

## RESEARCH ARTICLE OPEN ACCESS

# Beyond the Bin: The Influence of Motivation, Opportunity, and Ability on Food Waste Behavior in Households

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## ABSTRACT

This study examined household food waste behavior building upon a framework that integrates the motivation-opportunity-ability model (MOA), the theory of planned behavior (TPB), and norm activation model (NAM) enriched with insights from social practices theory (SPT). Using a dual-country sample (Germany and South Africa), an online survey ( $n = 1065$ ) measured how motivation, opportunity, and ability drive self-reported food waste behavior. The results show that the ability to reduce food waste, that is, habits and perceived and actual knowledge, unfold a strong influence on reported food waste behavior. Quite surprisingly, motivation to engage in food waste reduction, due to attitude, values, and ascription of responsibility, has the lowest impact on reported food waste behavior. Our findings enhance the current understanding of food waste drivers and highlight the significance of socio-psychological determinants of behavior, specifically ability and habits. The implications for both research and practical applications are discussed.

## 1 | Introduction

In light of an increasing world population and limited production capacities in terms of water, land, and energy, feeding the world has become a global political, economic, and social issue. According to Bhatia et al. (2023), “food waste generation and management” is a major factor in increasing the sustainability of humankind through improved food security. Food waste poses a major challenge for both developed and developing countries to secure food supply. According to estimates, one third of all food produced for human consumption is lost or wasted annually worldwide (Goodwin et al. 2022). According to the Food and Agriculture Organization of the United Nations (FAO 2019, 5) food waste can be defined as a “decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers.” Food waste occurs at

different stages of the food supply chain, with approximately 61% generated in private households (United Nations Environment Programme 2021). The reasons for consumer food waste are manifold and include unnecessary, or incorrectly planned, purchases, poor storage, and the misuse of, or not using, leftovers (see e.g., Aschemann-Witzel et al. 2015).

The recent Food Waste Index Report (United Nations Environment Programme 2021) found that household per capita food waste generation is largely similar across income groups in Germany and South Africa. Until now, it has been assumed that household food waste is mostly a developed country problem, whereas developing countries mainly face production, storage, and transportation losses due to unavoidable damage (World Food Program USA 2021). However, recent research underlines the urgency of food waste reduction in high, upper

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middle and lower middle income countries alike (United Nations Environment Programme 2021).

Food waste poses major challenges for social, environmental, and economic systems. Under the shadow of the COVID-19 pandemic, food insecurity rose in most African countries, Latin America, the Caribbean, and Asia (FAO et al. 2022). In southern Africa, undernourishment rose from 5.9% of the population in 2010 up to an estimated 9.2% in 2021 (FAO et al. 2022). Every year, the amount of food wasted, which is 1.3 billion tons, exceeds three times the quantity required to nourish approximately 800 million malnourished individuals (WWF 2018). From an ecological perspective, food waste contributes approximately 8% to global greenhouse gas emissions (Jaglo, Kenny, and Stephenson 2021), while wasted and lost food accounts for 38% of the total energy usage in the global food chain (United Nations 2023). Finally, from an economic viewpoint, annual food loss and food waste amounts to \$936 billion globally (FAO 2014). It is predicted that the world population will reach 9 billion by the year 2050 while food demand will double (WWF 2018).

Because of its global importance, the body of research dedicated to different facets of food waste has been growing throughout the last years. Researchers have dedicated significant attention to the consumption stage of the food chain, concentrating either on households or on restaurants (Mondéjar-Jiménez et al. 2016; Wang et al. 2017; Wang et al. 2022). However, some researchers have dedicated their research effort to the retail stage (e.g., Jere et al. 2021; Teller et al. 2018). Since private food waste in the domestic environment is currently the main cause of food waste, the current study focuses on the aforementioned stream of research in private households. Within this line of research, much attention has been given toward examining sociodemographic variables (e.g., Ellison and Lusk 2018), such as family size (e.g., Parizeau, von Massow, and Martin 2015), income and education (e.g., Soma 2019), as well as product attributes (e.g., Williams et al. 2012). For a comprehensive review on waste

drivers and interventions, see Hebrok and Boks (2017) and Al-Obadi et al. (2022).

Although those descriptive variables might explain food waste behavior to some extent, for political and corporate interventions designed to reduce food waste to be successful, it is essential that “[...] they target the key psychological mechanisms that underpin motivations and/or barriers to household food waste reduction” (Graham-Rowe, Jessop, and Sparks 2014, 194). Food waste of individuals, like other proenvironmental behaviors, is a complex interplay between habits, emotions, and cognitions (Russell et al. 2017; Quested et al. 2013). Some researchers call for theory-driven frameworks to identify causal processes and matching interventions to stimulate food waste reduction in private households (Steg and Vlek 2009; Graham-Rowe, Jessop, and Sparks 2014). In the field of proenvironmental and prosocial behaviors, which are often associated with morality, there are three theories that are well established. These are the theory of planned behavior (TPB) (Ajzen 1991, 2002), the motivation-opportunity-ability model (MOA) and the norm-activation-model (NAM). Each theory by itself has been applied to the field of food waste behavior, using either qualitative (e.g., Soma, Li, and Maclaren 2021; Heidig and Perrupato 2021) or quantitative (e.g., Wang et al. 2022), single-country research approaches. To overcome the inherent limitations of each theory, this study responds to the call for theory integration (e.g., Bamberg and Möser 2007) by combining the socio-psychological perspectives of TPB, MOA and NAM into one integrated research framework on food waste behavior (see Figure 1). In doing so, this research lines up to a stream of recent publications that combine MOA, TPB and theory of interpersonal behavior (TIB) (e.g., Matharu, Gupta, and Swarnakar 2022), TPB and personal norms (Schmidt 2019), or NAM and situational expectancy value theory (e.g., Lee, Chang, and Zhao 2023). We adapt the model from Li et al. (2019) to the food waste realm, while using a quantitative and dual country empirical approach to test our hypotheses. According to the review by Chia et al. (2023) on

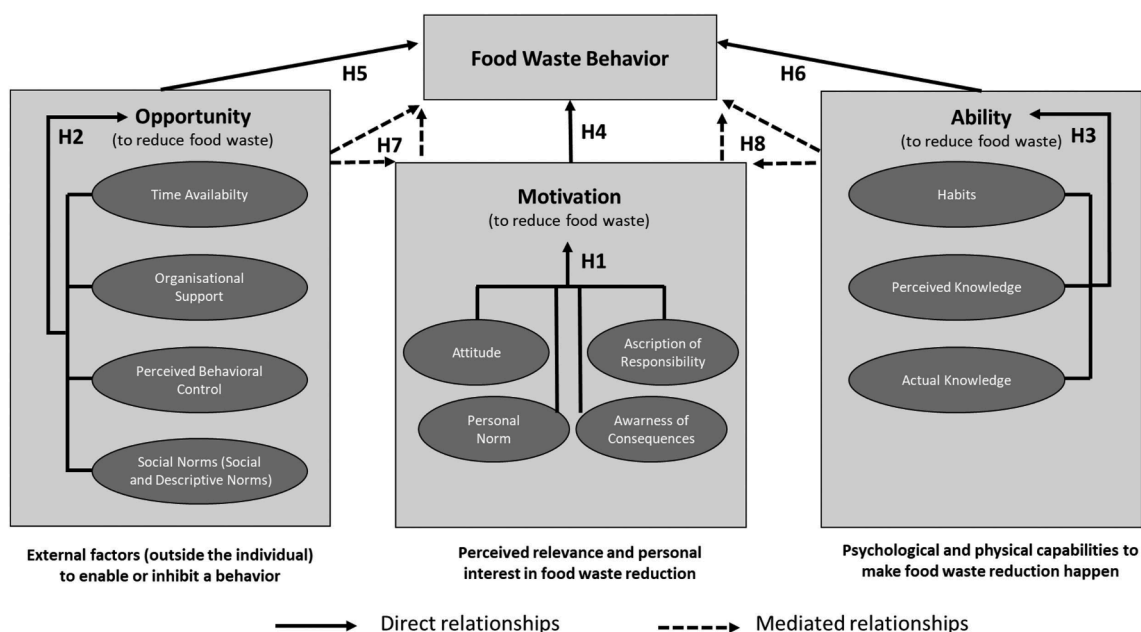


FIGURE 1 | Integrated research framework—MOA applied to food waste behavior.

country-specific drivers of household food waste, most research results originate from European countries, where shared geographical, economic, and cultural traits may result in similar influences and hindrances. This shared context could explain the positive outcomes observed in relation to food waste management interventions. However, the generalizability of these findings and interventions to areas outside of Europe remains uncertain. They call for future research that encompasses diverse regions, including Asia, North America, Africa, Oceania, Latin America, and the Caribbean.

