerial and policy measures have received the most attention by exploring product stewardship and extended producer responsibility, reverse logistics models, or sustainable food processing systems, among many others (Lewis, 2005; Spicer and Johnson, 2004; Dowlatshahi, 2000; Lee and Okos, 2011). When waste was inevitable, research has suggested waste valorization strategies (e.g., Cortés et al., 2020), such as waste-to-energy strategies (Soloaga et al., 2020). In contrast, the consumer perspective in waste reduction or zero waste has not received similar attention until several years ago (Barr et al., 2001; Tonglet et al., 2004; Evans and Cooper, 2010). Recently, scholars have determined that consumers are pivotal in waste minimization efforts (O'Connell, 2011; Marangon et al., 2014; Graham-Rowe et al., 2014; von Kameke and Fischer, 2018; Hu et al., 2019). Manzocco et al. (2016) suggested that the waste minimization concept has been a relatively misunderstood one since

many consumers intend it as synonymous with recycling. The importance of knowing the intentions and determinants of consumers' contribution to waste minimization has not been established with literature. It is important to provide some literary background to the role of consumers in waste management.

Past research on waste prevention behavior used either no specific theoretical framework (e.g., Marangon et al., 2014; Graham-Rowe et al., 2014; Rohm et al., 2017) or specific theories including nudging theory (Kameke and Fischer, 2018) or Value-Belief-Norm theory (Farr-Wharton et al., 2014). However, these models are not satisfactory since they induce less controllability for nudging and lack a clear distinction between the three constructs that are – in addition - supposed to impact each other causally. Therefore, following other studies (e.g., Hu et al., 2019; Minelgaitė and Liobikienė, 2019), we use the theory of planned behavior (TPB), which has proved beneficial to explore waste prevention behavior (Stancu et al., 2019) as it comprises a set of clearly distinguishable and actional constructs (attitude [i.e., the extent to which an individual evaluates positively or negatively a specific behavior], social norm, perceived behavioral control [i.e., the perceived level of difficulty and constraint in performing a behavior], intentions, behavior), creating a parsimonious model. We adapt and extend this model according to recent advances in the pro-environmental literature, namely by splitting social norm (i.e., social pressure that individuals perceived to perform or to refuse to perform a specific behavior [Ajzen, 1991]) into injunctive norm (i.e., individuals' perceptions of what significant others believe [Rivis and Sheeran, 2003]) and descriptive norms (i.e., beliefs regarding what other people actually do [Rivis and Sheeran, 2003]) (de Leeuw et al., 2015), by investigating perceived consumer effectiveness (PCE) (i.e., the belief that an individual can make a difference in the solution to a problem [Ellen et al., 1991]), environmental concern (awareness of environmental issues and concern for them [Tonglet et al., 2004]), and context perception (Ertz et al., 2016, 2017).

While the distinction between injunctive norms and descriptive norms had been suggested by Cialdini et al. (1990), Fishbein and Ajzen (2010), as well as de Leeuw et al. (2015) to study pro-environmental behaviors, few researchers that used the TPB actually did so or did so partially. For example, Stancu et al. (2016) made that distinction, but instead of using descriptive norms, they used moral norms, which may explain the lack of a significant effect that they found for that latter construct (i.e., moral norms). This study splits social norm into injunctive and descriptive norm to make up for that gap in past waste minimization research.

With regards to environmental concerns, Marangon et al. (2014) examined, from a quantitative approach, the impact of demographic and psychographic variables on food waste reduction, but they used a stepwise regression procedure instead of a structural path approach, thus preventing them from using reflective concepts and constructs. Their study, however, measured a facet of environmental concern, albeit with a single-item only. Surprisingly, despite the importance of environmental concern, no other study explored this construct in relation to waste minimization. In line with past research emphasizing the importance of environmental concern (e.g., Barr et al., 2001; Tonglet et al., 2004), we added that construct to the TPB framework.

Furthermore, past research has abundantly shown how external context and the perception of that context influences pro-environmental behavior (Ertz et al., 2016, 2017; Grimmer et al., 2016). Yet, only a handful of studies explored the impact of the perceived presence or absence of facilitating infrastructure in relation to waste minimization behavior (e.g., Knussen et al., 2004; Giannelloni and Robinot, 2015) and with mixed results (e.g., Chen and Tung, 2010). This study uses the perceived lack of facilities as a relevant variable of context perception to further investigate and settle how that aspect influences ZWB.

Beyond a facilitating context, consumers also need to feel that they may achieve waste minimization goals and objectives (i.e., perceived consumer effectiveness) (Izagirre-Olaizola et al., 2015; Hanss et al., 2016). Yet past research does not inform much on the extent to which perceived consumer effectiveness impacts waste minimization. This study integrates perceived consumer effectiveness to add deeper insights into ZWB enactment.

Finally, only a limited number of studies investigated actual waste minimization behavior, despite the intentions-behavior gap. Stancu et al. (2016) incorporated actual food waste behavior as the ultimate dependent variable, and despite a negative relationship between intentions not to waste and food waste behavior, the latter construct does not reflect overall waste minimization behavior. Minelgaitė and Liobikienė (2019) investigated actual and overall waste minimization behavior but with a limited set of predicting variables (i.e., attitudes and efforts). This study investigates actual reported behavior in order to increase model richness, relevance, and generalizability.

In sum, past literature considered a limited set of variables quantitatively to predict waste minimization intentions, without necessarily including additional meaningful predictors and without exploring actual waste minimization behavior. Thus, the overarching objective of this paper is to extend the TPB model to explain consumers' actual waste minimization behavior.

2. Literature review

2.1. Consumer waste minimization behavior

Tonglet et al. (2004) define waste minimization as "*the actions taken by householders to minimize their household waste, either at the point of purchase or within the home by re-using or repairing products rather than replacing them*" (p. 30). The concept of waste

minimization has recently been denominated as "Zero Waste" in consumer studies or "Zero Litter" in tourism research (Hu et al., 2019). Zero waste has been defined as follows:

> "Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them." (Zero Waste International Alliance, 2018).

