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Research

Being the "Better" student: intentions to reduce food waste

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Received: 18 January 2025 / Accepted: 17 March 2025
Published online: 25 March 2025

Abstract
This study identifies factors that influence the behavioral intentions of German university students to reduce food waste, particularly the moderating role of environmental consciousness. Data were collected through a survey of 368 university students in Germany. The findings show that individual attitudes, environmental knowledge, and awareness of consequences affect students' behavioral intentions to reduce food waste. In addition, the study introduces as a key moderating factor the concept of environmental consciousness, which strengthens the positive associations between individual attitude, environmental knowledge, and behavioral intention to reduce food waste. The moderating role of environmental consciousness in the relationship between awareness of consequences and behavioral intention is not significant, however. This research uniquely examines the factors promoting food waste reduction among university students in Germany, a group underexplored in current studies. Its insights can inform targeted interventions and enhance the understanding of sustainable behaviors in younger demographics.

Keywords Behavioral intention to reduce food waste · Individual attitude · Environmental knowledge · Awareness of consequences · Environmental consciousness · Germany

1 Introduction

Food waste is a grave problem worldwide that affects the social, environmental, and economic sectors, raising numerous complex issues. In the European Union (EU) alone, 59 million tonnes of food are wasted annually, amounting to 131 kg per person in a food market with an estimated value of €132 billion [1, 2]. Eurostat estimates that households, restaurants, and retailers may waste about 10% of the food available to EU consumers, reflecting food waste's deeper challenges; paradoxically, for example, over 37 million EU citizens face hunger because they lack enough money to have at least one meal every other day [1].

The enormous environmental impact of food waste includes significant ecosystem degradation and accounts for approximately 16% of greenhouse gas emissions from the EU's food system [3]. The growing climate crisis and its wide-ranging consequences, such as extreme weather events and loss of biodiversity, indicate an urgent need to address the environmental implications of consuming foods [4]. Recent years have witnessed unprecedented challenges in the agriculture sector due to global shocks such as the COVID-19 pandemic and the Russia-Ukraine war, which exposed vulnerabilities in the supply chain ecosystem, raising questions related to food security on the one

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hand while on the other hand worsening geopolitical, health-related, and socioeconomic disasters affecting many daily aspects of human life [5].

During the COVID-19 pandemic, people were forced to store more goods, especially wrapped dishes and takeout meal [6]. Consequently, the volume of bio-based household waste rose by 43% [7, 8]. When Russia later launched its military attack against Ukraine, the situation grew even more acute. Given Russia and Ukraine's important role as key suppliers of wheat, corn, and sunflower on the international food market as well as the fertilizer market, the war had a particularly large impact [9, 10]. In addition to economic problems, many countries have been affected, especially in Asia, Africa, and the Middle East, as they depend on Ukraine and Russia for affordable grain supplies [11, 12].

The war is expected to threaten the achievement of the Sustainable Development Goals (SDGs), in particular SDG 1 (End Poverty), SDG 2 (Zero Hunger), and SDG 12 (Responsible Consumption and Production), hindering the sustainable transformation of food systems in many countries [13]. The combination of these global challenges highlights the complex obstacles faced not only by agri-food systems but also by people at the individual level. This problem requires careful reflection to formulate effective approaches to ensure resilience and sustainability and to promote a shift to more sustainable eating habits.

Therefore, the United Nations highlights the need for change as part of global efforts to transform food consumption patterns for sustainable development. High-income countries are particularly important in this regard [14], so increased attention has been given to behavioral approaches that promote environmentally sustainable food consumption in those countries. In line with Target 12.3 of the SDGs, the EU aims to reduce food losses along supply chains and cut per capita global food waste by half at the retail and consumer levels by 2030 [2].

Exploratory research in the area of food demonstrates families' low awareness regarding food waste despite its magnitude [15, 16], yet a heightened consciousness may yield a noticeable reduction in generated food waste [17]. Environmental education targeting young people can foster responsible citizens who value their environment while simultaneously raising awareness of the importance of contributing to environmentally friendly practices, particularly in waste management.

Leal Filho et al. [18], Cui et al. [19], and Wu et al. [20] have examined the food waste produced at colleges, restaurants, canteens, and other food service facilities located at or owned by universities. However, such studies do not fully reveal students' food waste practices due to limited information about their individual-level behavior outside the institution. Clark and Manning [21] and Knežević et al. [22] analyzed students' awareness of food waste in the United Kingdom and Croatia, respectively, and both studies reveal that young people generally have an excellent understanding of matters related to food waste. Furthermore, these young adults are more concerned about economic losses than about health issues or environmental concerns. Gabriel et al. [23] examined German university students' interest in, knowledge of, and behaviors related to food waste as well as their perception of its importance. The results reveal the students' high interest in food-related topics and indicate their strong intentions to reduce food waste.