To the best of our knowledge, this is the first study that combines empirical evidence from both a developed and a developing country with a social-psychological research approach to food waste reduction to answer the following questions:

- What are the factors that comprise motivation, opportunity and ability towards food waste behavior?
- What drives consumers' motivation to reduce food waste in their households?
- What are the inter-relationships between motivation, opportunity and ability that influence food waste behavior?

## 2 | Background and Theoretical Foundation

An individual's intention to perform a certain behavior is often explained using the TPB, where attitudes toward the behavior, norms, and perceived behavioral control drive behavioral change (Ajzen 1991, 2002). TPB heavily focuses on intention as the main antecedent to behavior and reflects the level of motivation (Graham-Rowe, Jessop, and Sparks 2014) to engage in proenvironmental behaviors such as water conservation (Fielding et al. 2012), public transportation (Heath and Gifford 2002), waste recycling (Echegaray and Hansstein 2017), energy conservation (Allen and Marquart-Pyatt 2018), as well as food waste reduction (Russell et al. 2017). For a comprehensive review also see Yuriev et al. (2020) and Klöckner (2013). In the context of food waste reduction, individuals are more likely to engage in that behavior, when waste reduction is evaluated positively (attitude), important people in their lives are expected to approve of this behavior (subjective norm) and they feel confident to perform food waste reduction properly (perceived behavioral control). According to TPB, when the intention to reduce food waste is high, so is the likelihood of performing appropriate actions.

However, research shows that stated intentions and desired actions may diverge (ElHaffar, Durif, and Dubé 2020; Kollmuss and Agyeman 2002; Peattie 2010; Sheeran 2002). This discrepancy is also known as the value-action gap, attitude-behavior gap, or intention-behavior gap. It can be identified for different proenvironmental behaviors such as sustainable consumption (e.g., Park and Lin 2020), recycling (Chung and Leung 2007), and renewable energy consumption (Bird, Wüstenhagen, and Aabakken 2002; Momsen and Stoerk 2014). Especially in the field of individual green actions, Stern (2000) points out that knowledge and habits may have a stronger influence on behavior than attitude and intention. In a similar vein, Stefan et al. (2013, 379) found that the amount of reported food waste

by study participants was not significantly impacted by the intention not to waste food. They conclude that food waste "may not be the result of conscious intentions, but instead food waste is a result of the daily routines that consumers perform."

In order to account for the predictive power of knowledge and habits for proenvironmental behaviors, the current research applies a unified framework to explain food waste reduction, while combining the MOA framework with insights from NAM-theory and TPB. The MOA framework was originally developed and applied in the field of consumer marketing to explain consumer engagement in brand information processing from advertisements and corresponding purchase behavior (MacInnis, Moorman, and Jaworski 1991). In the MOA framework, consumer behavior is the result of three main influencing factors: motivation, opportunity, and ability. According to this model, behavioral change is likely to occur when interest and desire to do so is high (i.e., motivation) while barriers that hinder the implementation are low. The latter is given when consumers face options and time (i.e., opportunity) as well as skills and knowledge (i.e., ability) to perform behavioral change (Ölander and Thøgersen 1995). In recent years, the MOA framework has been successfully employed in research on food waste behaviors. One study explored the drivers of food waste reduction using focus groups in four European countries, including Germany (van Geffen et al. 2020). In their study, the authors found that household food waste is the result of a trade-off between competing goals in everyday situations, with food waste reduction being just one out of many. The group discussions showed that limited resources like time and money, as well as insufficient planning skills in purchasing, cooking and consuming, hindered participants' engagement in even better food waste reduction. Another focus group study conducted by Soma, Li, and Maclaren (2021) in Indonesia investigated the effectiveness of food waste awareness campaigns as one tool to intervene in food waste at the household level. Their study revealed that awareness campaigns hold potential to improve motivation and ability while struggling to address opportunities to reduce food waste. Conducted with a German sample, a study by von Kameke and Fischer (2018), which examined the potential of nudging, reached similar conclusions. The studies cited are concerned with explaining food waste interventions using primarily qualitative data without accounting for intercultural differences. A recent study, conducted by Matharu, Gupta, and Swarnakar (2022), found that perceived behavioral control was the most influential motivational factor in the household food waste of Indian consumers. In order to determine the relationship between different motivational factors, the cited study used the Decision-Making Trial and Evaluation Laboratory (DEMANTEL) technique. A study applying the MOA framework to explain food waste behaviors in the South African context is currently lacking.

Recently, the MOA framework has been expanded to include elements of the NAM, such as awareness of consequence, ascription of responsibility, and personal norms (e.g., Li et al. 2019) and elements of TPB such as attitudes and norms (van Geffen et al. 2020; Soma, Li, and Maclaren 2021).

Norm activation theory, also called NAM, was originally developed by Schwartz (1977) as a theory to explain and predict altruistic and prosocial behavior like recycling (Park and

Ha 2014), environmental protection (Yan and Chai 2021), and food waste reduction (Wang et al. 2022; Iriyadi, Setiawan, and Puspitasari 2023). According to NAM, behavioral change occurs when personal moral norms are activated. NAM comprises three main predictors of prosocial behavior: awareness of consequences, ascription of responsibility, and personal norm. Awareness of consequences describes whether a person is aware of the negative consequences of not acting prosocially or proenvironmentally. Ascription of responsibility describes whether a person feels responsible for negative consequences arising from missing altruistic behaviors (De Groot and Steg 2009). Personal norm is often referred to as a feeling of moral obligation to engage or refrain from specific behaviors (Schwartz 1977). The relationship between the three factors is conceived differently in literature. In one perspective, all three factors can be arranged in sequential order with problem awareness impacting ascription of responsibility, which again impacts the personal norm and finally proenvironmental behavior. A second model, however, sees awareness of consequences and ascription of responsibility as predictors of personal norms that impact prosocial behavior (Han 2014; De Groot and Steg 2009).

While the above-mentioned theories focus on individual-level factors, food waste is a complex behavior also influenced by social and material contexts that can be best explained through the more sociological lens of social practice theory (SPT). Specifically, food waste practices unfolding in households are embedded in wider social structures of everyday life (Evans, Campbell, and Murcott 2012). We therefore also integrate insights from SPT to understand the influence of opportunity and ability on food waste behavior.

In summary, the present research joins a chain of previous publications that explain complex consumer behavior by integrating different theories and models (Li et al. 2019; Wolske, Stern, and Dietz 2017; Shi, Fan, and Zhao 2017). In order to understand the drivers of food waste reduction the following research combines measures from MOA, NAM, TPB, and SPT into one unified framework as presented in Figure 1, and which will be discussed in the following section.

### 3 | Integrated Framework on Consumer Food Waste

According to the MOA framework, the level of food waste reduction is influenced by a person's motivation, opportunity, and ability to do so. These three factors can be seen as high-level abstractions not directly observed but measured from other variables (Li, Menassa, and Karatas 2017; Li et al. 2019).