Seminal work on waste minimization distinguished it from recycling (Barr et al., 2001; Tonglet et al., 2014). Recycling is impacted by knowledge, convenience, and access to curbside schemes, while waste minimization behavior refers to a broader concern about environmental issues that can be enacted in multiple ways (Tonglet et al., 2004). However, Tonglet et al. (2004) did not investigate the impact of environmental concern on waste minimization behavior. Furthermore, waste minimization was not significantly related to recycling intentions (Barr et al., 2001), suggesting that both waste minimization and recycling could constitute two distinct components of overall waste management behavior. However, neither Barr et al. (2001) nor Tonglet et al. (2004) measured beliefs, attitudes, and intentions related to waste minimization behaviors. Some studies have sought to bridge this gap, as shown in Appendix A (in the e-component file).

2.2. Theoretical and conceptual frameworks

Although there is a dearth of research on ZWB, several studies examined waste prevention behaviors empirically. Some did not use any theoretical framework but rather assessed econometrically or experimentally the impact of socio-economic, demographic, product, or purchase characteristics to explain (non-)waste (e.g., Marangon et al., 2014; Rohm et al., 2017), while others explored the barriers to waste minimization qualitatively (e.g.,

Graham-Rowe et al., 2014). In that case, only a few key variables are investigated in detail, but no theoretical framework governs the overarching study design.

Among the theoretical frameworks used, nudge theory has been implemented by Kameke and Fischer (2018), as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentive purchase" (Thaler and Sunstein, 2008, p. 6). Although interesting, this theory has some drawbacks as it induces less controllability due to higher levels of distraction for participants while causing possibly ethical issues, especially if the nudge is unavoidable (Filimonau et al., 2017). The Value-Belief-Norm (VBN) theory is another framework used in understanding waste behavior (Farr-Wharton et al., 2014). Interestingly, VBN theory integrates attitudinal factors and contextual or external forces as well as habits, routines, and personal capabilities, resulting in a richer account for explaining a given behavior or lack thereof. However, the difference between a value, a belief, and a norm can be challenging to assess, resulting in various constructs being possible candidates in all three categories (Ghazali et al., 2019). Other researchers resorted to the Theory of Planned Behavior (TPB) (e.g., Stancu et al., 2016; Hu et al., 2019; Minelgaitė and Liobikienė, 2019). This framework appears to be the most popular in investigating waste prevention, but this might reflect the overall popularity of that model. Upon closer scrutiny, this model has a number of benefits, such as higher controllability due to limitation to a set of parsimonious variables that are expected to predict behavior and use of constructs that are conceptually different enough from each other to avoid operationalization confusion. Therefore, in line with this stream of research applying the TPB, we use the same theoretical framework by adapting it and extending it according to past literature in pro-environmental behavior.

2.3. The theory of planned behavior and its extension

The TPB provides a framework for examining the predictors that affect behavioral choices. According to the TPB, individual behavior results from perceived behavioral control and behavioral intentions, whereas intentions are an outcome of attitude towards the behavior, subjective norm, and perceived behavioral control (Ajzen, 1991). Fundamentally, the TPB posits that higher behavioral intentions trigger a higher probability that specific behavior is being enacted.

The TPB has been applied in multiple areas of pro-environmental research, such as waste minimization (e.g., Tonglet et al., 2004; Stancu et al., 2016; Hu et al., 2019). However, despite this strong support, the model has also been subject to several criticisms.

One of the most common critics is the "intention-behavior gap," suggesting that good intentions may not necessarily translate into good acting on those intentions ("inclined abstainers," cf. Sheeran and Orbell, 1998; Sheeran, 2002). Therefore, limiting the study of behavior to its intentions will provide inconclusive findings since those will be contingent upon the volitional intention-behavior link. This is why this study focuses on actual behavioral outcomes. Yet, in contrast to past research (i.e., Stancu et al., 2016), it focuses on waste minimization behavior instead of waste behavior.

The second criticism of this model refers to the necessity to include additional variables to improve its predictive and explanatory power (Tonglet et al., 2004; Ertz et al., 2017). Ajzen (1991) acknowledged that the TPB might incorporate new variables as long as they significantly explain the behavior. Some researchers questioned the lack of moral considerations and thus started to add moral norms and personal norms in the TPB (Hu et al., 2019). Several studies have suggested splitting the subjective norms construct into two sub-variables, namely descriptive and injunctive norms, to improve the predictive capability of the TPB (Cialdini et al., 1990; Fishbein and Ajzen, 2010; De Leeuw et al., 2015). Collectively, these mixed results suggest that research should assess the simultaneous impact of descriptive

and injunctive norms, instead of subjective norm, on waste minimization behavior. The proposed model in this study also accounts for other additional variables, including perceived lack of facilities, environmental concern, and perceived consumer effectiveness.

3. Conceptual model and hypotheses

3.1. Environmental concern

While recycling is influenced by knowledge, access to curbside schemes, convenience, and public institutions, waste minimization behavior results from voluntary motives as well as environmental concern (Barr et al., 2001). For example, Tonglet et al. (2004) found that individuals with a greater propensity to waste minimization behaviors tend to show more concern for environmental issues.

Environmental concern (EC) means awareness of environmental issues (Chaudhary and Bisai, 2018; Hu et al., 2010). Since environmental concern can be defined as a general attitude or predisposition toward the existence of environmental problems, it should positively influence pro-environmental behavior in general and waste minimization in particular. However, most studies found that environmental concern has a low or nonsignificant effect on pro-environmental behavior (Hines et al., 1986/1987; Bamberg, 2003; Chaudhary and Bisai, 2018). It may be that general attitudes do not directly impact a specific behavior, so attitudes do not impact behavior directly in the TPB (Ajzen, 1991). Indeed, for Fishbein and Ajzen (1975), attitude and behavior have to be at similar levels of specificity. Later, Ajzen and Fishbein (1980) indicate that general determinants such as EC may indirectly impact behavior. The indirect effect would occur through behavioral, normative, and control beliefs, on the one hand, and through attitudes, subjective norms, and perceived behavioral control, on the other. Bamberg (2003) tested that theoretical proposition empirically and reported a positive impact of EC on the behavioral, normative, and control beliefs in the context of PEB. He also

identified a positive relationship of EC on subjective norm and PBC. However, the magnitude of the effects was comparatively smaller, and these relationships added layers of complexity to the model. Therefore, to ensure parsimony of the conceptual model, as initially sought and suggested by Ajzen (1991), we hypothesize the following:

H1a. Environmental concern is positively related to behavioral beliefs.