Despite growing awareness of food waste as a critical environmental issue [24], there remains a limited understanding of the specific psychological and cognitive factors influencing students' intentions to reduce food waste. Existing studies primarily focus on general consumer behavior or institutional food waste management [25], leaving the research gap by means of individuals 'attitudes, environmental knowledge, and awareness of consequences role in shaping students' behavioral intentions. Additionally, while environmental consciousness is widely acknowledged as a key factor in sustainable behavior, its moderating effect on the relationship between these variables and food waste reduction intentions has not been thoroughly examined. This study addresses this gap by providing a comprehensive framework that explores these interconnections, offering new insights into how universities and policymakers can foster more effective interventions to encourage sustainable food consumption behaviors among students.

The research objectives of the study are: first, to identify the drivers of university students' intentions to reduce food waste in Germany and, second, to explore the moderating role of environmental consciousness. These aims contribute to the objective of developing measures to foster sustainable consumption practices among university students. The study posed the following research questions:

1. What are the most effective factors influencing university students' behavioral intentions to reduce food waste in Germany?
2. How does environmental consciousness moderate the relationship between those driving factors and behavioral intentions to reduce food waste?
3. What strategies can be developed to promote sustainable consumption practices to effectively reduce food waste among university students?

This research builds on the Knowledge-Attitude-Practices (KAP) model to explore how knowledge of food waste impacts attitudes and intentions among university students, a crucial yet underexplored demographic. It contributes to theory building by complementing the KAP model with the integration of identity and moral aspirations. The results indicate that being a "better" student strengthens attitudes toward sustainable behavior. The study highlights how social norms and aspirations bridge the gap between knowledge and behavior, enriching the KAP model framework. It also contributes to sustainability education by linking knowledge acquisition to identity-driven pro-environmental actions.

This study substantially contributes to understanding the drivers of sustainable behavior among university students in Germany by identifying critical factors that influence their behavioral intentions to reduce food waste. By examining the roles of individual attitudes, environmental knowledge, and awareness of consequences, the study offers a nuanced perspective on how these variables collectively shape intentions to minimize food waste. Additionally, it highlights the moderating impact of environmental consciousness, revealing that students with a higher level of environmental consciousness exhibit a stronger relationship between these factors and their waste-reduction intentions. This finding underscores the importance of fostering environmental consciousness to amplify the effects of attitudes, knowledge, and awareness on sustainable practices. In summary, this study not only enhances the academic discourse on food waste reduction but also provides actionable insights for educators and policymakers aiming to cultivate sustainable behaviors in student populations.

Novelty of this study arises from integrating psychological and cognitive factors into a comprehensive framework that explains students' intentions to reduce food waste. Unlike previous research, which often examines food waste behaviors from a general consumer perspective or focuses on institutional strategies, this study specifically targets university students, a demographic with distinct consumption patterns and decision-making processes. The inclusion of environmental consciousness as a moderating variable further sets this research apart, as it provides a deeper understanding of how students' pre-existing environmental values influence the relationship between their attitudes, knowledge, and awareness of consequences in shaping behavioral intentions. By highlighting these nuanced interactions, this study moves beyond traditional linear models and offers a more dynamic perspective on how sustainable food practices can be encouraged in educational settings.

The remaining sections of this paper are structured as follows: Sect. 2 describes the theoretical background and hypotheses development, Sect. 3 details the research method, Sect. 4 suggests the analysis of the results, and Sect. 5 discusses the findings, limitations, and avenues for further research.

2 Theoretical background

2.1 Knowledge-attitude- practices model

This study adopts the KAP approach and focuses on three factors related to food waste among university students: their awareness of the issue of food wastage (knowledge), their perspective on food wastage (attitude), and their intention regarding food wastage (practice). The KAP model provides a systematic view of the relationship of awareness, beliefs, and practices, which enables identifying bottlenecks or incentives in the transition from intention to actual behavior [26–28]. This is important to understanding students' sustainability-related practices, as many behaviors include cognitive, affective, and behavioral aspects, demanding an integrated view. The KAP model employed in this study identifies areas where people's knowledge and attitudes are not enough to change habits into more sustainable ones, thus indicating areas suitable for effective programs aimed at changing habits [28, 29].