*Motivation:* From a psychological perspective, motivation can be defined as goal-directed arousal (Park and Mittal 1985), willingness, interest, or desire to process specific information (MacInnis, Moorman, and Jaworski 1991). In this research, we define motivation as the level of a person's perception of the relevance of food waste reduction and willingness to process waste reducing information. In terms of food waste reduction, motivation is a central determinant (Graham-Rowe, Jessop, and Sparks 2014). There are alternative ways the motivational factor can be conceptualized (see Ölander and Thøgersen 1995). In

order to follow the moral character of behaviors with obvious environmental impact, we adopt the three components of NAM theory to measure motivation, as well as attitude as a fourth component derived from TPB. In doing so, we follow the procedure of Li et al. (2019) who applied this conceptualization in an energy saving setting. According to this argument, the motivation to reduce food waste develops if an individual is aware of the consequences of wasting food, he or she feels accountable for food waste reduction and finally experiences moral obligation toward lowering food waste in his or her household. Besides these three factors, derived from MOA, a fourth factor, that is, attitude, from TPB, can be added to the conceptualization of motivation (Ölander and Thøgersen 1995). Attitudes reflect the degree to which the individual cognitively and emotionally evaluates a specific behavior as more or less favorable (Graham-Rowe, Jessop, and Sparks 2014). Accordingly, positive attitudes toward food waste reduction enhance motivation to translate into action. To sum up, the following hypothesis is proposed:

**H1.** *Motivation to reduce food waste is comprised of four factors, namely, (a) attitude, (b) awareness of consequences, (c) ascription of responsibility, and (d) personal norm.*

*Opportunity:* Factors with external influence on the individual can be subsumed under opportunities (Michie, van Stralen, and West 2011). Opportunities enable or impede certain actions and can be conceptualized as both subjective as well as objective influences (Ölander and Thøgersen 1995). We measure opportunity with four factors: time availability, perceived behavioral control, social norms, and organizational support. *Time availability* captures the temporal constraints in private household that allow or hinder the individual to invest extra effort in food saving. This has formed an element of opportunity since the early publications in the field of consumer research (MacInnis, Moorman, and Jaworski 1991). In the same vein, we conceptualize *perceived behavioral control* (from TPB) as a form of perceived constraint through the individual. Li et al. (2019) used this variable as a measure for ability. However, we argue that the feeling of control over reducing food waste in a household is often determined by one's role (e.g., responsible for grocery shopping) within a family structure. Therefore, perceived behavioral control can be interpreted as the result of structural preconditions varying between households and thereby creating different opportunities to engage in food waste reductions. Also, in line with TPB, normative factors shape conditions outside the control of the individual. *Social norms* can be differentiated into descriptive and subjective norms (Li et al. 2019). While descriptive norms display an individual's perception of other people's food waste behavior, subjective norms are made up from perceived expectations of important others (Russell et al. 2017). Finally, this study considers *organizational support* to reflect the structural nature of opportunity. This consideration is in line with Li et al. (2019), who found empirical support for the assumption that a company's commitment toward energy saving is a construct of opportunity and positively enhances energy-reducing behaviors of individuals. In the context of food waste, organizational support can be interpreted as food retailers' and food producers' actions and campaigns that incentivize customers to reduce food waste. This support includes activities such as classic information campaigns, over package sizing, and workshops (for more information also see DEFF and CSIR 2021).

**H2.** *Opportunity to reduce food waste is comprised of four factors, namely, (a) time availability, (b) perceived behavioral control, (c) social norm, and (d) organizational support.*

*Ability:* For motivations to translate into actions, an individual needs certain psychological and mental abilities to act. The ability construct in the MOA model can be operationalized with task knowledge and habits (Ölander and Thøgersen 1995). First, *task knowledge* covers the mental capability to engage in proenvironmental behavior. Missing knowledge on how to plan, store and conserve food impedes food waste reduction. Task knowledge can be differentiated into perceived and actual knowledge. While perceived (or subjective) knowledge refers to an individual's perceptions of his or her knowledge-level, actual (or objective) knowledge refers to how much an individual actually knows (Han 2019). Secondly, *habits* can be defined as routines that "make us capable of performing the task in a nearly automatic fashion, employing a minimum of conscious attention" (Ölander and Thøgersen 1995, 364). Consuming food and creating food waste is a daily routine and often habitual (Russell et al. 2017). Past research has shown that habits in general and food waste disposal in particular have a pronounced emotional component (Quested et al. 2013) and a strong influence on motivation and behavior (Ölander and Thøgersen 1995). Studies relying especially on SPT highlight the importance of food-related procedures for food waste generation in domestic practices (Wahlen 2011). Household routines that contribute to food provision, as well as to food waste, encompass planning, shopping, storing, cooking, eating, and management of leftovers (Wahlen and Winkel 2017). Throughout these stages, food items may be evaluated for their edibility, leading to either waste or redistribution (Schanes et al. 2018). Therefore, we assume that existing habits on food disposal (i.e., performing smell and taste checks before disposal) capture one's ability to perform food waste reduction.

Therefore, consistent with the MOA model we expect that habits, actual and perceived knowledge will account for significant variances in ability. Thus:

**H3.** *Ability to reduce food waste is comprised of three factors, namely, (a) actual knowledge, (b) perceived knowledge, and (c) habits.*

Also, in line with the MOA model, we expect that the effect of opportunity and ability on food waste behaviors will be mediated by motivation, meaning that motivation only translates into action when opportunities are given, and abilities are present (Ölander and Thøgersen 1995). Motivation without opportunity and ability will not lead to food waste reduction, and neither will opportunity and ability without motivation. It should be noted that we measured food waste behavior, and not food waste reduction, and therefore we hypothesize that if, for example, motivation increases, then food waste behavior would decrease. This explains why the next three hypotheses suggest negative relationships between the MOA components and food waste behavior.

**H4.** *Motivation to reduce food waste has a negative and direct effect on food waste behavior.*

**H5.** *Opportunity has a negative and direct effect on food waste behavior.*

**H6.** *Ability has a negative and direct effect on food waste behavior.*

**H7.** *The effect of opportunity on food waste behavior will be mediated by motivation.*

**H8.** *The effect of ability on food waste behavior will be mediated by motivation.*

## 4 | Research Methodology

The study used a quantitative, descriptive approach, with an e-mailed questionnaire in a cross-sectional survey of quota samples in Germany and South Africa.

### 4.1 | Study Area

In order to fulfill the call for food waste research in diverse countries, South Africa and Germany were used as study areas. These two countries mainly differ in terms of geographical, economic, and cultural aspects, thereby expanding existing research with single-country-approaches. South Africa is recognized as a developing economy (Marnewick and Bekker 2022), while Germany clearly is a developed economy. In addition, a further reason for the choice of these countries is that trade between Germany and South Africa indicates the inter-relationship between these two countries and their importance to each other. Germany is South Africa's third biggest export partner and the second biggest importer into South Africa (South African Revenue Service 2023). The comparative GDP per capita for the two countries are US\$6684 (South Africa) and US\$48,756 (Germany) (Countryeconomy.com 2023), which suggests that food waste might be more important, but less prevalent, in South Africa than in Germany. This is supported by the differing Gini coefficients (31.7 for Germany and 63.0 for South Africa) as discussed in the next section. Furthermore, there are considerable cultural differences between the two countries (Schnalke and Mason 2014), thus avoiding countries that are too homogeneous. For these reasons, Germany and South Africa make a good location for studying food waste in developed and developing countries.

### 4.2 | Respondents

The German population for this research comprised individuals aged 18 and above. Since the Gini coefficient of 31.7 for Germany (The World Bank Group 2019) implies a wealthy population, most Germans are probably aware of the food wastage problem and the necessity for waste reduction. Therefore, a quota based primarily on age (18 and above), plus income and gender was selected.

The Living Standards Measure (LSM) system of segmentation has been used in South African research for a number of decades (Lappeman et al. 2021). It excludes income, as this has been associated with race, and instead focuses on factors influencing lifestyle standards. South Africa's high Gini coefficient

of 63.0 (The World Bank Group 2019) implies that consumers in the lower LSM categories probably live a survival existence and thus probably pay little attention to the concept of food waste. In addition, the lower LSMs, 1–4, are 80%–100% rural with low incomes and little purchasing power, particularly regarding food products. Therefore, the mainly urban LSM groups 5–10 (Chronison 2012) were chosen as the South African population for this research.

Because of certain demographic shifts upwards in the LSM categories, as consumers have become wealthier over the past 30 years (Kantar TNS 2019; Langschmidt 2017), we used the newer ES Socio-Economic Measures (SEM) to allow for the demographic changes in South Africa (Reidon 2018). The proportions from the SEM categories were applied, instead of the LSM proportions, to create our quota sample. This process is illustrated in Table 1. We chose not to use SEM as a sampling tool as it is so new that databases of respondents are not yet readily available for use. The only real differences appear at the lower end (i.e., LSMs 1–4) (Muller 2017), which are excluded from our study. The result is a quota profile of individuals as presented in Table 1.

The geographical spread of the sample, with regard to the provinces in South Africa and the federal states in Germany, is according to the size of the population in these provinces and states. A research company, using their online panel of registered clients who provide personal information like age, gender, income, and address, guaranteed that the samples would meet the quota criteria mentioned above. This was achieved by sending out accordingly targeted emails and continuing data collection until the quota criteria were met.

The online panel members chose whether to participate or not, so this was a self-selected sample, that is, it was nonprobability. According to Bless, Higson-Smith, and Sithole (2013), bias or nonresponse error can result from self-selection sampling, but the reasonable spread of respondents shown in Table 2 indicates a low likelihood of such bias or error.

