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DETERMINANTS OF ACTUAL BEHAVIOR RELATED TO BIO-WASTE SORTING

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Purpose: The aim of the work was to define the factors determining the selective segregation of bio-waste. The article answers three research questions: 1) What observable variables can measure the constructs resulting from the unified theory of technology acceptance, where the studied technology is segregation of bio-waste? 2) Do the observable variables create scales with acceptable validity and reliability within each construct? 3) Which of the studied constructs significantly affect the actual behavior of correct segregation of bio-waste?
Design/methodology/approach: The assumed objective was achieved through literature analysis, qualitative research conducted among respondents from different countries and quantitative research based on a survey with the participation of people from Poland and Germany. The obtained data was analyzed using structural equation modeling (PLS-SEM)
Findings: Based on the research conducted, it was found that the intention to properly sort bio-waste is significantly influenced by expected ecological and economic benefits, perceived ease of sorting and social pressure. Intentions are a strong and significant predictor of actual behavior in the area of sorting bio-waste. Promotion of bio-waste sorting does not significantly influence actual behavior
Originality/value: Many studies concern the general approach to waste segregation. In our work, we identified the determinants of segregating a specific category of bio-waste. We also provide cultural context resulting from the international research sample.
Keywords: sorting bio-waste, sustainable consumption, sustainability, pls-SEM.
Category of the paper: Research paper.

1. Introduction

The literature notes the insufficient consideration of the issue of bio-waste in scientific research, despite the fact that it constitutes a significant stream of municipal waste and has a direct impact on climate change, the environment and the quality of life of residents. This prompts us to address a topic that not only responds to contemporary climate challenges but is also of great importance for the development of circular economy practices and increasing the efficiency of waste treatment processes. In the context of the climate crisis, proper segregation of bio-waste is crucial for reducing greenhouse gas emissions, especially methane, which is generated when it is not stored properly.

The main problem of the article is to define the factors determining the selective segregation of bio-waste. The following research questions were asked:

RQ1: What observable variables can measure the constructs resulting from the unified theory of technology acceptance, where the studied technology is segregation of bio-waste?

RQ2: Do the observable variables create scales with acceptable validity and reliability within each construct?

RQ3: Which of the studied constructs significantly affect the actual behavior of correct segregation of bio-waste?

The first chapter discusses the importance of selective collection of bio-waste in the context of counteracting the climate crisis and the need to implement a circular economy. Additionally, the Unified Theory of Acceptance and Use of Technology (UTAUT) is presented as a theoretical basis for analyzing the factors influencing the intention to separate bio-waste. The second chapter describes the methodological course of qualitative and empirical research, from the formulation of research questions and hypotheses, through the selection and construction of measurement tools, to the analysis of data using structural equation modeling (PLS-SEM). The third chapter presents the results of quantitative and qualitative research on the separation of bio-waste. Structural equation modeling (PLS-SEM) was used, including the assessment of the measurement and structural model. The research included a qualitative and quantitative stage. First, interviews were conducted with people from different countries to identify observable variables for key constructs related to bio-waste segregation. Based on these interviews, a survey was prepared and completed by 249 respondents from Poland and Germany. The survey data was analyzed in the R environment, assessing the reliability and validity of the scales using factor loadings, AVE, CR and Cronbach's alpha. Structural equation modeling using the PLS-SEM method was used to analyze the relationships between variables, which allowed for the assessment of the validity of the model and the determination of the strength and significance of the factors on intentions and actual behavior related to bio-waste segregation.

The originality of the material presented lies in moving beyond the general discussion of waste segregation. Our research identifies the specific determinants influencing the segregation of bio-waste, a category often overlooked in previous studies. In addition, by incorporating an international sample, we provide a cultural perspective that enriches the understanding of waste management practices across diverse contexts.