The KAP model created by Kallgren and Wood [30] interprets human behavior in the three clusters of knowledge, attitude, and practices. It suggests that people acquire knowledge that develops their beliefs and, consequently, their willingness to act, especially if such actions are beneficial or avoid an unpleasant situation. A pattern of consumption is characteristic of this model, which has been widely applied in examining several environmental behaviors, such as green purchasing, recycling, and waste minimization [31–33]. Thus, by adopting the KAP model, this study adds to the body of existing literature on how beliefs and attitudes create willingness to act within a particular anti–global warming behavior, emphasizing the moderating limiting factor of consciousness to modify this model.

2.2 Intention to reduce food waste

Behavioral intention to reduce food waste is a key predictor of individual action [34]. *Behavioral intention* refers to the desire to waste less food and has an important effect on the actual amount of food wasted. Some research [35–37] reports a positive relationship between low levels of waste and aspirations for such a reduction, which has been confirmed by studies on fruit and vegetable waste management and household waste behaviors [38]. These studies have also shown a strong influence of behavioral intention on the development of practices to limit food waste.

Huang and Tseng [39] assert that attitudes determine behavioral intentions by aligning people's intentions with their likes and dislikes. As persistent mental states [40], attitudes greatly affect people's opinions on a topic. Thus, external elements, such as societal norms, and interior elements, such as attitudes, interact to shape behavior as a whole. Food waste problems are primarily attributed to consumer behavior in affluent societies, and food waste behavior is known to be significantly influenced by consumer attitudes and intentions [41]. Visschers et al. [37] emphasize the predictive value of behavioral intentions and attitudes in reducing food waste. Consequently, it is crucial to investigate and comprehend the behavioral intentions associated with decreasing food waste in the context of German university students to develop methods and interventions that effectively support sustainable practices.

2.3 Conceptual framework and hypotheses development

2.3.1 Individual attitudes

Personal attitudes are crucial in determining the intentions behind actions [42–44]. Ajzen [45, 46] defines *individual attitude* as a person's assessment of whether a behavior is positive or unfavorable. Attitudes derive from personal experience and information about the subject of the attitude. Even if the consequences are not immediately observable in the food waste practices they can be assessed, such as beliefs. Beliefs are considered as cognitive responses. Frequently, a stronger attitude is found to forecast behavior [35]. According to earlier research, attitude influences intention more than any other factor [47, 48].

Regarding the reduction of food waste, individual attitudes are each person's beliefs, views, values, and preferences about the importance of minimizing food waste. Stronger behavioral intentions to engage in activities that support waste reduction initiatives will probably result from positive attitudes toward reducing food waste [49]. Examining the impact of personal attitudes as an independent variable sheds light on the psychological motivations behind university students' goal to reduce food waste, inspiring the following hypothesis:

H1: Positive individual attitudes toward food waste reduction among university students produce a significant, positive effect on their behavioral intentions to engage in practices that minimize food waste.

2.3.2 Environmental knowledge

Tavitiyaman et al. [50] describe environmental knowledge as a general understanding of facts, concepts, or relationships in regard to the environment and its ecosystems. Mostafa [51] emphasizes that such knowledge also encompasses people's appreciation of the interrelatedness of diverse factors that affect the environment. Environmental knowledge emerges as a crucial significant variable, taking into consideration the understanding and the ability to influence students' intentions to conserve food, as it represents the ability to conceptualize principles and actions related to developmental sustainability and safeguarding the environment [52].

Previous studies have shown that people's (including students) environmental knowledge can positively affect pro-environmental intentions [53]. For instance, Yadav and Pathak [54] confirm that, among students, a higher level of environmental awareness is associated with an increased desire to purchase environmentally friendly products. Paço and Lavrador [55] contend that consumers with higher levels of environmental knowledge are more likely to take positive action on matters pertaining to the environment. In the absence of sufficient knowledge about the environment, therefore, pro-environmental tendencies may be limited [56], leading to the second hypothesis:

H2: Among university students, a higher level of environmental knowledge has a significant, positive effect on behavioral intention to engage in practices that minimize food waste.

2.3.3 Awareness of consequences

The altruistic research framework suggests that individuals possess the ability to understand the implications of their behavior [57]. Understanding consequences is seen as individuals' comprehension of the potential results and impacts of any action they take [58]. This means that university students who are aware of food wastage minimization can be presumed to know that wasting food both harms the ecosystem and diminishes food availability, thereby negatively affecting society and the economy. Previous studies have contended that awareness is an important factor in reducing people's food waste [37], and awareness of the negative consequences of food waste significantly influences college learners' behavioral intentions to decrease it [35]. Thus, awareness of negative outcomes related to food waste represents an important independent variable in predicting behavioral intentions concerning waste reduction, as awareness of consequences is strongly related to food waste behavior. Moreover, awareness of economic consequences is more negatively related than understanding of the environmental and social consequences [59]. These considerations inspired the following hypothesis:

H3: Among university students, heightened awareness of the consequences of food waste has a significant, positive effect on behavioral intention to engage in practices that minimize food waste.