H1b. Environmental concern has a positive influence on normative beliefs.

H1c. Environmental concern has a positive effect on control beliefs.

H1d. Environmental concern is positively and significantly related to waste minimization behavior through the mediation of beliefs and TPB variables and intention.

3.2. Beliefs

According to Ajzen (1991), human behavior is influenced by behavioral beliefs, normative beliefs, and control beliefs. Academic literature shows that each independent TPB factor is correlated with its salient belief (e.g., Yadav and Pathak, 2017; De Leeuw et al., 2015; Borges et al., 2016; Bamberg, 2003), and those beliefs improve the understanding of how TPB variables are linked to intentions.

Behavioral beliefs determine attitude toward the behavior in that attitude is the result of belief about the outcomes that a behavior induces (behavioral belief) and the importance of this outcome to an individual (outcomes evaluation). Regardless of whether these outcomes are evaluated positively or negatively, individuals form an attitude toward a particular behavior according to the consequences and importance of that behavior.

Normative beliefs influence subjective norms because subjective norms result from the perceived opinions of other individuals who are essential to a person (normative belief) and the extent to which the person is motivated to comply with these options (motivation to

comply) (Fischbein and Ajzen, 1975). Beliefs about the normative expectations and support of others refer to the "likelihood that important referent individuals or groups approve or disapprove of performing a particular behavior" (Ajzen, 1991, p. 195).

Control beliefs predict perceived behavioral control (PBC) since the belief in accessing resources and opportunities without substantial hindrances shapes PBC. In other words, "the more resources and opportunities individuals believe they possess, the fewer obstacles they anticipated, and the greater perceived behavioral control over the behavior" (Li et al., 2018, p. 1402).

A structural path approach is preferable to assess the impact of beliefs on attitudes, norms, and PBC. Therefore:

H2. Behavioral beliefs are positively related to attitude.

H3a. Normative beliefs have a positive influence on injunctive norms.

H3b. Normative beliefs are positively related to descriptive norms.

H4. Control beliefs have a positive impact on the perceived behavioral control.

3.3. Attitude

Behavioral attitude refers to the extent to which an individual evaluates positively or negatively a specific behavior (Fishbein and Ajzen, 1975). In extant waste minimization research, the impact of attitudes has been well validated (Tonglet et al., 2004; Stancu et al., 2016; Hu et al., 2019; Minelgaitė and Liobikienė, 2019). Therefore:

H5. Attitude regarding waste minimization has a positive effect on intention toward waste minimization behavior.

3.4. Subjective norm

Subjective norm (SN) refers to the social pressure that individuals perceive to perform or refuse to perform a specific behavior (Ajzen, 1991). Ajzen (1991) and Fishbein and Ajzen (2010) refined the subjective norm construct by adding descriptive norms to existing injunctive norms. De Leeuw et al. (2015) divided more formally subjective norm into two distinct constructs, namely injunctive norms, on the one hand, and descriptive norms, on the other. Injunctive norms refer to individuals' perceptions of what important others (e.g., family, friends, colleagues, social circles) believe they should do (Rivis and Sheeran, 2003). By contrast, descriptive norms relate to beliefs regarding what other people actually do (Rivis and Sheeran, 2003). The results on the impact of both norms on intentions are mixed.

On the one hand, some studies report that descriptive norms are significantly related to intentions while injunctive norms are not (de Leeuw et al., 2015). Alternatively, past research also found that descriptive norms exert a higher effect on an individual's behavior than injunctive norms (Keizer et al., 2011). On the other hand, the waste minimization literature reports a significant impact of injunctive norms, while descriptive norms were not considered but replaced by moral norms instead (Stancu et al., 2016). Therefore, no study tested for the simultaneous impact of both injunctive and descriptive norms on waste minimization behavioral intentions. Accordingly, the following hypotheses are proposed:

H6. Injunctive norms are positively and significantly associated with intentions.

H7. Descriptive norms have a positive effect on intentions.

3.5. Perceived behavioral control

According to Ajzen (1991), perceived behavioral control (PBC) refers to the level of difficulty of performing a behavior. When individuals perceive to have more opportunities, resources, and fewer obstacles, they will also perceive higher control over their behavior. In extant waste minimization research, the impact of PBC has been well validated (Tonglet et al.,

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2004; Stancu et al., 2016; Hu et al., 2019; Minelgaitė and Liobikienė, 2019). Therefore, the following hypotheses are proposed.

H8a. Perceived behavioral control is positively related to intention toward waste minimization behavior.

H8b. Perceived behavioral control has a positive effect on waste minimization behavior.

3.6. Perceived consumer effectiveness

Perceived consumer effectiveness (PCE) refers to "a domain-specific belief that the efforts of an individual can make a difference in the solution to a problem" (Ellen et al., 1991, p.103). This definition implies that PCE may not predict general pro-environmental behavior. Perceived consumer effectiveness closely relates to other theoretical constructs. First, PCE is distinct from PBC because the former focuses on achieving desired behavior outcomes while the latter refers to a person's beliefs and ability to realize a specific behavior. Second, PCE differs from self-efficacy since PCE focuses more on achieving a behavior outcome, while self-efficacy refers to individuals' confidence in their capacity to enact a given behavior (Bandura, 1992). In the pro-environmental literature, it has been shown that PCE affects intentions (Izagirre-Olaizola et al., 2015; Hanss et al., 2016) and waste minimization behaviors (Izagirre-Olaizola et al., 2015). However, few studies have included this variable to study individuals' intentions to adopt specifically waste minimization behavior. To keep the model parsimonious, the study is limited to the impact of PCE on intentions. Therefore:

H9. Perceived consumer effectiveness has a positive effect on intentions.