2. Literature review: hypotheses development

Bio-waste is understood as biodegradable waste from gardens, parks, food and kitchen waste from households, restaurants, catering establishments, retail outlets, as well as comparable waste from plants producing or introducing food into circulation. Very important from the point of view of the waste management hierarchy and in order to reduce greenhouse gas emissions from waste storage in landfills is the creation of appropriate conditions for effective selective collection and proper processing of bio-waste into environmentally safe compost. Currently, according to the imposed restrictions, bio-waste is to be segregated, recycled or selectively collected, limiting mixing with other types of waste. Waste with similar biodegradable properties, meeting European and national standards regarding their compost properties, is collected together. Member States of the European Union are also taking action to encourage home composting, fermentation of bio-waste and the use of materials created from bio-waste (The European Parliament and the Council of the European Union, 2018).

In order to examine intentions and compare them with actual behavior of people separating bio-waste, we used the Unified Theory of Acceptance and Use of Technology model (Venkatesh et al., 2003). According to the UTAUT theory, intentions of technology users are shaped by the following constructs: expected effectiveness, expected effort, social influence and facilitating conditions. These constructs can be influenced by moderating variables such as age, gender, experience and voluntariness of use. This theory also proves that users' intentions have a direct impact on their actual behavior. This theory was created by combining eight previous theories explaining technology acceptance by users. It combines the Theory of Reasoned Action (Fishbein, Ajzen 1975), Technology Acceptance Model (Davis, 1989), Motivational Model (Davis et al., 1992), Theory of Planned Behavior (Ajzen, 1991), a combination of the TAM model and the TPB theory (Taylor, Todd, 1995), Personal Computer Usage Model (Thompson et al., 1991), Diffusion of Innovations Theory (Rogers, 1995), and Social-Cognitive Theory (Bandura, 1986). By combining elements of many previous models, it provides a comprehensive approach to analyzing user behavior. It takes into account both individual and external factors. It analyzes attitudes and intentions, not forgetting the influence of the environment. This model explains the intentions and actual behavior of its users well. It is also very versatile, which is why it is easily applied to research in various fields.

Proper segregation of bio-waste can significantly contribute to reducing methane emissions through anaerobic digestion, which provides significant ecological benefits. It is carried out in closed reactors, which means that it has lower emissions to the atmosphere, and they are easier to control. Generating energy from renewable energy sources, such as biogas from bio-waste, reduces dependence on fossil fuels and contributes to reducing greenhouse gas emissions. This is also important for the effective management of bio-waste. Anaerobic digestion can in many cases be the most advantageous treatment method from an ecological and economic point of view (European Commission, 2008).

The expected economic benefit refers to the expected financial savings resulting from activities involved in the segregation and disposal of bio-waste. For several years, there have been various reliefs available to households and businesses regarding bio-waste. According to the resolution on the exemption from part of the fee for municipal waste management, owners of single-family properties may be partially exempt from this fee. In addition to reliefs from municipal waste management fees, in order to encourage homeowners to compost bio-waste, some communes are introducing subsidies for the installation of home composters. An example of such subsidy is the "Kompostownik" program (Urząd Gminy Michałowice, 2023). This subsidy can be used not only by individuals, but also by housing communities, legal entities, entrepreneurs, public finance sector entities that are municipal or district legal entities, if they have the right to dispose of a property located in the commune. It should also be added that proper management and disposal of bio-waste also contributes to the reduction of waste in landfills, which affects the expenditures for managing these landfills. In connection with this, we will put forward the following research hypothesis:

H1a: The expected ecological and economic benefits of proper segregation of bio-waste significantly influence the intention to segregate it.

The perceived ease of correct sorting of bio-waste plays a key role in shaping the intention to separate it. We understand this construct by the extent to which consumers consider the process of separating bio-waste to be simple and intuitive. An important aspect influencing the perceived ease of sorting bio-waste is the available knowledge on correct waste segregation. Consumers can acquire this knowledge through environmental education, previous experience, and pro-ecological campaigns. People who have already had contact with the process of separating bio-waste and already have the necessary knowledge perceive this process as easier than people who have never had contact with it before (Ministerstwo Klimatu i Środowiska, 2021). Many municipalities, cities, and residential areas try to teach their residents and increase ecological awareness by creating eco-guidelines, posters, and information boards (Związek Międzygminny "Czysty Region", 2023). Therefore, we will put forward the following research hypothesis:

H1b: The perceived ease of proper segregation of bio-waste significantly influences the intention to segregate it.