2.4 The moderating role of environmental consciousness

The suggested theoretical framework identifies environmental consciousness as a main moderator. According to Khan [60], Pellegrini & Tagliabue [42], and He and Harris [61], it demonstrates individuals' increased understanding and concern about environmental issues, which in turn increase their chances of embracing sustainable behaviors. Gansser and Reich [43] elaborate that environmental consciousness reflects a general readiness to recognize and exhibit pro- environmental behavior; it constitutes an understanding of the environmental crisis. Golob and Kronegger [62] note that environmental consciousness encompasses both environmental concern and the perceived severity or importance of environmental issues. Notably, studies highlight the tendency of people with lower environmental consciousness to overlook environmental factors when making decisions, whereas people with greater environmental consciousness give sustainability high priority. It is anticipated that environmental consciousness modifies the links between an individual's attitude, understanding of environmental issues, and awareness of consequences in the context of minimizing food waste, inspiring the following hypothesis:

H4: Environmental consciousness strengthens the relationship of (**a**) individual attitudes, (**b**) knowledge of environmental issues, and (**c**) awareness of consequences with German university students' behavioral intentions to reduce food waste.

Figure 1 presents the study's research framework, showing the links between the dependent variable "behavioral intentions" and the independent variables "individual attitudes," "knowledge of environmental issues," and "awareness of consequences." The figure also shows the moderating effect of environmental consciousness.

3 Methodology

3.1 Questionnaire design

A questionnaire survey collected data from 368 students of University X in Germany, who participated online. [The university has been anonymized for the review process]. The researchers employed convenience sampling, as its ease and practicality enabled them to reach an acceptable sample size despite modest resources and logistical constraints [63]. A pilot study was conducted to ensure that the respondents understood the proposed questions and to ascertain the quality of the content and its necessary relevance to the specific local situation. Because the survey's target audience were German, material in the English language was translated to German language using the back-translation method.

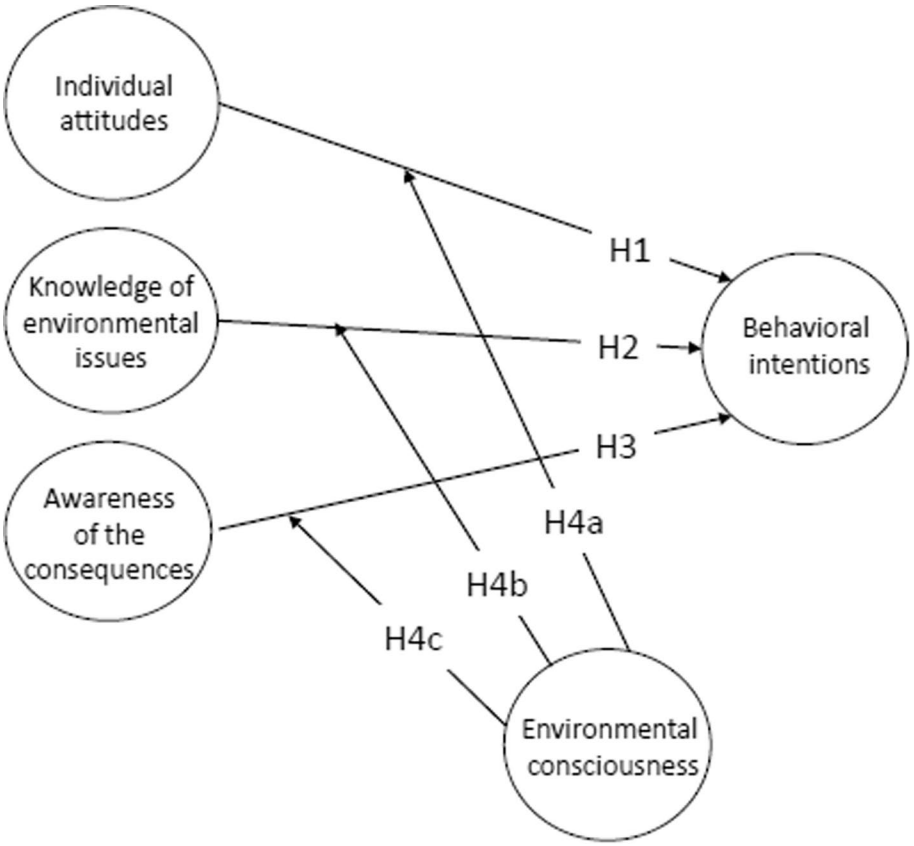

Fig. 1 The research framework

This method ensured that the translated materials had the same messages as in the original questions and that the questions' intended meanings were preserved, thus making certain that the survey was accurate and credible [64, 65].