A *t*-distribution needs a sample size of 385.16 (excluding correction factor) (Sekaran and Bougie 2013). This is determined for a 95% level of confidence, assumed variance of 1 and allowed error of 0.1 (for a 7-point Likert-type scale). To allow for incomplete or otherwise unusable responses a sample size of 550 was set for each country. The size of the final, useable samples was 529 for South Africa and 536 for Germany, which is considerably above the identified minimum of 385.

**TABLE 1** | Adjusted sample quotas and achieved sample.

	LSM 5	LSM 6	LSM 7	LSM 8	LSM 9	LSM 10	Total
LSM % of SA population	22	34	11	5	6	3	81
SEM % applied to SA population	20.8	18.8	18.8	14.6	12.4	14.6	100
<i>N</i> of LSM 5–10 quota sample	114	104	104	80	68	80	550
<i>N</i> of sample achieved	110	94	101	79	69	76	529
% of sample achieved	20.8	17.8	19.1	14.9	13.0	14.4	100

Abbreviation: LSM, Living Standards Measure.

### 4.3 | Measures and Derivation of Data Collection Instrument

The questionnaire was developed from previously validated sources in the relevant literature, as illustrated in Supporting Information: Appendix A (Bless, Higson-Smith, and Sithole 2013). The questions covered behavior, motivation, opportunity, and ability variables. All multiple item scales were computed by averaging all scale items with higher values representing higher presence of a construct. Cronbach's coefficient alpha was used to assess reliability with a coefficient of 0.7 or higher considered reliable (Sekaran and Bougie 2013). As shown in Table 3, coefficients above, or very close to, 0.7 were obtained for all the dimensions. Therefore, the instrument was accepted as reliable.

*Food waste behavior* was measured via self-reporting, due to the nature of the study and practical data collection difficulties, rather than via observational measures. This approach is discussed further in Section 7.2. This self-reported food waste behavior (hereafter referred to as just food waste behavior for simplicity sake) was thus measured using two items, following past research on habitual food waste behavior (Russell et al. 2017). We operationalized food waste behavior with the frequency and quantity of discarded food categories in the past. The participants were asked to indicate (1) “How regularly do you think food is thrown away in your household (e.g., as a result of cooking too much or food spoiling)? (1 = *never*, 7 = *most mealtimes*)” as a measure of frequency. Quantity of food categories waste was assessed with (2) “Over the past week have you thrown out the following items? Please tick all that apply (fruit, vegetables, dairy products, grain products (e.g., bakery products), meat, poultry, fish products).” Answers to this question were summed to provide an index of food waste behavior. “How regularly food is thrown away” had a 7-point scale, while “which products are thrown away” had 7 different categories. According to the number of product groups thrown away, a number up to 7 was allocated. Thus, both questions had the same scale, but with a different starting point, and the index could thus be generated as the mean value of the 2 questions. Since one scale is from 1 to 7 and the other from 0 to 7 the lowest potential value of the scale is 0.5 and the highest 7.0. Thus, both items together result in an overall index of food waste behavior, with lower values indicating reduced food waste.

According to our framework, motivation to reduce food waste was conceptualized with attitude, awareness of consequences,

**TABLE 2** | Demographic profile of respondents.

Dimension	Category	Total		South Africa		Germany	
		<i>f</i>	%	<i>f</i>	%	<i>f</i>	%
Gender	Female	557	52.3	281	53.1	276	51.5
	Male	508	47.7	248	46.9	260	48.5
Age	18–24	153	14.4	113	21.4	40	7.5
	25–34	311	29.2	225	42.5	86	16.0
	35–49	257	24.1	133	25.1	124	23.1
	50–59	192	18.0	45	8.5	147	27.4
	60+	152	14.3	13	2.5	139	25.9
Household size (no. of people)	1	171	16.1	17	3.2	154	28.7
	2	260	24.4	50	9.5	210	39.2
	3	215	20.2	118	22.3	97	18.1
	4	211	19.8	159	30.1	52	9.7
	5	110	10.3	94	17.8	16	3.0
	6+	98	9.2	91	17.2	7	1.3
Education	None, some, or all primary	83	7.8	0	0.0	83	15.4
	Some high school	233	21.9	27	5.1	206	38.4
	High school/matriculation	274	25.7	170	32.1	104	19.4
	Technikon	198	18.6	120	22.7	78	14.6
	University degree	262	24.6	198	37.4	64	11.9
	Other post matric	15	1.4	14	2.6	1	0.2
Monthly household net income	R0–R8000/€0–€1250	177	16.6	96	18.1	81	15.1
	R8001–R18,000/€1250–2000	273	25.7	162	30.6	111	20.7
	R18,001–R37,000/€2001–3000	291	27.3	164	31.0	127	23.7
	R37,001–R63,000/€3001–5000	224	21.0	78	14.7	146	27.2
	More than R63,000/€5000	100	9.4	29	5.5	71	13.2
Total		1065	100.0	529	49.7	536	50.3

Note: R = South African Rands; € = Euros.

**TABLE 3** | KMO and Bartlett's tests for factor analysis.

		Motivation	Opportunity	Ability
Kaiser–Meyer–Olkin measure of sampling adequacy		0.899	0.798	0.781
Bartlett's test of sphericity	Approx. chi-square	5432.307	5432.307	2507.892
	<i>df</i>	66	66	45
	Sig.	0.000	0.000	0.000

ascription of responsibility, and personal norm. *Attitude* toward food waste reduction was assessed with six semantic differentials, asking participants to indicate their opinion on

“I think that reducing food waste in my household is ...” (bad/good, unimportant/important, not-beneficial/beneficial, unpleasant/pleasant, useless/useful, worthless/valuable). This

was mostly adapted from Russell et al. (2017) with slight modifications to improve understanding. Responses for these questions were structured according to 7-point scales (e.g., 1 = *very bad*, 3 = *neutral*, 7 = *very good*). *Awareness of consequences* was measured using two items (1) “When I reduce food waste in my home, I do something good for society” and (2) “When I reduce food waste in my home, I do something good for the environment”. Additionally, *ascription of responsibility* was assessed through the following items: (1) “Because my personal contribution would be negligible, I do not feel responsible for food waste in my country” and (2) “Companies such as producers and retail, not me, are responsible for food waste in my country”. Finally, *personal norm* was operationalized with two measures (1) “Regardless of what others do, I feel morally obligated to reduce the waste of food in my home” and (2) “I feel guilty when I throw away food”. Measures for awareness of consequences, ascription of responsibility, and personal norms are similar to those used in previous research (Li et al. 2019) but were shortened and adapted slightly to suit food. They were assessed using 7-point scales (1 = *completely disagree*, 7 = *completely agree*).

*Opportunity* to reduce food waste was conceptualized with time availability, perceived behavioral control, social norm, and organizational support. *Time availability* was measured using three items. These items were adapted from Li et al. (2019) for home instead of work application and included: (1) “I have little time to pay attention to reducing food waste at home”, (2) “I usually have a lot of work to do at home, I cannot make extra efforts to save food (e.g. through conservation)”, and (3) “I don’t have extra time during weekdays to think about ways to reduce or avoid the waste of food”. *Perceived behavioral control* was assessed through three standard TPB items (Russell et al. 2017): (1) “Regarding how much I have over whether I reduce food waste in my household, I have... (1 = *very little control*, 7 = *a great deal of control*)”, (2) “Regarding how difficult it is to reduce food waste in my home, I find it... (1 = *very difficult*, 7 = *very easy*)” and finally, (3) “It is mostly up to me whether I reduce food waste in my home.” Similar to other measures of *social norms* (Carrus, Passafaro, and Bonnes 2008; Li et al. 2019), we used one item to assess descriptive norms (“Many people that are important to me are trying to avoid food waste”) and two items for subjective norms (1) “Most people important to me expect me to reduce food waste” and (2) “Most people important to me think I should avoid food waste at all.” The Carrus questions were adapted to food use instead of public transportation. *Organizational support* was measured through items influenced by the Li et al. (2019) questions that focused on employers’ support for employees in food saving. We adapted or developed items more relevant to producers’ or retailers’ support for consumers’ food saving actions. Thus, the following three items were created to assess country-specific encouragement by producers and retailers to reduce private food waste: (1) “Food producers in my country make it easy for me to reduce food waste (e.g. through package size, portioning, durability),” (2) “Food retailers in my country create incentives so I do not overstock food,” and (3) “Food producers and/or retailers inform me how to safe food from being wasted (e.g., through newsletters, campaigns, product reminders).” Unless otherwise mentioned we used 7-point scales (1 = *completely disagree*, 7 = *completely agree*).