Social pressure plays a key role in shaping the intention to sort bio-waste and is an important motivating factor for pro-ecological behavior. It refers to the influence that the environment has on the decision-making process and shaping the foundations. According to research, people are more likely to act in accordance with social expectations, especially if they are widely accepted and supported by the environment such as family, friends, and co-workers (Rokicka, 2023). The influence of social pressure can also be seen when people living in communities where waste sorting is common are more likely to follow the rules of correct waste sorting than people who do not see such behavior in their environment. This effect is explained by the theory of normative influence (Ajzen, 1991). According to this theory, people strive to adapt to social norms in order to avoid disapproval or gain acceptance by the group. Therefore, we will put forward the following research hypothesis:

H1c: Social pressure significantly influences the intention to properly sort bio-waste.

The promotion of bio-waste segregation plays an important role in environmental education, increasing ecological awareness and the popularity of segregation itself (Schultz, 2014). The most important promotional tools are information campaigns. Increasingly often, when talking about social media, the topic of parasocial relationships is mentioned. This is important for the message to reach, because when the viewer has such a relationship with a given creator, they will be more inclined to trust the content they provide (Bérail, Bungener, 2022). One such campaign using social media is the information and educational campaign of the Ministry of the Environment under the slogan "High Five for Segregation". The campaign aimed to educate the public on the correct segregation of municipal waste. A more popular method of education on behaviors that positively affect the climate is the creation of eco-guidelines. They often concern advice on how to reduce the amount of waste produced, what pro-ecological habits we can adopt in our daily lives, as well as on the correct sorting of waste (Jastrzębie-Zdrój, 2020). We can already observe the positive results of such campaigns. According to research commissioned by the ProKarton Foundation, the involvement of Poles in the environment is growing. In 2024, as many as 92% of respondents segregate packaging waste, which is an increase of as much as 13% compared to 2023. Knowledge about recycling has also increased, 67% of respondents were aware of the possibilities of processing liquid food cartons in Poland (ProKarton, 2024). Therefore, we will put forward the following research hypothesis:

H2a: The promotion of bio-waste segregation has a significant impact on the correct sorting of bio-waste.

The intention to separate bio-waste can significantly influence their segregation, but it is not synonymous with the actual behavior (Ajzen, 1991). The intention refers to the conscious intention to take pro-ecological actions, while by actual behavior we understand the actual habits and behaviors. Therefore, we will put forward the following research hypothesis:

H2b: The intention to sort bio-waste has a significant impact on the correct sorting of bio-waste.

In this way, we built the theoretical framework of our research (see Figure 1).