3.7. Behavioral intentions

The TPB suggests that intentions reflect the motivation to perform a given behavior and mediate the link between attitudes, PBC, as well as subjective norm and actual behavior (Ajzen, 1991). These theoretical assumptions have been validated by findings from the emerging waste minimization literature with a limitation to food waste behavior only (Stancu et al., 2016). Therefore:

H10. Behavioral intentions are positively related to waste minimization behavior.

3.8. Perceived lack of facilities

While perceived behavioral control is a constitutive variable of the TPB, perceived lack of facilities is not part of the TPB but has been added to the framework due to its high relevance for waste prevention purposes.

In previous studies applying TPB, facilities were included as a component of the PBC. However, some studies removed facilities from PBC. Indeed, previous studies in the recycling context assumed that the traditional measure of PBC is insufficient to explain an individual's recycling intentions (Chen & Tung, 2010; Davies et al., 2006; Boldero, 1995). Other studies have found that facilities influence PBC and individual's behavioral intentions to recycle waste (Liao et al., 2018; Knussen et al., 2004).

In fact, previous studies found that the presence or absence of facilities moderates the relation between TPB variables and intentions toward pro-environmental behavior, but these results remain mixed. Knussen et al. (2004) found a moderating effect of perceived lack of facilities (PLF) on the link between PBC and recycling intentions. More recently, Giannelloni and Robinot (2015) demonstrated that PLF moderates attitude and subjective norm on car use reduction in ski resorts. However, Chen and Tung (2010) found no moderating effect of the variable between PBC as well as subjective norms and intentions toward recycling. Further,

other studies found a significant direct effect of PLF on recycling behavior (Boldero, 1995; Sidique et al., 2010) and intentions to separate takeaway waste (Liao et al., 2018).

These results may suggest that individuals need to have access to dedicated facilities that make pro-environmental behavior more convenient and easier (Wan et al., 2014; Chen and Tung, 2010). Moreover, results show that this variable is the most influencing predictor among usual TPB variables (Liao et al., 2018; Davis and Morgan, 2008). Contextual factors were found to be the strongest predictor of pro-environmental behaviors and improve the predictive power of the TPB model (Davis et al., 2006; Donald et al., 2014). More precisely, it is the perception of the context that interacts with TPB variables to trigger more pro-environmental behaviors (Ertz et al., 2016, 2017). Therefore, in this study, facilities were distinguished from PBC, and the moderating effect of this variable is taken into account in the TPB model. Consequently:

H11a. Perceived lack of facilities is negatively related to intention toward waste minimization behavior.

H11b. Perceived lack of facilities has a significantly negative effect on waste minimization behavior.

H11c. Perceived lack of facilities significantly dampens the effect between TPB variables and intention toward waste minimization behavior.

Fig.1 summarizes the conceptual framework for waste minimization behavior.

[INSERT FIGURE 1 ABOUT HERE PLEASE]

4. Method

Past studies examined consumers' waste prevention predictors using questionnaire surveys (Marangon et al., 2014; Kameke and Fischer, 2018; Hu et al., 2019; Minelgaitė and

Liobikienė, 2019), qualitative methods (Graham-Rowe et al., 2014), mixed methods (Farr-Wharton et al., 2014; Rohm et al., 2017) or conceptual reviews (O'Connell, 2011; Aschemann-Witzel et al., 2015). This study uses a confirmatory approach following a hypothetico-deductive paradigm employing a questionnaire survey comprised of several measurement items aimed at assessing the different variables in the conceptual framework and other sociodemographics questions.

4.1. Study area description

The population consists of North American consumers. The choice to focus on North America (the USA and Canada) is motivated by the fact that this world region faces severe waste management issues and challenges. The United States produce more than 30% of the world's total waste though the country accounts for only 4% of the world's population (Bradford et al., 2018, p. 1). In 2014, a study by the Conference Board on a host of environmental sustainability indicators ranked Canada 15th among 17 developed nations due to the high amount of waste produced per citizen, the highest among all the studied countries (CBC News, 2014). In volume, Canadians generate approximately 31 million tons of garbage annually (CRC Research, 2014), while the United States threw out over 258 million tons of MSW over the same timeframe (Bradford et al., 2018). North American consumers constitute, therefore, a particularly appropriate population for waste minimization studies due to their high MSW generation rates.

4.1. Measurement items

The questionnaire started with items assessing the reflective constructs comprised in the study, including a six-item scale of environmental concern adapted from Kilbourne and Pickett (2008). Regarding the TPB variables, we used an eight-item scale for behavioral beliefs, a four-item scale for normative beliefs, a four-item scale for control beliefs, all three

derived from Ebreo and Vining (2001), as well as Yadav and Pathak (2017). A four-item scale measured attitudes, a six-item scale measured PBC, a six-item scale assessed intentions, and we used an eight-item ad hoc scale for ZWB. These four measures were all adapted from Ajzen (2006). Injunctive norms were measured with a four-item scale, while descriptive norms are assessed with a three-item scale, both derived from Ajzen (2006). PCE was measured with a five-item scale (Izagirre-Olaizola, 2015) and PLF with two items (Knussen et al., 2014; Chen and Tung, 2010). Except for attitude, which used semantic differential scaling, and ZWB, which was measured with a frequency scale ranging from 1 "Never" to 7 "Every day," all other items were measured with a Likert-type scale ranging from 1 "Strongly disagree" to 7 "Strongly agree." Information about measurement items, measurement scales, and references is presented in Appendix B (in the e-component file). The questionnaire also contained questions about demographics.

4.2. Sample

To access American and Canadian respondents, potential respondents were recruited through the Amazon MTurk platform. MTurk is an online crowdsourcing marketplace that comprises a large panel of potential respondents, mainly from North America and especially from the United States and Canada. Respondents aged 18 years old and over were presented with a link to the survey hosted on the Qualtrics platform for answering the questionnaire. The data were therefore collected based on random sampling using the Qualtrics platform through Amazon M-Turk. The population size of the study area comprising both the United States and Canada contains 365.8 million individuals. In the framework of this research, the final sample was composed of 455 valid responses. Table 1 provides details about the sample.