The survey tool used a 5-point Likert scale questionnaire (5 = strongly agree, 4 = agree, 3 = no opinion/neutral, 2 = disagree, and 1 = strongly disagree) and comprised six parts. Part 1 collected demographic information; part 2 examined individual attitudes using five items based on the work of Jaiswal and Aagja [66], and Richter [67]; and part 3 measured the awareness of consequences using five items adopted from Obuobi et al. [68]. Part 4 examined environmental knowledge via five items from Khan [60], Gansser and Reich [43], and Attiq et al. [69], and part 5 considered environmental consciousness using five items adapted from Jaiswal and Aagja [66]. Lastly, part 6 used six items adapted from Kim and Hall [70] to assess behavioral intention toward food waste behavior.

3.2 Data collection and sample

Germany produces 10.9 million tonnes of food waste annually [67], of which 6.5 million tons are generated by households. Significant food waste is generated by students, as they often change accommodation, do not live in new premises, etc. [71]. A study by Clark and Manning [21] also found that students have weaknesses in food management.

Germany has a well-developed higher education system, and the number of students coming to study is constantly growing. In the winter term of the 2022–2023 academic year, 2.92 million students were enrolled in its universities [6], an increase of more than a million students over the 2002–2003 academic year, indicating a growing demand for higher education among the German population and foreigners choosing Germany for their studies. Therefore, a university student sample is suitable for the present study.

To test the hypotheses, we created a survey comprising 29 questions with the aim of gathering consumer responses on the topic. We used convenience sampling to invite consumers to fill out the questionnaire, approaching individuals on the campus of University X and inviting them to participate in the survey. The link to the questionnaire was shared with students through social media posts, including Facebook groups. We disseminated the questionnaire via Google Forms.

The respondents were first asked whether they were current students at University X. If they answered "No," they were denied access to the remaining questions, which filtered out respondents who were not currently enrolled students. A

total of 368 responses were received and analyzed for this study. The students' average age was 19.34 years (SD = 1.06) and ranged from 18 to 23 years. Among those surveyed, 53.3% ($n = 196$) were male, and 46.7% ($n = 172$) were female.

3.3 Statistical analysis

The data analysis employed a composite-based structural equation modeling (SEM) method, a more advanced method for studying the linkage among observed and latent variables. The analysis was conducted using SmartPLS software, as it was found to be useful in adjusting for non-normality of data and for small samples [72]. This approach enabled the evaluation of both measurement models and structural models, with the reliability and validity of the constructs being measured while the relationships proposed in research hypothesis were tested. The use of SmartPLS was modeled in a way that maintained accuracy and flexibility, enabling the model to effectively identify the various factors that motivate an individual to adopt sustainable consumption behaviors [73].

4 Results

4.1 Measurement model assessment

This study used an evaluation technique that complies with the criteria established by Nunnally and Bernstein [74] as indicated by the Cronbach's alpha values, which measure construct reliability and exceed the threshold of 0.7 as shown in Table 1, demonstrating strong reliability. Additionally, the convergent validity of the measurement instrument is proven because all the constructs have Average Variance Extracted (AVE) values above the threshold of 0.5 using the assessment criterion proposed by Henseler et al. [64]. The model's discriminant validity was evaluated by the Fornell-Larker criterion [75]. As shown in Table 2, the AVE of each latent construct must be greater than any other construct's highest squared correlation.

4.2 Structural model assessment

Table 3 depicts the results of the structural equation modeling, summarizing the structural parameters estimated, *t*-statistics, and *p*-values of each hypothesized pathway in the proposed model. For assessing the statistical significance of path coefficients 5,000 data sets were created in bootstrapping with replacement procedure and the model was fitted to these.

The findings reveal a number of noteworthy positive relationships between the independent and dependent factors. In particular, there is a stronger relationship between food wastage behavioral intentions and individual attitudes ($\beta = 0.447$, $t = 11.460$, $p < 0.000$) than between those intentions and environmental knowledge ($\beta = 0.174$, $t = 2.927$, $p = 0.004$) or awareness of consequences ($\beta = 0.152$, $t = 3.514$, $p < 0.000$), supporting hypotheses H1, H2, and H3.

Regarding the moderating role of environmental consciousness, the findings support a positive correlation with individual attitudes ($\beta = 0.160$, $t = 3.971$, $p < 0.000$) and with environmental knowledge ($\beta = 0.160$, $t = 2.782$, $p < 0.006$). However, the moderating role of environmental consciousness in the relationship between awareness of consequences and behavioral intention toward food waste ($\beta = 0.012$, $t = 0.231$, $p = 0.817$) returns a non-significant value, so hypothesis H4 is only partially confirmed: H4a and H4b are supported, whereas H4c is not.