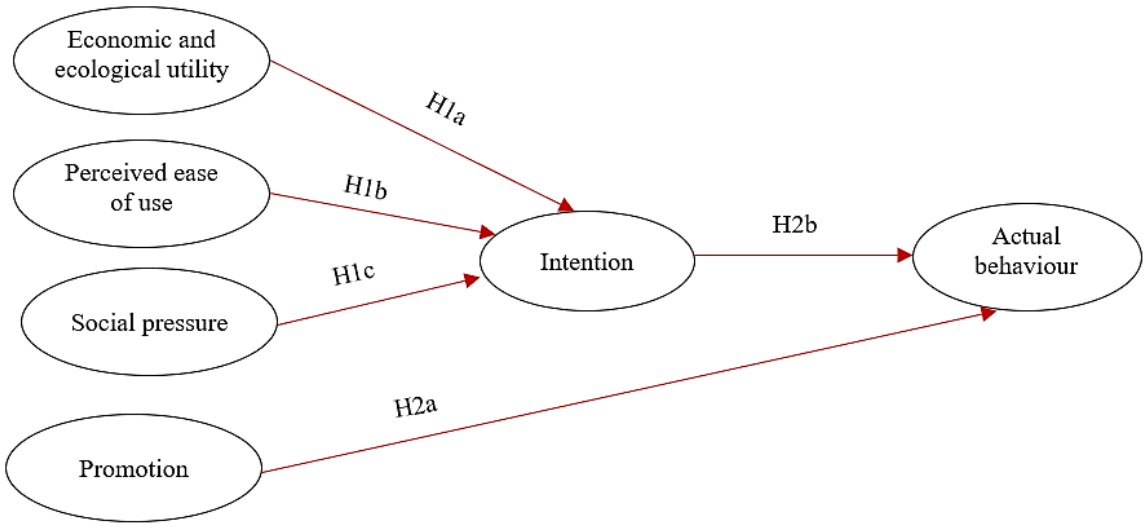

Figure 1. Research model.

Source: own study.

3. Methods

3.1. Measurement tool

Qualitative research

During the qualitative research, interviews were conducted based on the following questions:

1. Do you know of any government or local programs supporting the segregation of bio-waste (in Poland, discounts for the price of garbage, funding composters)?
2. What does the process of waste segregation look like on a daily basis, how many groups, what division?
3. Where did you learn about the correct waste segregation process (school, educational campaigns, government programs)?
4. What happens to bio-waste after it is thrown away? Is it reused (e.g. composting, biogas production) or does it go to landfill?
5. Is waste segregation mandatory? What are the consequences for not segregating it and do people actually follow these rules?

The interviews were conducted in English, and respondents provided answers based on their own experiences in their countries of residence. The geographical diversity of the sample made it possible to compare practices and perceptions of bio-waste segregation in different cultural and systemic contexts. The main goal of this stage of the study was to identify which of these countries Poland is closer to in terms of the level of development of the bio-waste segregation system and social awareness in this area.

Qualitative research

Each construct of the research model was treated as a latent variable. Therefore, to measure these constructs, a set of observable variables was developed. These variables took the form of statements that were presented to survey respondents. The respondents' task was to respond to these statements on a Likert scale. This scale takes values from 1 to 5, where 1 means "strongly disagree" and 5 means "strongly agree" (Likert, 1932). Observable and latent variables are presented in table 1.

Table 1.
Questionnaire structure

Construct	Item	Statement
Economic Utility and Ecological Utility (ECO)	ECO1	The cost of disposing of properly segregated bio-waste is lower.
	ECO2	Composting bio-waste is more profitable because it allows the waste to be reused as fertilizer.
	ECO3	Sorting bio-waste reduces the amount of mixed waste, which reduces the cost of waste collection.
	ECO4	By segregating bio-waste, I reduce the negative impact on the climate (lower methane production).
	ECO5	I think I am doing something good for the environment by separating bio-waste.
	ECO6	By separating bio-waste, I reduce the amount of waste in landfills.
	ECO7	By separating bio-waste, I am contributing to environmental protection.
Perceived Ease of Use (EOU)	EOU1	Sorting bio-waste is easy because I have space for an extra bin in the kitchen.
	EOU2	Sorting bio-waste is convenient because containers are available in my area.
	EOU3	Sorting bio-waste is convenient thanks to the tools provided, such as biodegradable bags or composters.
Social Pressure (SP)	SP1	Sorting bio-waste allows me to keep up with the ecological trend.
	SP2	Sorting bio-waste strengthens my image as a person who cares about the environment.
	SP3	Sorting bio-waste allows me to make a good impression on others.
	SP4	Sorting bio-waste gives me social acceptance.
	SP5	Sorting bio-waste makes me feel like a better person.
	SP6	By separating bio-waste, I set a good example for others.
	SP7	Family, friends and neighbors expect me to sort bio-waste.
Intention to Use (INT)	INT1	I separate bio-waste and will do so in the future.
	INT2	I intend to separate bio-waste within the next year.
	INT3	I intend to separate bio-waste within the next five years.

Cont. table 1.