[INSERT TABLE 1 ABOUT HERE PLEASE]

5. Results

5.1. Measurement model

A confirmatory factor analysis (SPSS 26.0) estimated the measurement model. The Cronbach's alphas and Composite Reliability indices of each construct are shown in Appendix B. Both sets of indicators surpassed by far the suggested threshold of 0.700 (Hair et al., 2012). These results ensure unidimensionality and reliability for all constructs.

The factor loadings for each item were high above the 0.5 level (Hair et al., 2012) (see Appendix B). At the 0.001 level of confidence, all items proved to be statistically significant. Besides, as shown in Appendix B, the AVEs of each construct were well over the 0.500 cut-off point suggested by Nunnally and Bernstein (1994). Collectively, these results ensure convergent validity (Ringle et al., 2015). Furthermore, according to the Fornell-Larcker criterion, discriminant validity is ensured if the square root of the AVE for each construct is greater than the correlation involving that construct (Nunnally and Bernstein, 1994). As shown in Appendix C (in the e-component file), all AVEs fulfill this criterion.

5.2. The Structural Model

Given the satisfactory results obtained for the measurement model, the structural model was also tested next. First, the fit was estimated at the overall level. The fit indices indicated good overall model fit (Chisq/Df = 3.32, rms Theta = 0.104). In addition, when using PLS for path modeling, the Goodness of Fit (GoF) assesses how well a PLS path model might explain the data set at hand (Henseler and Sarstedt, 2013). We, therefore, used it in addition to the other fit indices to triangulate model specification. GoF values range from 0 to 1, with values of 0.10 (small), 0.25 (medium), and 0.36 (large) suggesting global validation of

the model (Tenenhaus et al., 2005). The GoF value of the model built in this research was 0.57, being therefore large (Tenenhaus et al., 2004), and above the 0.50 cut-off level (Tenenhaus et al., 2004), indicating the global validation of the model, which is thus parsimonious and plausible (Henseler et al., 2016).

The fit was further estimated at the local level by examining path coefficients and R^2 values. Path coefficients should be between 1 and -1, whereas results between 0.2 and -0.2 are weak (Chin, 2010). The R^2 values range from 0 to 1, with 0.1 as small, 0.25 as medium, and 0.36 as large (Wetzels et al., 2009). The testing results of path coefficients and R^2 are shown in Table 2 and Figure 2. The results show that all the path coefficients and R^2 values are statistically significant and meaningful except "DN -> INT." These results indicate high local fit and support all but two of the proposed hypotheses (i.e., H7 and H11b).

[INSERT TABLE 2 ABOUT HERE PLEASE]

Regarding path coefficients, EC is positively related to BB, NB, and CB, supporting H1a-c. In turn, BB has a significant positive effect on ATT, NB has a significant positive effect on both IN and DN, while CB is positively related to PBC, lending support to H2-4. Further, Intentions to perform a ZWB are primarily influenced by PCE and PBC, while IN and ATT exert a weaker effect on INT, and DN is nonsignificant. These results lend support to H5-6 and H8a as well as H9, but not to H7. Interestingly, albeit negative, PLF exerts a comparatively weaker effect on INT than the other predictors, suggesting that the negative effect of lack of facilities may be counterbalanced by the positive impact of other constructs, especially PCE and PBC. Finally, INT is positively related to ZWB, while the impact of PBC is somewhat weaker. Collectively, these results support H8b, H10, and H11a. Surprisingly, PLF has a positive effect on ZWB, which invalidates H11b.

An analysis of the sociodemographic control variables reveals that high PLF dampens ZWB in some sociodemographic subgroups, including retired individuals. In fact, higher PLF triggers lower ZWB among retired respondents only, especially compared to employed and self-employed individuals for whom higher PLF does not lead to less ZWB. Yet, both employed and self-employed respondents represent most of the sample, which explains the lack of negative impact of PLF, at least on ZWB, and the lack of support for H11b. Gender also seems particularly impactful on intentions since women tend to show higher ZWB intentions than males. With regards to age, the impact of attitudes on ATT on INT, BB (on ATT), CB (on PBC), DN (on INT), NB on IN and DN, environmental concern on all belief variables, and especially INT on ZWB appears strongest for people aged 56 to 65 years old. In contrast, the impact of constraining variables such as PBC, PCE, and PLF appears strongest on both INT and ZWB for the younger people, especially those aged 18 to 35 years old. The other control variables of income and education did not significantly affect the relationships in the model. The final results of the structural model with SmartPLS are presented in Figure 2.

[INSERT FIGURE 2 ABOUT HERE PLEASE]

5.3. Bootstrapping

We tested for the moderation effect of PLF on the link between INT and ZWB using Hayes' (2018) model 1 in the bootstrapping-based PROCESS macro v3.4.1. with 10,000 resamples. The indirect effects yield no t-value and p-value but a confidence interval. The value 0 must be excluded from that confidence interval for the indirect effect to be considered significant (Sperry and Widom, 2013). The results suggest a non-significant interaction effect between INT and PLF (β = -0.033 [-0.102, 0.036]) invalidating H11c.

We further tested for the mediation effect from EC to ZWB using the same PROCESS procedure except that we used model 6. Four different models were tested through each of the different mediators. The results suggest that EC exerts a significant total effect on ZWB through intentions (β = .474, p < 0.001), supporting H1d. This relationship is totally mediated by BB, ATT, and INT since the direct effect (DE) was not significant (β = 0.060, ns) while the indirect effect (IE) was significant (β = 0.474 [.299, .523]). Likewise, the relationship is totally mediated by CB, PBC, and INT with a non-significant direct effect (β = 0.053, ns) and a significant indirect one (β = 0.421 [.328, .524]). On the other hand, IN (DE: β = .105, p < 0.05, IE: β = .369 [.289, .457]) and DN (DE: β = .123, p < 0.01, IE: β = .351 [.271, .438]) only partially explain the effect of EC on ZWB. Likewise, CB and PBC on ZWB (DE: β = .201, p < 0.000, IE: β = .273 [.207, .348]), as well as INT alone on ZWB (DE: β = .160, p < 0.01, IE: β = .314 [.234, .403]) only partially explain the impact of EC on ZWB. In other words, in contrast to BB and ATT or CB and PBC, NB, IN and DN may not fully explain the effect of EC on ZWB.