Participants’ *ability* to reduce food waste was conceptualized through actual knowledge, perceived knowledge, and habits. In line with existing knowledge research (Han 2019), we measured their *perception of food-waste relating knowledge* with three items: (1) “I know which products belong in which compartment, or part, of the refrigerator, so that they stay fresh for a long time,” (2) “I know the difference between the ‘use-by-date’ and ‘best-before-date’ on food,” and (3) “I know ways to make food durable (1 = *completely disagree*, 7 = *completely agree*).” However, to determine participants’ *actual knowledge*, we asked them to rate the extent the following facts are true: (1) “Meat products belong on the top shelf of the refrigerator,” (2) “Food that has passed its ‘best before date’ is safe to eat,” and (3) “In the freezer, vegetables can stay fresh for at least 15 months (1 = *completely false*, 7 = *completely true*).” While the first statement is false (reverse coded), the remaining statements are true. The perceived and actual knowledge questions were adapted from Li et al. (2019) for food application instead of energy application. In order to measure food disposal *habits*, we used the Self-Report Behavioral Automaticity Index, that has proven a valid instrument (Gardner et al. 2012), asking the participant: “Before disposing food, a smell and taste check is something... (1) I do automatically, (2) I do without having to consciously remember, (3) I do without thinking, and (4) I start doing before I realize I am doing it (1 = *completely disagree*, 7 = *completely agree*).”

#### 4.4 | Data Collection—Administration of Instrument

Face and content validity was assessed by two of the authors, who are subject matter experts, and the third author who is a statistical expert. A detailed deconstruction and analysis of the questionnaire and examination of each variable’s compositional questions for logical and consistent meaning was conducted. The questionnaire was then pilot tested in South Africa for face validity with 12 consumers matching the quota criteria. As a consequence, an explanation was included in the questionnaire introduction and a few improvements to sentence construction and spelling were made. One of the German-speaking researchers translated the questionnaire into German, and it was then checked for translational equivalence (Hair Jr. et al. 2003). This German questionnaire was then pilot tested in Germany with German consumers matching the German quota profile. This also identified some minor wording and phrasing changes. Finally, a live, online pretest was conducted with 58 South African and 54 German consumers selected via the quota criteria mentioned previously. This then indicated that the questionnaire was acceptable. Construct validity was achieved via the exploratory factor analysis (EFA) as discussed in Section 4.2. The EFA (see Supporting Information: Appendix B) shows that the constructs are accurate representations of the issues being studied.

The questionnaire was forwarded to the research company who e-mailed it, with an embedded link to the questionnaire, to their opt-in panel of German and South African consumers as per the quota criteria. This was repeated over the period 24 September–24 October 2022 until the quotas were complete. Each panel member received only one invitation to this study

and could only participate in research once every 2 months, thus avoiding practice bias. Self-selection bias was avoided as the study's topic was not shown in the initial invitation to participate (George 2010).

#### 4.5 | Data Analysis

A total of 1100 completed questionnaires (550 each for Germany and South Africa) were received and analyzed using SPSS version 25. Quality checks rejected 34 responses due to their violation of the quality criteria of insufficient data, contradictory answers, and insufficient time spent answering. This left 529 South African and 536 German valid responses.

Analysis was done by applying univariate descriptive statistics, EFA, and simple and multiple regression analysis, with the latter being used to identify relationships between the variables.

### 5 | Results

The findings resulting from the analysis are presented in this section. First, a profile of the sample is presented, followed by the descriptive statistics and then the detailed analysis for each of the research questions.

#### 5.1 | Profile of Sample Demographics

The final, useable responses for South Africa, Germany, and the total sample, according to the six demographic categories, are provided in Table 2.

This demographic profile shows the sample distribution for both Germany and South Africa to be similar to the population distributions. As the German sample was based on German

population proportions, and as data collection continued until the quotas were filled, this similarity is to be expected. The South African sample matches the LSM groups (see Table 1), the proportions of which are based on the SA population distribution. The German sample proportions differ marginally from the South African population, with the female proportion of the sample (53.1%) being slightly larger than in population (51.0%) (StatsSA 2020). This is because LSMs 6, 7, 8 and 9 are biased toward females (Living Standards Measure 2017) and because females more often do the shopping in emerging, or developing, countries. For example, females account for 59.0% of mall shoppers in South Africa (Docrat 2007). Therefore, the achieved sample was accepted as sufficiently representative of the two populations.

#### 5.2 | Exploratory Factor Analysis

EFA, without presetting the number of factors, and based on principal component analysis using Varimax rotation with Kaiser normalization and an extraction base of eigenvalue > 1, was used to check the constructs and statements developed from the literature. The Kaiser–Meyer–Olkin measures of sampling adequacy were good (0.781 and 0.798) or very good (0.899), and the Bartlett's tests of sphericity were statistically highly significant ( $p < 0.000$ ), for all three factor analyses, as shown in Table 3.

The final factor loadings for these three constructs, and their factors, are listed in Supporting Information: Appendix B, showing that they are accurate representations of the issues being examined in this study.

The initial factor analysis showed that, as indicated by the literature, motivation is comprised of attitude, subjective norms, and ascription of responsibility. Awareness of consequences and personal norms loaded clearly as one factor, and therefore, has been included in the analysis as a new factor that we have called

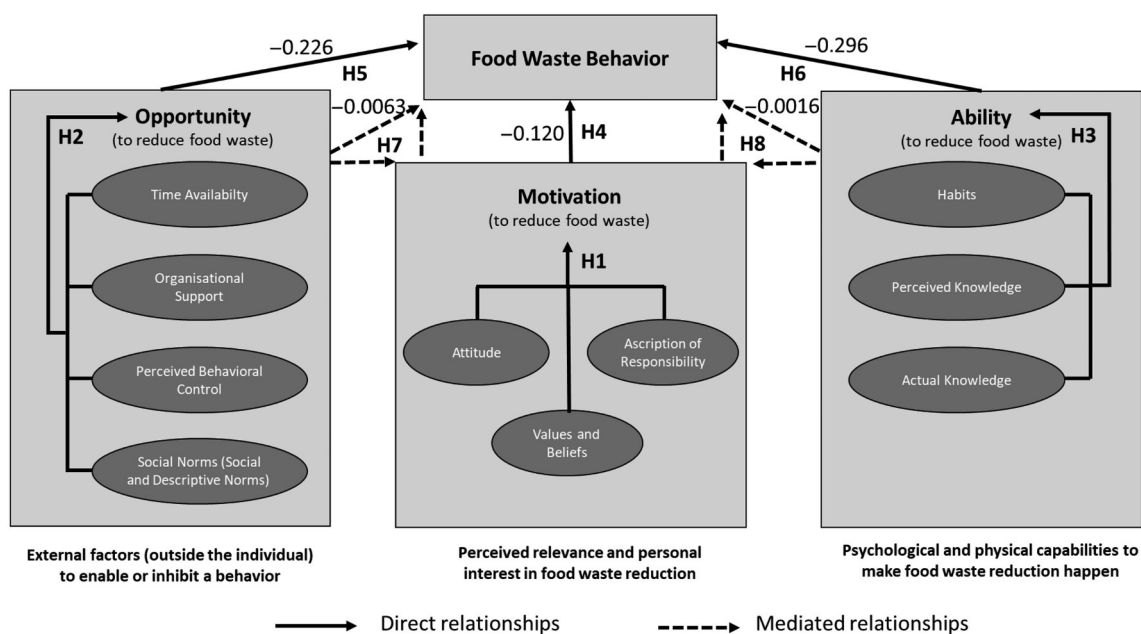


FIGURE 2 | Revised integrated framework—MOA applied to food waste behavior—with beta values.

“values and beliefs.” For both opportunity and ability, all factors loaded accurately as per the literature. The detailed results of the final EFA are shown in Supporting Information: Appendix B and a new revised integrated framework, based on the EFA, is presented in Figure 2.