Promotion (PROM)	PROM1	Bio-waste segregation is often advertised on social media.
	PROM2	Sorting bio-waste is often advertised on TV.
	PROM3	The separation of bio-waste is often advertised in newspapers.
	PROM4	Sorting bio-waste is often advertised in campaigns by large companies.
	PROM5	Sorting bio-waste is often advertised in educational campaigns.
	PROM6	Bio-waste segregation is promoted by influencers.
Actual Behaviour (AB)	AB1	I choose food products and packaging that facilitate the segregation of bio-waste (e.g. biodegradable packaging).
	AB2	I separate bio-waste even if it requires extra effort on my part (e.g. removing leftovers from food containers).
	AB3	I segregate bio-waste because I believe that it has a real impact on waste reduction and environmental protection.

Source: own study.

3.2. Research sample

Research sample in qualitative research

The qualitative research involved interviews with seven people from different countries: Germany, Sweden, Singapore, Bulgaria, Mexico, Canada and India. The respondents were aged 19 to 34 and represented both students and working people. The geographical diversity of the sample made it possible to compare practices and perceptions of bio-waste segregation in different cultural and systemic contexts. The main goal of this stage of the study was to identify which of these countries Poland is closer to in terms of the level of development of the bio-waste segregation system and social awareness in this area.

Research sample in quantitative research

The survey was conducted in March and April 2025. The survey was prepared in electronic form. The questionnaire was translated into German and appropriately adapted to this group of respondents by adjusting the education system in the demographic section. The survey involved 248 respondents, of whom 58.47% were Poles and 41.53% were Germans. In the sample, 64.52% were women, 35.08% men and one person identified as other. In terms of age, the respondents were divided into six groups, of which the most numerous were: 18-25 years (37.9%), 46-55 years (17.34%), over 55 years (13.71%). The majority of respondents came from rural areas (50%), then medium-sized towns up to 100,000 inhabitants (25.4%) and large cities over 100,000 inhabitants (24.6%). The majority of respondents defined their education as secondary (48.79%), the second largest group was the group of respondents with higher education (34.68%). Detailed results regarding the research sample are presented in Figure 2.