Fit indices were assessed to determine whether the model works in general. The SmartPLS program also employed the Stone-Geisser Q^2 for evaluation [76]. According to Hu and Bentler [77], the extent to which the model fits the data is assessed using the standardized root mean square residual (SRMR). Predictive relevance exists when the Q^2 exceeds zero. Hu and Bentler [77] suggest that an SRMR value that does not exceed 0.08 for the composite model indicates a good model fit.

Based on the SRMR values computed for the composite model, which embraces both the independent and dependent variables, the Q^2 value is 0.079, which is just below the critical level of 0.08, indicating a satisfactory fit of the model. The independent variables account for 68.4% of the variance in behavioral intention toward food waste as indicated by the adjusted R^2 value of 0.684. The composite model's SRMR value was 0.77 when a moderating variable was considered, which falls within the recommended range and indicates adequate model fit. The adjusted R^2 value changed to 0.738, however, which means that when the moderating effect is considered, the independent variables account for 73.8% of the variance in behavioral intention toward food waste.

Discover Sustainability (2025) 6:201 | https://doi.org/10.1007/s43621-025-01021-2

Table 1 Reliability and loading values of the constructs

Construct	Item	FL	CA	CR	AVE
Individual attitudes	I make a conscious effort to plan meals and use perishable items before they expire	0.750	0.827	0.868	0.572
	I prioritize buying smaller quantities of perishable goods to minimize the risk of their going to waste	0.829			
	I experience a sense of guilt or regret when I see food going to waste	0.811			
	I pay attention to portion sizes when cooking to avoid leftovers that may go unused and eventually be discarded	0.782			
	If a food item looks slightly past its best-by date, I am willing to taste it to determine its freshness before discarding it	0.724			
Environmental knowledge	I am knowledgeable about choosing products with eco-friendly certifications or labels	0.722	0.861	0.885	0.608
	I know how to recycle food waste properly so that it does not have a negative impact on the environment	0.799			
	I have knowledge regarding products that have packaging designed for minimal wastage	0.731			
	Sustainable food choices are familiar to me, and their role in reducing environmental damage is clear to me	0.867			
	Food preservation techniques play a major role in reducing food waste and environmental impact; this has been my concern	0.831			
Awareness of consequences	Wasting food means wasting limited food supplies	0.853	0.922	0.941	0.761
	Throwing away food can worsen global hunger rates	0.879			
	Throwing away food can increase global poverty levels	0.886			
	Continually ignoring the effects of wastage perpetuates an unsustainable loop that stifles worldwide efforts to foster the security and stability of foods	0.900			
	Uneaten meals put undue pressure on water resources, since considerable amounts of water are used throughout the production of unconsumed meals	0.841			
Environmental consciousness	The knowledge of what I eat humbles me, because I realize how much damage it causes to nature and especially the environment	0.837	0.908	0.924	0.708
	When deciding between similar food products, I prioritize choosing options that have a lower environmental impact, even if they may cost more	0.912			
	I actively avoid purchasing food products from companies or brands that have a negative impact on the environment	0.835			
	I make a conscious effort to select food items with environmental certifications, even if they come with a higher price tag	0.829			
	I regularly seek out and absorb information about environmental issues to stay informed and make conscious choices	0.792			
Behavioral intentions	I am committed to planning my meals and shopping responsibly to minimize personal food waste	0.808	0.842	0.878	0.547
	I actively practice portion control to ensure that I cook or order only the amount of food I can consume	0.708			
	I am willing to experiment with creative ways to use leftover ingredients to reduce food waste in my kitchen	0.718			
	I consistently check the freshness of perishable items in my refrigerator and use them before they go to waste	0.798			
	I actively seek information and adopt practices for proper food storage to extend the shelf life of my groceries	0.769			
	I'm open to sustainable food choices, such as reducing meat or choosing local products, to lessen my meals' environmental impact	0.722			

*FL, Factor Loading; CA, Cronbach's Alpha; CR, Composite Reliability; AVE, Average Variance Extracted

Table 2 Discriminant validity of the constructs

	BI	IA	EK	AC	EC
BI	0.840				
IA	0.706	0.756			
EK	0.715	0.616	0.779		
AC	0.738	0.648	0.641	0.872	
EC	0.678	0.466	0.685	0.658	0.842

IA, individual attitudes; EK, environmental knowledge; AC, awareness of consequences; EC, environmental consciousness; BI, behavioral intentions