6. Discussion and implications of the results

The present research has used an extended TPB model integrating essential constructs such as EC, PCE, and PLF. These factors improved to a great extent the understanding of consumer waste minimization behavior and reconciled mixed findings in topical research.

Furthermore, although this study does not use the composite measure of beliefs (i.e., BB, NB, CB), as in previous research (Bamberg, 2003; de Leeuw et al., 2015; Borges et al., 2016; Yadav and Pathak, 2017), the findings suggest significant and positive relationships between salient beliefs and their respective criterion. Hence, attitudes toward ZWB will be favorable if the consequences expected from this specific behavior are positive. Also, beliefs about the normative expectations and behavior of others have a positive influence on IN and

DN. Finally, the findings demonstrate that whenever individuals consider that they have opportunities and resources and that there are few difficulties to perform the behavior, in this case, they will tend to perceive a high control over their behavior. Additionally, few studies have included beliefs as antecedents of TPB variables, so this study uses the full TPB model while extending it meaningfully.

PCE, PBC, IN respectively influence intentions toward zero waste and ATT.

In fact, perceived consumer effectiveness (PCE), an added construct, has the most substantial impact on intentions (INT) to perform Zero Waste Behavior (ZWB). The direct effect of PCE on intentions contributes to the high share of variance explained in intentions, and intentions explain almost half of the variance of ZWB. This means that the more consumers perceive that they have the ability to make a difference concerning environmental issues, the more they intend to perform ZWB. These findings echo similar results regarding the PCE-INT link in sustainable behavior (Hanss et al., 2016) and recycling (Izagirre-Olaizola et al., 2015). Therefore, PCE is an essential factor in an extended TPB investigating ZWB.

Besides, although both PBC and ATT have a lower direct effect on INT than PCE, both variables directly mediate the impact of EC on ZWB. The indirect effect represents the amount by which the total effect of the independent variable (i.e., EC) is lowered when the mediator is introduced in the model (Ertz, Karakas, Sarigöllü, 2016). The results suggest that the effect of EC is substantially reduced when BB and ATT or CB and PBC are introduced with INT. This means that the positive effect of EC on ZWB can be fully explained by BB, ATT, and INT, as well as CB, PBC, and INT. In contrast, IN and DN only partially mediate this relationship and need, therefore, stronger EC levels to impact ZWB. In other words, consumers that are concerned about the environment will only enact ZWB if they hold a positive attitude towards waste minimization and if they perceive high behavioral control. By

contrast, their ZWB will be assured, regardless of what significant others think of waste minimization or, if important others minimize waste themselves (i.e., social pressure).

In addition, while IN has a direct effect on intentions, DN does not. Past research demonstrated that in a generic pro-environmental context, DN significantly impacts INT while IN does not (de Leeuw et al., 2015) or not as strongly (Keizer et al., 2011). This result was later contradicted in the waste minimization literature, which found that IN exerts a significant impact on INT (Stancu et al., 2016). We contribute to that literature stream by confirming the significant role of IN in predicting INT, but further show that this is not the case for DN. DN thus mirrors personal norms in their lack of significance on INT (Stancu et al., 2016). Furthermore, albeit IN has not the most potent effect on INT, it has not the weakest either, and the findings suggest that social pressure perceived by consumers has some impact on INT. The results of the present research may thus indicate that, in the study of waste minimization behavior, the use of IN might be more appropriate instead of (personal) norm, which has been found significant by some (Hu et al., 2019) and insignificant by others (Tonglet et al., 2004; Stancu et al., 2016; Li et al., 2018), or DN which have been identified as nonsignificant in this study. In sum, consumers' perceptions of how others approve of their waste minimization behavior are important (i.e., IN), but others' waste reduction behavior (i.e., DN) may not be as important. IN alone is, therefore, a useful replacement of the classic subjective norm variable of the TPB and augments the TPB relevantly for the study of ZWB.

ZWB is respectively influenced by EC (especially through a total indirect effect of that construct on ZWB), intentions, PBC, and PLF.

In fact, as another added construct, EC significantly increases consumers' salient beliefs supporting the findings of Bamberg (2003). Therefore, EC was found to exert a total indirect effect on waste minimization behavior via BB, ATT, and INT, as well as CB, PBC, and INT. These findings mean that EC is a significant determinant of ZWB and support the

work of Cox and Downing (2007) or Williams et al. (2012) about the importance of EC. In addition, these findings support Ajzen and Fishbein's (1980) reflection that general attitude cannot directly impact behavior. Thus, the consideration of EC as a primordial antecedent provides a very useful insight in this regard.

Intention emerged as the second most impactful variable for predicting ZWB. Interestingly, it comes after EC suggesting that in PEB in general, and waste minimization, in particular, intentions alone are not sufficient in predicting behavior as posited in classic TPB theory (Ajzen, 1991), and other meaningful constructs such as EC need to be considered.

More in line with classic TPB theory, PBC comes third after intentions in its impact on ZWB, which shows that while EC is an important intrinsic drive towards more ZWEB, the latitude perceived by consumers to realize the behavior which his more of an extrinsic motive plays a key role too.

As another added construct, PLF has a positive impact on ZWB, albeit the weakest one. A more detailed analysis revealed that a negative impact of PLF on ZWB was more prevalent among retirees. In contrast, this is not the case for employed and self-employed individuals who represent the majority of the sample, which explains the lack of negative impact of PLF, at least on ZWB. This negative effect for retired people compared to (self-) employed one could be related to the fact that (self-)employed people might access information on procedures to sort waste effectively or to curb resource consumption through their work environment or clients/suppliers (e.g., Zero Waste programs, top management strive for sustainable certification [LEED, Energy Star]). These may empower them with knowledge on ZWB, which could ultimately ripple into ZWB even though they do not perceive ZWB facilities near them. Being disconnected from such environments and hence knowledge on ZWB, retired people might be more dependent on access to physical facilities, whereas lack of such facilities will thus negatively impact their ZWB.