### 5.3 | Reliability

A Cronbach's coefficient alpha of 0.7 or higher was the criterion set for reliability (Sekaran and Bougie 2013). Table 4 shows that coefficients above, or very close to, 0.7 were obtained for most constructs. The only exception is a value of 0.555 for actual knowledge, which must be seen as critical, but is acceptable in this early stage of research. The value can be explained as being due to the different areas of knowledge. Some people with

a high (7) knowledge in the “vegetable” question have a low (1) knowledge in the meat question (35%). This could be reasonable when the person is, for example, a vegetarian. Taking this into consideration the measurement of actual knowledge should be improved in further research. Therefore, the instrument was accepted as reliable.

### 5.4 | Descriptive Statistics

Based on the revised integrated framework, the means and standard deviations for each construct and the associated subconstructs for the total sample are provided in Table 5.

With regard to the dependent variable of the study, “food waste behavior,” the key descriptive statistics of the two component

**TABLE 4** | Reliability of constructs.

Construct	Subconstruct	Explained variance	Cronbach's alpha	Interpretation
Motivation (explained variance 68.07)	Attitude	33.95	0.909	Excellent
	Ascription of responsibility	21.72	0.639	Questionable
	Values and beliefs	12.41	0.802	Good
Opportunity (explained variance 73.89)	Time availability	20.89	0.889	Good
	Organizational support	18.33	0.809	Good
	Perceived behavioral control	18.18	0.725	Acceptable
	Social (subjective and descriptive) norms	16.49	0.817	Good
Ability (explained variance 60.94)	Actual knowledge	26.74	0.555	Poor
	Perceived knowledge	19.61	0.710	Acceptable
	Habits	14.59	0.834	Good

**TABLE 5** | Descriptive statistics (N: SA = 529; Germany = 536; Total = 1065).

Construct	Mean	Std dev	Subconstructs	Mean	Std dev
Food waste behavior	2.12	1.324	Frequency—how regularly food thrown away	2.77	1.390
			Quantity—type of products thrown away	1.47	1.584
Motivation	5.20	0.830	Attitude	5.98	1.179
			Ascription of responsibility	3.63	1.821
			Values and beliefs	5.99	1.150
Opportunity	4.92	0.957	Time availability	4.68	2.009
			Perceived behavioral control	5.78	1.145
			Organizational Support	3.96	1.668
			Social norms (subjective and descriptive)	5.26	1.485
Ability	5.01	0.905	Perceived knowledge	5.71	1.179
			Actual knowledge	4.14	1.368
			Habits	5.19	1.469

Note: Scale ranges: food waste behavior is 0.5–7 (e.g., 0.5 = no food waste to 7 = high food waste) and for all others scale range is 1–7 (e.g., 1 = no motivation to 7 = high motivation).

subvariables (frequency of throwing away and type of products thrown away) according to the two countries, are provided in Table 6.

These descriptive statistics indicate that fruit and vegetables are the most frequently disposed of food products, while meat, fish, and poultry are the least disposed of. Throwing “nothing” away in the past week was claimed by about one in five respondents. Of further interest is the fact that South Africans threw away food products in the past week significantly more frequently than Germans, with the exception of fruit products.

## 5.5 | Regression Analyses

In order to assess the remainder of the hypotheses, regression analysis was used to identify the influence of the various predictor variables on the dependent variable, “food waste behavior.”

### 5.5.1 | Single Regressions

To assess H4–H6, single regressions with ANOVA compare the influence of predictor variables (motivation, opportunity, and ability) on the dependent variable (food waste behavior). These results are provided in Table 7. All these regressions satisfied the requirements for valid analysis—the Durban Watson values between 1.121 and 1.824, all tolerance values >0.094. The plot of standardized estimated values against standardized residuals did not show any major violations of homoscedasticity, and Q-Q diagrams had no major violations of normally distributed residuals.

Regarding H4, the  $R^2$  is extremely low but significant, the beta value is satisfactory, and the Durban Watson value is acceptable, providing a slight indication of positive autocorrelation.

Regarding H5, the  $R^2$  is very low but highly significant, the beta value is satisfactory, and the Durban Watson value is acceptable, providing a slight indication of positive autocorrelation.

**TABLE 6** | Food waste behavior descriptive statistics ( $N$ : SA = 529; Germany = 536; Total = 1065).

How regularly do you think food is thrown away in your household (e.g., as a result of cooking too much or food spoiling)?					
Germany	$N$	%	South Africa	$N$	%
1—Never	72	13.4%	1—Never	84	15.9%
2	236	44.0%	2	172	32.5%
3	107	20.0%	3	127	24.0%
4	55	10.3%	4	76	14.4%
5	40	7.5%	5	47	8.9%
6	15	2.8%	6	11	2.1%
7—Most mealtimes	11	2.1%	7—Most mealtimes	12	2.3%
	Mean	Std dev		Mean	Std dev
	2.71	1.370		2.83	1.409

Over the past week have you thrown out any of the following items?						
	$N$	%	% of cases	Germany	SA	Difference
Vegetables	374	19.4%	35.1%	28.2%	42.2%	Hi sig
Fruit	339	17.6%	31.8%	35.4%	28.2%	Hi sig
Dairy products	252	13.1%	23.7%	19.6%	27.8%	Sig
Grain products	251	13.0%	23.6%	21.6%	25.5%	Hi sig
Meat	164	8.5%	15.4%	11.2%	19.7%	Not sig
Fish products	93	4.8%	8.7%	4.7%	12.9%	Hi sig
Poultry	92	4.8%	8.6%	6.2%	11.2%	Hi sig
Nothing	366	19.0%	34.4%	41.6%	27.0%	Hi sig

Food waste behavior index (0.5: little food waste—7: high food waste)				
	Total	Germany	South Africa	Diff—SA – Ger
Mean	2.120	1.989	2.252	0.26 (Hi sig)
Std dev	1.324	1.286	1.350	
Cohen's $d$ value (strength of effect)				0.2 (Small)

Regarding H6, the  $R^2$  is low but highly significant, the beta value is satisfactory, and the Durban Watson value is acceptable, providing a slight indication of positive autocorrelation.

### 5.5.2 | Multiple Regressions

To assess H7 and H8, the influence of opportunity and ability, mediated by motivation, on food waste behavior was calculated with multiple regression. These results are presented in Table 8.

Regarding H7, the  $R^2$  is very low but highly significant, the beta value is satisfactory, and the Durban Watson test is acceptable, indicating a slight positive autocorrelation. The significant, direct influence of opportunity on food waste behavior is  $-0.226$  and the significant influence within the multiple regression is  $-0.219$ . Thus, the total effect of opportunity on food waste behavior of  $-0.226$  can be split into a direct effect of  $-0.2194$  and an indirect/mediating effect of motivation of  $-0.0063$ . Thus, H7 can be verified with a small mediating effect of motivation.

Regarding H8, the  $R^2$  is also very low but highly significant, the beta value is satisfactory, as is the Durban Watson test, which indicates slight positive autocorrelation. The significant, direct influence of ability on food waste behavior is  $-0.296$  and the significant influence within the multiple regression is  $-0.294$ . Thus, the total effect of ability on food waste behavior of  $-0.296$  can be split into a direct effect of  $-0.294$  and an indirect/mediating effect of motivation of  $-0.0016$ . Thus, H8 can be verified with a strong mediating effect of motivation.

## 6 | Discussion

The findings from this study are presented below, relative to the research objectives, as well as a comparison of these results against those of previous studies, which, as previously mentioned, mostly took place in developed countries. This discussion is also structured according to the eight hypotheses,

with an indication of the acceptance or otherwise of these hypotheses.

### 6.1 | What Factors Comprise Motivation, Opportunity, and Ability for Food Waste Behavior?

As can be seen from the factor loadings in Supporting Information: Appendix B for motivation, our findings agreed with our conceptualization regarding attitude and ascription of responsibility as components of motivation. However, we found that awareness of consequences and personal norm loaded as a single factor. We propose the following reason for this result: the three factors, awareness of consequences, ascription of responsibility and personal norm, were derived from NAM. According to Schwartz (1977), awareness of consequences of an individual's proenvironmental behavior activates a personal norm that determines a person's intention to act proenvironmentally. It seems that, in the field of food waste, awareness of doing something good for society and the environment is more closely linked to one's personal norm in the sense of feeling obligated to reduce food waste than in other proenvironmental settings (e.g., energy-saving behaviors). For this reason, we assume that awareness of consequences and personal norms are so closely interlinked that they appear as one factor in our analysis. Therefore, H1 can only be partially accepted, since motivation was shown to be composed of only three factors, attitude, ascription of responsibility, and the new factor that we named values and beliefs.