Table 3 Structural equation modeling results

Paths	Path coefficient	t-statistics	*p*-values
IA—> BI	0.447	11.460	0.000
EK—> BI	0.174	2.927	0.004
AC—> BI	0.152	3.514	0.000
EC—> BI	0.256	4.128	0.000
ME1—> BI	0.160	3.971	0.000
ME2—> BI	0.160	2.782	0.006
ME3—> BI	0.012	0.231	0.817

IA, individual attitudes; EK, environmental knowledge; AC, awareness of consequences; EC, environmental consciousness; BI, behavioral intentions; ME1, moderating effect 1; ME2, moderating effect 2; ME3, moderating effect 3

5 Discussion

5.1 Findings

The study investigated key factors influencing university students' behavioral intention to reduce food waste in Germany, focusing on individual attitudes, environmental knowledge, and awareness of consequences. The results reveal a positive relationship between individual attitude and behavioral intention, suggesting that students who hold more favorable attitudes toward food waste reduction are more inclined to adopt waste-reducing behaviors. This aligns with previous research [35, 43, 48], indicating that attitude is a significant predictor of environmentally conscious behaviors and implying that fostering positive attitudes may be essential to influencing food waste behavior in this demographic.

Knowledge of environmental issues emerged as another significant factor influencing students' behavioral intentions. Students who possessed greater knowledge of the environmental impacts of food waste were more likely to express intentions to reduce waste. This finding highlights the importance of environmental education, suggesting that enhancing students' understanding of food waste's ecological repercussions could motivate their more sustainable consumption [52, 53]. The positive association between environmental knowledge and waste-reduction intention reinforces the value of incorporating environmental topics into university curricula, potentially making students more conscious of their individual role in addressing global challenges [50, 56].

In regard to food waste, awareness of its ripple effect in society proved important to the intention to behave in a certain way. Students with a higher social, economic, and environmental awareness of the food waste issue were more willing to minimize it. This implies that educational measures that draw attention to the effects of food waste on resources and society may promote students' engagement in more sustainable behavior. In sum, the findings outline the role of attitudes, knowledge, and awareness in predicting the intention to perform a specific behavior and may be useful to universities and policymakers who wish to encourage students to act more sustainably [37, 59, 78].

This study examines the extent to which German university students intend to reduce food waste and considers the moderating influence of environmental consciousness in that regard, yielding important results. First, positive personal attitudes toward reducing food waste had a significant positive impact on students' behavioral intentions.

Second, their environmental knowledge influences students' behavioral intentions; higher levels of environmental knowledge among students positively affect their likelihood of engaging in activities to curb food waste. Third, increased awareness of the consequences of food waste is another key predictor of behavioral intentions. Students with greater awareness of the bad consequences of putting meals in the trash tend to participate more in minimizing food waste. These findings confirm what has been reported elsewhere: that personal attitudes, knowledge, and awareness affect people's motivations and behaviors, resulting in less food waste [21–23].

The positive moderating effect of environmental consciousness on the relationship between individual attitudes and behavioral intentions means that people who not only have positive attitudes but also demonstrate high levels of environmental awareness are more likely to take meaningful steps to reduce food waste. Similarly, the moderating effect of environmental consciousness on the relationship between environmental knowledge and behavioral intention highlights the importance of fostering environmental consciousness beyond factual knowledge. While knowledge of environmental certification and organic food choices is extremely important, people with higher environmental consciousness are more likely to act on this knowledge, translating it into practical efforts to minimize food waste.

However, the small moderating effect of environmental consciousness on the relationship between awareness of consequences and behavioral intention suggests that the relationship between awareness of consequences and behavioral intention may be relatively stable and not significantly affected by individual differences in environmental consciousness. Thus, awareness of the negative consequences of food waste can be a strong motivator of behavioral intentions in itself, regardless of the level of environmental consciousness.

5.2 Theoretical implications

The findings make a significant contribution toward understanding which factors contribute to German university students' interest in reducing food waste. Using theoretical perspectives including the KAP model [30], the study indicates that environmental knowledge, attitudes, and behaviors go hand in hand. In terms of theory development, the KAP framework is improved by highlighting individual attitudes, environmental knowledge, and awareness of consequence as key drivers of behavioral intention.

In addition to advancing the application of the KAP model, this study contributes to theory building by considering environmental consciousness as a moderating variable, which has not been thoroughly investigated in prior research. By exploring how environmental consciousness moderates the relationship of knowledge, attitude, and behavioral intention, the results suggest the range of conditions that influence pro-environmental behaviors. This improvement of the KAP model framework is relevant to research in the domain of students' sustainable behavior because it highlights the need to account for both contextual and individual-level factors in explaining the effectiveness of knowledge and attitudes in promoting behavioral transformations.