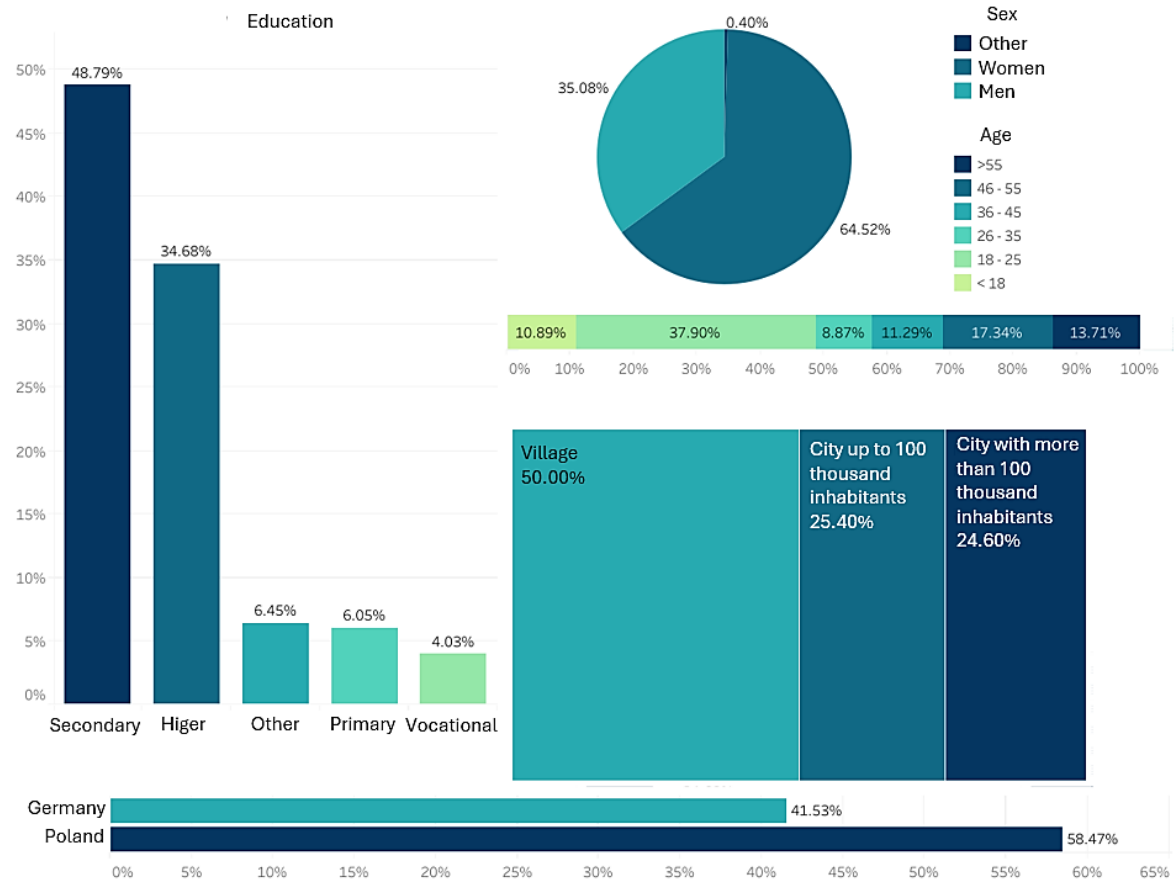

Figure 2. Research sample (n = 248).

Source: own study.

4. Results

4.1. Qualitative research results

Analysis of the content of the interviews reveals significant differences in the level of development of bio-waste segregation systems between countries. In countries such as Germany, Sweden, Canada and Singapore, institutional activities supporting correct segregation are noticeable – from providing appropriate containers, through educational campaigns, economic incentives and legal regulations. For example, in Canada there is an obligation to have three waste containers, and compliance with the segregation rules is enforced – at least in the case of companies and institutions. Sweden and Germany also have extensive systems for collecting and processing bio-waste, often linked to the production of biogas or compost. In turn, in countries such as Bulgaria, Mexico or India, these systems are fragmentary or ineffective. They often operate only formally, without real supervision over their operation in society. Respondents from Bulgaria and Mexico indicated that waste

segregation is neither mandatory nor enforced, and bio-waste most often ends up in landfills. There is also a lack of real economic incentives and infrastructure supporting citizens' activities in this area.

Sources of knowledge and education play an important role in shaping attitudes towards bio-waste segregation. In countries with a high level of environmental education (e.g. Sweden, Canada, Germany), respondents indicated that they first obtained information about segregation at school and then at home. Knowledge was also reinforced through social campaigns, advertising and activities of public institutions. In countries with a lower level of environmental education (e.g. Bulgaria, India), respondents more often admitted to a lack of formal education in this area, to gaining knowledge indirectly from their own observations or family habits. The participants' responses indicate clear differences in the scope of mandatory and enforceable segregation rules. In Canada and India, there are formal regulations imposing the obligation to segregate bio-waste, and failure to comply with them may result in sanctions (e.g. fines or refusal to collect waste). In countries such as Bulgaria or Singapore, however, these regulations are more of a recommendation nature, and their compliance is largely left to the good will of citizens. This state of affairs significantly affects the effectiveness of implemented environmental policies.

The analyzed responses also showed a variety of perceptions of the fate of bio-waste after it has been disposed of. In countries such as Sweden, Canada and Germany, respondents were aware that bio-waste is processed in an ecological way – for example, through composting or generating biogas. In countries with a weaker bio-waste processing infrastructure (e.g. Mexico, India), uncertainty about the fate of bio-waste prevailed, and the responses were often limited to statements such as “it probably ends up in a landfill”. The interviews showed that institutional and cultural factors, such as the level of trust in the government and a sense of civic duty, play an important role in motivating citizens to separate waste. An example is Bulgaria, where respondents openly indicated a low level of trust in institutions and a lack of motivation to undertake pro-ecological activities, which was explained both by a lack of control and the belief that waste ends up in one place anyway.