Previous research found a moderating effect of PLF studied recycling behavior (Knussen et al., 2004; Chen and Tung, 2010). Indeed, individuals will not tend to recycle if they think that they lack the infrastructure to enact recycling behaviors. However, this study reveals that PLF dampens only intentions in the context of overall waste minimization, not actual ZWB. Besides, PLF does not weaken the strong relationship between intentions to minimize waste and actual ZWB. Actually, most consumer's PLF is significantly but positively influencing their ZWB, suggesting that other situational or contextual variables may explain the behavior, such as time, money, or difficulty level (Tonglet et al., 2004). As previously mentioned, this could be due to the high share of employees and self-employed respondents in the sample for whom this effect was the most salient. Therefore, while recycling is an outcome of knowledge, access to a curbside scheme, and convenience (Tonglet et al., 2004; Barr et al., 2001), waste minimization may involve knowledge and possibly other different contextual inhibitors.

This study shows that when incorporating EC, PCE, PLF, IN, and DN to the TPB, these antecedent variables contribute, through direct and indirect effects, to explain a staggering 72.6% of the variance of intentions toward ZWB. In addition, according to the TPB model, behavioral intention is the most immediate predictor of behavior (Ajzen and Fishbein, 2005). However, only a few studies have measured actual or past waste minimization behavior. This study shows that behavioral intentions do not only predict ZWB directly, but there is also almost half of the variance of ZWB (i.e., 45.3%) that is being explained by these antecedents.

7. Managerial implications

This section presents the implications for practitioners from the results of this study. First, PCE constitutes the most impactful variable of the model, and, therefore, policies,

programs, and strategies should be adopted early on to instill the capacity to achieve waste minimization goals and objectives in consumers. Both organizations and local authorities could set up step-by-step programs with specific goals and objectives of waste minimization assorted with tools. The evolving programs could consist of small goals such as 'halving the number of bags going to the dustbin every week,' 'reusing every reusable container (e.g., glass container, plastic bag),' or 'depositing for refund 100% of refundable bottles or cans'. Since PBC appeared as a second important construct, it is also important to empower consumers by making them feel in control of the course of action to achieve the goals and objectives. To this end, the suggested programs should be assorted with relevant tools and materials guiding consumers to the relevant sources to accomplish each goal and objective encapsulated in the program. These tools and materials should address the negative effect of waste, the potential for reusing consumption waste, opportunities to minimize (over)consumption, information on low-waste offers and marketplaces (e.g., farmers' markets), as well as strategies to divert waste from the dustbin. Drawing on the power of interactivity and gamification, interactive versions of such programs could take the form of point-based applications, serious games, or platforms in which consumers may enter their waste minimization actions. Since social pressure constituted another important factor, strategists might draw on social media to encourage individuals to get social validation for their ZWB (i.e., IN) by publishing their activities to others (e.g., share). Combining interactivity and sociality should favor creating a common social norm, to which consumers will contribute and by which they will also be influenced themselves. The programs will broaden consumers' perspectives on waste reduction while providing clear-cut guidelines on achieving it.

8. Limitations and future research avenues

Although sampling procedure frames such as MTurk have been reported to be as valid as traditional methods (Casler et al., 2013; Buhrmester et al., 2016), about 80% of respondents have less than 46 years old. This higher proportion of younger respondents could be due to the data collection method as MTurk is an online platform, and younger people tend to use more predominantly such platforms. With the aging trend (Heer et al., 2020), research should therefore include more senior consumers in their study. This study did not use a composite measure to analyze behavioral, normative, and control beliefs. Besides, no pilot study was conducted to identify different beliefs since the pre-conceived variables of the TPB were used instead. This study made a certain contribution in investigating ZWB. It investigates a large number of variables quantitatively to predict waste ZWB while including additional meaningful predictors in an extended TPB framework and exploring actual ZWB. Thus, the overarching objective of this paper is to extend the TPB model to explain consumers' actual waste minimization behavior. However, self-reported behavior is used. For cross-validation and replications purposes, future studies might focus on actual waste generation, such as weighing or counting actual waste. Besides, the study measures the frequency of the behavior, but it is not sufficient to ensure the presence of the behavior (Ajzen, 2002). Future research could use panel behavior data to collect observable behavior following intentions.