H2 is accepted, as our study confirmed the literature findings that opportunity is comprised of time availability, perceived behavioral control, social norm, and organizational support. This is shown by the factor loadings for opportunity in Supporting Information: Appendix B reflecting the same four factors as identified by the literature.

For the second hypothesis, it is interesting that the factor loadings for the dimensions time availability, perceived behavioral control, social norm and organizational support are high and clear. There are no substantial cross-loadings—the highest,

TABLE 7 | Single regressions for motivation, opportunity and ability.

		$R^2$	Beta	Sig	Durban Watson
H4	Motivation → food waste behavior	0.006	$-0.120$	$<0.014$	1.143
H5	Opportunity → food waste behavior	0.027	$-0.226$	$<0.001$	1.174
H6	Ability → food waste behavior	0.048	$-0.296$	$<0.001$	1.121

TABLE 8 | Multiple regression of opportunity and ability, mediated by motivation.

		$R^2$	Beta	Sig	Durban Watson
H7	Opportunity and motivation ⇒ food waste behavior	0.027	<b><math>-0.219</math></b>	$<0.001$	1.174
H8	Ability and motivation ⇒ food waste behavior	0.048	<b><math>-0.294</math></b>	$<0.001$	1.211

but still very small, cross-loading can be found for “Many people that are important to me are trying to reduce food waste,” which loads with 0.764 on social norm and with only 0.238 on perceived behavioral control. This is in line with past research that shows a complex interplay between social norms and perceived behavioral control, indicating that social norms can influence the strength of perceived behavioral control in predicting behavioral intentions (Park et al. 2009). The lowest factor loading can be found for the perceived difficulty to reduce food waste on perceived behavioral control (0.691). It is very interesting that the loadings on the other factors have a similar strength (organizational support 0.197, social norm 0.156, and time availability 0.214). This suggests that, on a very low level, the difficulty of reducing food waste might, for some people, be connected to time constraints, peer pressure and a lack of organizational support.

H3 is accepted, as our study confirmed the literature that has found that ability is comprised of perceived knowledge, actual knowledge, and habits. This is shown by the factor loadings for ability in Supporting Information: Appendix B reflecting the same three factors as identified by the literature.

As far as ability is concerned, the situation is a little different. On the one hand, the cross loadings for actual knowledge are as low as for the opportunity dimension, while on the other hand, there is a slightly stronger cross-loading for perceived knowledge and a fairly strong loading for habits. Considering the items for perceived knowledge, these cross-loadings make sense—“I know how to make food more durable” shows loadings of 0.652 for perceived knowledge and 0.471 for habits, and the corresponding loadings for “I know the difference between the ‘use-by-date’ and ‘best-before-date’ on food” are 0.545 and 0.502, that is, very similar values. Considering everyday life, the connection of these knowledge dimension to habits also makes sense. This is in line with past research which found a significant positive association ( $r^2=0.393$ ,  $p=0.004$ ) between food habits and knowledge about nutrition (AlKasasbeh and Akroush 2024).

## 6.2 | What Drives Consumers' Motivation to Reduce Food Waste in Their Households?

To test H4–H6, which answer this question, regression analysis was used. The results of our study show that food waste in households decreases when there is motivation to reduce food waste (H4). This hypothesis was confirmed, but with very weak explanatory power and medium negative influence ( $r^2=0.006$ ,  $\beta=-0.12$ , significant at  $p=0.014$ ). Compared with the other influencing factors, this factor has the least influence on food waste behavior. The implication of this finding is that, although actions to motivate consumers to reduce food waste can have an effect on food waste reduction, the effect is so small that it is almost pointless to implement such actions by themselves. This is because of the complementary roles of the other two factors, namely opportunity and ability.

When it comes to the influence of opportunity on food waste behavior, analysis showed a medium negative influence with weak explanatory power ( $r^2=0.027$ ,  $\beta=-0.226$ , highly significant

at  $p<0.001$ ). The implication of this finding is that, although the hypothesis (H5) is confirmed, opportunity plays only a small role in food waste behavior. However, it should be noted that the explanatory power and the influence of opportunity are both higher than those of motivation. Again, the implication of this weak explanatory power is that, although actions to influence the dimensions comprising opportunity are important (medium negative influence), they cannot be expected to have a high impact on food waste behavior by themselves, although they would probably be more effective than just focusing on the motivation dimensions.

Finally, H6, which considers the negative influence of ability on food waste behavior, can also be confirmed, again with weak explanatory power and medium negative influence ( $r^2=0.048$  (low),  $\beta=-0.296$ , highly significant at  $p<0.001$ ). Although this influence is small, it is notable that ability has a slightly higher influence on food behavior than opportunity, both of which have higher influence than motivation. Although also having weak explanatory power, the medium negative influence of the ability factor is the most important of the three factors, and so actions to increase the ability of consumers to adopt behaviors that reduce food waste are the most important, that is, actions to strengthen the knowledge and habit dimensions like increasing knowledge about food waste and encouraging the development of good food waste reduction habits.

## 6.3 | What Inter-Relationships Between Motivation, Opportunity, and Ability Influence Food Waste Behavior?

To test H7 and H8, both single and multiple regression analyses were used. We first tested if motivation mediates the effect of opportunity on food waste behavior (H7). The direct influence of opportunity on food waste behavior is significant ( $p<0.001$ ), with a low  $r^2$  of 0.027 and  $\beta$  of  $-0.226$ . Within the multiple regression of opportunity and motivation on food waste behavior, the influence is significant ( $p<0.001$ ), with a low  $r^2$  of 0.027 and a  $\beta$  of  $-0.219$ . The total effect of opportunity on food waste behavior is  $-0.225$ , which can be split into the direct effect of opportunity on food waste behavior of  $-0.219$ , and the indirect/mediating effect of motivation on food waste behavior of  $-0.006$ . The conclusion to be drawn from this analysis is that opportunity does influence food waste behavior, and that motivation is a mediating influence on the relationship between opportunity and food waste behavior, and therefore H7 can be accepted. However, it must be noted that the mediating effect of motivation, although statistically significant, is quite small, and, in fact, is less than the direct influence of opportunity on food waste behavior. Nevertheless, the implication is that in addition to taking actions to increase the opportunity for food waste reduction, motivating actions should be adopted simultaneously.

The regression analysis to test if the influence of ability on food waste behavior is mediated by motivation shows that the direct influence of ability on food waste behavior is statistically significant ( $p<0.001$ ) with a low  $r^2$  of 0.108 and a  $\beta$  of  $-0.296$ . The influence of ability in the multiple regression of ability and

motivation on food waste behavior is also statistically significant ( $p < 0.001$ ) with a very low  $r^2$  of 0.048 and a beta of  $-0.294$ . This can be split into the direct effect of ability on food waste behavior of 0.294, and the indirect/mediating effect of motivation on food waste behavior  $-0.002$ . This analysis shows that the effect of ability on food waste behavior is mediated by motivation and so H8 can be accepted. However, the mediating effect is very small when compared with ability's effect on motivation, and more importantly, to ability's direct effect on food waste behavior. Although motivation has a small mediating effect on food waste behavior, its positive influence on the ability factor implies that actions to increase the ability dimensions should be simultaneously accompanied by motivating activities.

## 6.4 | Summary of Findings From Hypothesis Testing

Our analysis provides empirical evidence for the proposed framework, except for awareness of consequences and personal norms, which form a single factor, which we named “values and beliefs.”

Regarding H4–H6, these hypotheses showed that all three constructs do have a negative and direct influence on food waste behavior, but that this influence is quite small. It was interesting to note that ability has a greater influence than the other two and that motivation has the least influence.

Next, the three constructs were individually and separately added to the regression analysis to assess their influence on food waste behavior. Additionally, the influence of opportunity and ability on food waste behavior, with motivation acting as a mediating factor was analyzed. These mediating influences were confirmed, but the mediating effects were found to be very small. Although both opportunity and ability have a small influence on motivation ( $r^2$  of 0.162/beta of 0.350, and  $r^2$  of 0.108/beta of 0.278, respectively), their direct influences on food waste behavior were much stronger than that of motivation. Ability had an  $r^2$  of 0.048 and beta of  $-0.296$ , and opportunity had an  $r^2$  of 0.027 and a beta of  $-0.226$ , while motivation's effect on food waste behavior only had an  $r^2$  of 0.006 and a beta of  $-0.120$ .