In addition, this study's findings contribute to the broader pro-environmental literature, as previous research has mostly emphasized knowledge or attitudes in a rather limited way among individuals. For example, some earlier studies [31, 32] attempted to understand the significance of environmental knowledge in relation to behaviors, but few have examined the role played by awareness of consequences in employing the KAP triad. Thus, by considering awareness of consequences as a significant factor, this paper expands on previous findings to offer insights into the cognitive processes underlying attitudes that minimize waste. This contribution to theory building not only adds to the KAP model but also provides a foundation for other studies to examine the influence of awareness on other sustainability-relevant behaviors.

This study contributes to scholarly understanding of how behavioral intentions are formed by exploring the relationship between thoughts and emotions. Unlike past research that looked at knowledge, attitudes, and behaviors separately, this study highlights how these factors are connected when it comes to reducing food waste. The findings indicate that being aware of the consequences links knowledge and attitudes, suggesting that efforts to promote sustainable behavior should go beyond just sharing information (e.g., [79])—they should also emphasize the real-world impact of waste. This perspective supports modern behavioral models that stress a more comprehensive approach to environmental education, reinforcing the need to include emotional and hands-on experiences in research on pro-environmental behavior.

5.3 Practical implications

From a practical standpoint, the researchers provide useful insights for policymakers, educational institutions, and environmental advocates. Interventions may be proposed that target personal attitudes and environmental knowledge related to sustainable food consumption, which may involve designing educational programs that increase young

people's understanding of the environment in relation to food scarcity. We believe that the inclusion of fostering a positive attitude toward waste reduction could translate into real behavioral shifts among university students.

The present study emphasizes the need to promote environmental consciousness. Educational programs and activities that help students become more aware of their environmental effects and nurture a sense of responsibility toward the environment can promote more ecologically conscious eating habits. Collaborating with environmental organizations, universities can provide educational resources, workshops, and campaigns that specifically focus on students' role in reducing food waste.

Moreover, institutions can integrate sustainable food practices into campus dining services by implementing portion control strategies, encouraging reusable containers, and offering incentives for waste-conscious behaviors. Universities may also establish food-sharing platforms where students can redistribute surplus food instead of discarding it. These structural changes, coupled with awareness campaigns, can help bridge the gap between knowledge and action, reinforcing behavioral intentions to reduce food waste.

Additionally, policymakers can leverage digital tools and social media platforms to engage students in sustainability efforts. Mobile applications that track food waste habits, provide tips on sustainable consumption, or gamify waste reduction could encourage students to adopt more responsible behaviors. By fostering a culture of sustainability through both digital and institutional initiatives, stakeholders can create a long-lasting impact on students' attitudes and behaviors regarding food waste reduction.

5.4 Limitations and future research avenues

While this study offers insightful information, its limitations must be acknowledged. The findings may not be applicable in different cultural contexts due to the empirical focus on German students. Awareness of sustainability-related issues, including food waste, is high in Germany [80]. Other topics might dominate students' awareness in other regions, such as wars in the Middle East or droughts in Africa, and this study may not fully account for the geographical specificity, cultural characteristics, and environmental elements that influence how people manage food differently in various places. Future research could address this limitation by conducting cross-cultural analyses to assess the generalizability of the identified components to different cultural contexts. In addition, response bias may have arisen from relying solely on self-reported data. Future research could combine observational and self-report methods to overcome this limitation and obtain a more complete picture of actual food waste reduction behavior.

While the present study examines how environmental consciousness changes behavior, additional, unexplored factors may influence the interplay between an individual's attitudes, environmental knowledge, awareness of consequences, and behavioral intentions. To better understand the complex relationships between psychological factors and sustainable behavior, future research could focus on identifying and thoroughly examining other moderating variables.

Longitudinal studies could be conducted to better understand the intricacies associated with the formation of intention to reduce food waste. The effectiveness of interventions and the duration of sustainable behavior would be greatly enhanced by long-term monitoring of behavioral change. Such research could assess the long-term impact of educational programs and initiatives that support sustainable eating among young students.

Author contributions All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by D.M. and M.S. The first draft of the manuscript was written by D.M., M.S., M.E. and R.W. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. This research did not receive any funding.

Data availability The datasets collected and/or analyzed during the current study are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate This is a non-intervention study and did not collect any personal identifying details of the participants. Data gathering and processing meets the Helsinki declaration and the German Datenschutzgrundverordnung. The participation of respondents was voluntary in the study. Verbal informed consent was obtained from all individual participants included in the study.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

Clinical trial number Not applicable.

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