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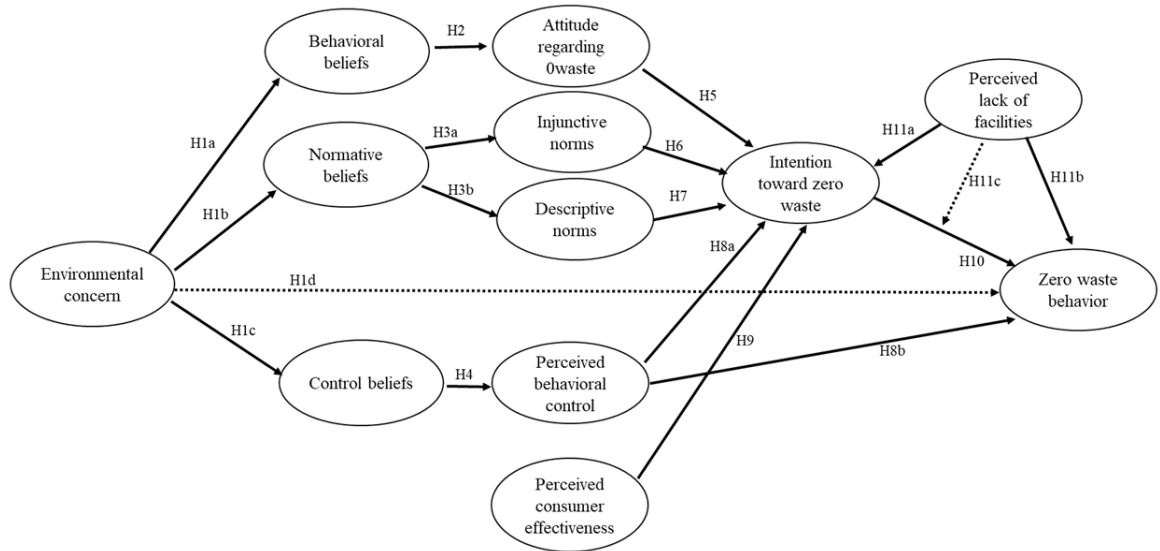
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Figure 1. Conceptual framework
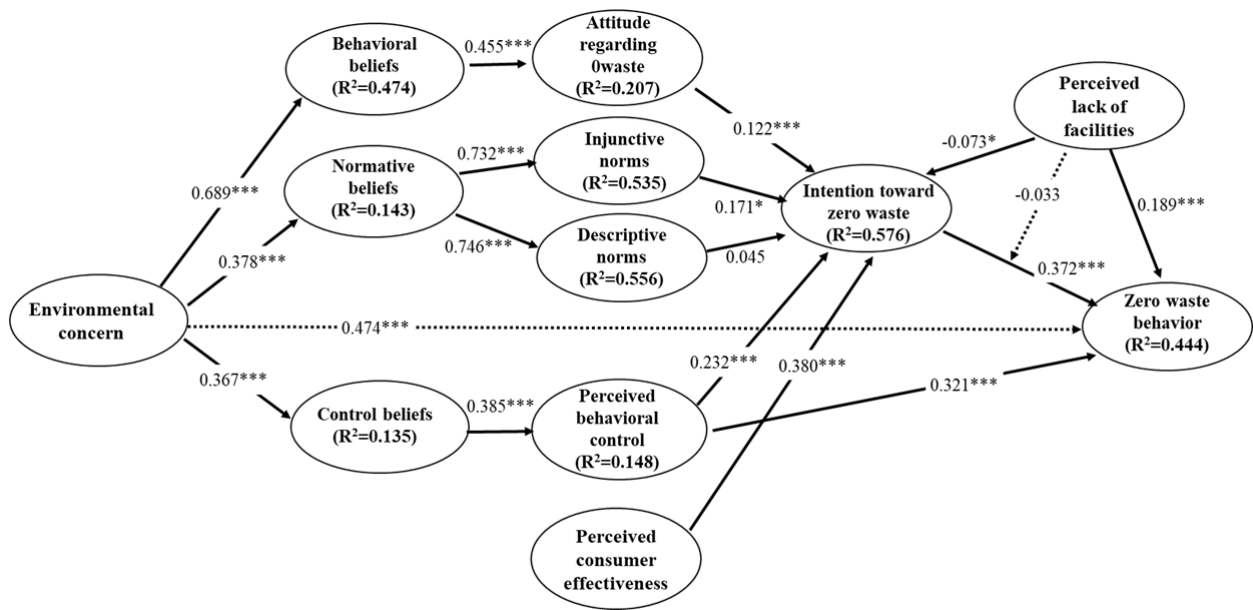
Figure 2. Results of the structural equation model

Note: *** p<0.00, ** p<0.01, * p<0.05.

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239 **Table 1.**

240 Sociodemographic information of the sample

Type	Categories	Percent
Gender	woman	44.81%
	man	55.19%
Age	18-25	14.39%
	26-35	43.40%
	36-45	22.64%
	46-55	11.79%
	56-65	5.90%
	More than 65 years old	1.89%
Education	Less than high school	0.47%
	High school graduate (includes equivalency)	9.46%
	Some college, no degree	15.60%
	Associate's degree or College degree	9.22%
	Certificate, diploma (less than Bachelor's degree)	0.71%
	Bachelor's degree	46.81%
	Master's degree	13.71%
	Doctorate (Ph.D., MD, DBA, D.Eng.)	1.89%
	Graduate or professional degree	2.13%
Profession	A student	3.77%
	Employed	77.83%
	Self-employed	11.08%
	Unemployed	4.72%
	Retired	2.59%
Income	Under 25 000 $USD	15.84%
	25 000 to 49 999 $ USD	35.22%
	50 000 to 74 999 $ USD	21.28%
	75 000 to 99 999 $ USD	15.84%
	Over 100 000$ USD	10.40%
	I prefer not to answer	1.42%

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242 **Table 2.**

243 Path coefficients and hypotheses testing

	Path Coefficients	*t*-statistics	*p*-values	Hypotheses	Testing results
ATT -> INT	0.122***	3.386	0.001	H5	Supported
BB -> ATT	0.455***	11.258	0.000	H2	Supported
CB -> PBC	0.385***	7.389	0.000	H4	Supported
DN -> INT	0.045	0.713	0.476	H7	Not Supported

EC -> BB	0.689***	18.585	0.000	H1a	Supported
EC -> CB	0.367***	7.393	0.000	H1c	Supported
EC -> NB	0.378***	7.922	0.000	H1b	Supported
IN -> INT	0.171*	2.481	0.013	H6	Supported
INT -> ZWB	0.372***	6.434	0.000	H10	Supported
NB -> DN	0.746***	30.054	0.000	H3b	Supported
NB -> IN	0.732***	27.196	0.000	H3a	Supported
PBC -> INT	0.232***	4.024	0.000	H8a	Supported
PBC -> ZWB	0.321***	5.537	0.000	H8b	Supported
PCE -> INT	0.380***	6.653	0.000	H9	Supported
PLF -> INT	-0.073*	1.992	0.047	H11a	Supported
PLF -> ZWB	0.189***	4.974	0.000	H11b	Not Supported

244   *Note*: *** p<0.001, ** p<0.01, * p<0.05.

245   Attitude regarding zero waste (ATT), Behavioral beliefs (BB), Control beliefs (CB), Descriptive norms (DN), Environmental

246   concern (EC), Injunctive norms (IN), Intention toward zero-waste (INT), Normative beliefs (NB), Perceived behavioral control

247   (PBC), Perceived consumer effectiveness (PCE), Perceived lack of facilities (PLF), Zero waste behavior (ZWB).

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