The study has confirmed the structure of the three MOA constructs, namely *motivation* being comprised of “attitude,” “ascription of responsibility,” and a combined variable we call “value and beliefs”; *opportunity* made up of “time availability,” “perceived behavioral control,” “organizational support,” and “social norms”; and *ability* being comprised of “perceived knowledge,” “actual knowledge,” and “habits,” mostly as specified in the literature. All three constructs have a negative and direct, but small, influence on food waste behavior. Motivation mediates the influence of both opportunity and ability, but this influence is also modest. It is notable that both opportunity and ability have a considerably greater influence on food waste behavior than motivation, with ability being the most important construct. These findings were consistent with those of Matharu et al. (2022: 258) who found that “...interventions should focus on providing opportunities and enhancing skills that make it easier for consumers to minimize their food waste.”

## 7 | Implications

### 7.1 | Implications for Intervention Practices

The findings presented suggest various implications for intervention practices. Due to their influence on food waste in households, the motivation, opportunity, and ability of individuals are good starting points for public and commercial action. Food waste reduction at the household level is greatly influenced by macro-environmental changes induced by policymakers (e.g., regulations on date labels, esthetic standards for food) and institutional changes of all partners in the supply chain (e.g., packaging size, food labeling), which can encourage consumers to waste less food (Stangherlin and De Barcellos 2018; Aschemann-Witzel, De Hooge, and Normann 2016). Furthermore, it has to be taken into consideration that there might be barriers against these type of activities or barriers that discourage consumers from reducing food waste, such as inefficient food planning, overbuying/bulk buying, improper storage habits, misinterpretation of “best before” dates, attitudes to serving “leftovers,” and the householder's desire to be a “good provider” (Stangherlin and De Barcellos 2018). However, this paper has focused on the drivers of food waste behavior and thus we give recommendations on how such food waste reduction behavior can be positively influenced by both policy makers and companies.

Considerable marketing and promotional efforts have been placed on motivating and encouraging consumers to take action to avoid food waste, especially in the form of public awareness campaigns. However, our findings, as summarized in Figure 2, indicate that this might not be the most effective approach, since motivation showed the least influence on food waste behavior. This is in line with research conducted by van Geffen et al. (2020) that shows a mismatch between individual moral beliefs about the idea of food waste in general and the actual disposal of food in everyday life. As such, public awareness campaigns (Soma, Li, and Maclaren 2021) and classic communication efforts to influence attitudes, values and beliefs might compete with individual norms about giving leftovers to those in need (van Geffen et al. 2020). Creating anti-wastage social norms to stimulate negative attitudes toward food waste might be a promising path but it is only possible when different actors of the food supply chain work together (Stangherlin and De Barcellos 2018).

We, therefore, suggest more focus on intervention practices that strengthen ability and opportunity to reduce food waste. Although not the strongest influencer, opportunity should be focused on by manufacturers and retailers who should take steps to make the avoidance of food waste as easy as possible. This could involve steps like making recycling and/or composting bins freely available, creating receiving points at stores for leftover, but still safe, foods for distribution to the needy, where legally allowed, or for reuse in animal foods. Research conducted by Williams et al. (2012) shows that a quarter of food waste in private households is related to packaging, that is, packages being too big or too difficult to empty. Therefore, selling food in realistic and practical sizes would be perceived as organizational support. Moreover, in order to strengthen social norms to save food from being discarded, social media activities of companies should focus more on proenvironmental aspects. With respect

to time availability and perceived behavioral control, different “nudgings” as proposed by von Kameke and Fischer (2018) could reinforce opportunities to waste less food. Preplanned food delivery, company suggestions for meal planning or feedback on food actually wasted per household would fall into this category.

Since ability had the greatest influence on food waste behavior, considerable effort, via promotional activities, should be aimed at increasing the consumer’s knowledge of how to reduce waste. In order to strengthen actual and perceived knowledge, companies and public institutions could publish recipes for using older or excess foods (e.g., directly on product packaging), creating advertisements or competitions aimed at educating consumers on how to avoid food waste, and emphasizing in advertisements and promotional material how food waste avoidance can become a habit. In this context, knowledge of the meaning of “best before dates” plays a decisive role. Past research has shown that environmentally educated households discarded less food due to expiration dates than their less knowledgeable counterparts (Williams et al. 2012). Prompts on the packaging to do “smell-and-taste-tests” before discarding food could break habits and boost knowledge (Heidig and Perrupato 2021). Likewise, smart technology in fridges and freezers might help households, in the future, to better plan, store, and use stored products and therefore implement new consumption habits.

## 7.2 | Limitations and Implications for Future Research

Although this study was carefully conducted, several limitations should be considered. Researchers, when reading this paper or attempting a replication study, should take note of the following:

First, since the sample only included South African and German respondents, extrapolation to other countries should be done cautiously.

Second, the South African sample was delimited to LSMs 5–10, which account for about 80% of the population. However, this may be changing as lower LSMs urbanize and become wealthier and aspire to the purchasing and behavioral characteristics of the higher LSMs. However, most LSM 1–4 purchases are probably still essential, utilitarian products, focusing on survival. It is, thus, unlikely that excluding LSMs 1–4 significantly biased the results, but this may not be true in the future. Therefore, research into LSMs 1–4’s changing purchasing patterns is needed to confirm this suspicion.

Third, food waste behavior may well be influenced by other factors not included in our framework. Our framework adopts a socio-psychological focus, thus excluding demographic variables (e.g., age or gender), cultural differences, and regulatory restrictions. Past research showed no clear relation of gender or age to food waste generation (for a discussion see Thyberg and Tonjes 2016). These variables are therefore not part of our framework. Moreover, one could also expect that national culture and consumption culture would have an influence on food waste quantity and quality. Shopping patterns (Neff, Spiker, and Truant 2015) and food traditions (Pollan 2009) rooted in a country’s culture influence how food is purchased, stored, and

used in meal preparation. In developing countries, households make smaller but more frequent purchases than in developed countries, leading to lower amounts of wasted food (Pearson, Minehan, and Wakefield-Rann 2013). However, the United Nations Environment Programme (2021) showed that household per capita food waste generation is broadly similar across country income groups. Although our study combined data from Germany and South Africa, it did not focus on cultural differences as drivers of food waste. Using national boundaries as delimiters and proxies for culture would largely ignore intra-country heterogeneity, which is especially relevant in a diverse country like South Africa, and cross-country similarities between Germany and South Africa with respect to motivation, opportunity, and ability of households (Messner 2021). Our objective was to obtain a comprehensive understanding of food waste across the global north and south (Aschemann-Witzel, Ho, and Soma 2020), thereby identifying psychological patterns and interventions that can be applied in developed and developing countries, without the need for country-specific adaptations. Future studies could explore how intra-cultural variations affect the motivation to reduce food waste. This seems to be especially fruitful for a country like South Africa where food waste estimates range between 8 (Oelofse, Muswema, and Ramukhwatho 2018) and 177 kg (Oelofse and Nahman 2013) per capita per annum, depending on sample composition. Finally, it would also be interesting to investigate how regulatory restrictions, like food safety regulations and donation liability protections, influence the perceived opportunities of households to contribute to food waste reduction.

A fourth limitation of this study is its reliance on self-reported behavior. The most accurate way to measure food waste behavior would be through direct observation. However, due to the nature of the study and practical considerations within the research project, conducting observational measures was not feasible. Consequently, we depended on participants’ self-reported food waste behavior and their recall of food wasted over the past week. This reliance on self-reported data, especially for behavior and also knowledge, is a limitation. Self-reports on physical behavior like disposal of food can be subject to social desirability and recall limitations due to complexity (Sallis and Saelens 2000). Future research would benefit from examining the consistency between self-reported and observational measures of behavior in this area.

## 8 | Conclusion

Despite these limitations, this study has contributed to knowledge about food waste management by addressing Bamberg and Möser’s (2007) call for theory integration by creating an integrated framework based on the TPB, the MOA, and the NAM. Furthermore, it is, to our knowledge, the first study to conduct quantitative research and provide empirical evidence on factors contributing to food waste behavior with a dual country sample. The findings underscore the importance of opportunity and ability for food waste behavior and suggest that policy makers and companies should focus on these drivers in order to encourage the reduction of food waste at the household level. Reducing food waste is also a major topic in an international context. For future research, we will therefore focus on how cultural and

economic differences might explain country-specific differences in food waste between developing and developed countries.

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### Supporting Information

Additional supporting information can be found online in the Supporting Information section.