4.2. Questionnaire validation

To validate the scales used in the questionnaire, their validity and reliability were examined. The following were calculated for each scale: 1) factor loadings resulting from conformational factor analysis, 2) Cronbach's α coefficient, 3) CR coefficient and 4) average variance extracted (AVE). Seminr package was used for this purpose. To consider the scale valid and reliable, Cronbach's α and CR should exceed the threshold value of 0.7, and AVE the value of 0.5 (Hair et al., 2011, 2014, 2019). The obtained results are presented in table 2.

Table 2.
Convergent validity measures

Construct	Item	Loadings	AVE	CR	α Cronbacha
Economic Utility and Ecological Utility (ECO)	ECO1	0.505	0.516	0.879	0.837
	ECO2	0.628			
	ECO3	0.652			
	ECO4	0.718			
	ECO5	0.848			
	ECO6	0.806			
	ECO7	0.806			
Perceived Ease of Use (EOU)	EOU1	0.852	0.632	0.837	0.714
	EOU2	0.741			
	EOU3	0.789			
Social Pressure (SP)	SP1	0.733	0.574	0.903	0.876
	SP2	0.833			
	SP3	0.733			
	SP4	0.753			
	SP5	0.792			
	SP6	0.855			
	SP7	0.570			
Intention to Use (INT)	INT1	0.781	0.703	0.876	0.797
	INT2	0.879			
	INT3	0.853			
Promotion (PROM)	PROM1	0.822	0.662	0.921	0.899
	PROM2	0.834			
	PROM3	0.787			
	PROM4	0.833			
	PROM5	0.829			
	PROM6	0.773			
Actual Behaviour (AB)	AB1	0.725	0.661	0.853	0.742
	AB2	0.841			
	AB3	0.865			

Source: own study.

To examine the discriminant validity, the HTMT criterion (Table 3) and the Fornell-Larcker criterion (Table 4) were used. Table 3 shows that none of the values exceeds the assumed threshold value of 0.9, which indicates satisfactory values. In turn, the results in Table 4 show that the main diagonal has the highest values, which also confirms acceptable discriminant validity (Hair et al., 2011, 2014, 2019).

Table 3.
The HTMT criterion representing discriminant validity for scales

	ECO	EOU	SP	INT	PROM	AB
EOU	0.582					
SP	0.721	0.632				
INT	0.685	0.607	0.590			
PROM	0.188	0.249	0.278	0.298		
AB	0.756	0.724	0.723	0.816	0.308	

Source: own study.

Table 4.
The Fornell-Larcker criterion representing discriminant validity for scales

	ECO	EOU	SP	INT	PROM	AB
ECO	**0.718**					
EOU	0.470	**0.795**				
SP	0.657	0.519	**0.758**			
INT	0.580	0.520	0.526	**0.838**		
PROM	0.172	0.197	0.258	0.258	**0.813**	
AB	0.613	0.542	0.603	0.667	0.257	**0.813**

Source: own study.

4.3. Factors determining bio-waste segregation

Positive results of construct validation in the measurement model allowed us to proceed to the next stage of analysis. The next stage consisted in determining the relationships between individual constructs and assessing the impact of the assumed variables on the intentions to use and the actual behavior of respondents. To achieve this goal, the structural equation modeling method was used using the PLS-SEM approach. Based on this method, a graph illustrating the tested model was generated, which is presented in Figure 3. Tables 5 were also prepared.

For the developed structural model, the value of the coefficient of determination R^2 and Adjusted R^2 were calculated, which determines the extent to which the variability of the dependent variable can be explained by the relationships between variables in the model. The results of the analysis indicate that the model explains 45.3% of the variance of the constructs intentions to correctly sort bio-waste and promotion in relation to actual behavior (R2 = 0.453, Adj.R2 = 0.448). In turn, the variances of the constructs expected economic and ecological benefits, perceived ease of correct sorting of bio-waste and social pressure were explained in 42.7% in relation to the intention to correctly sort bio-waste (R2 = 0.427, Adj.R2 = 0.420). The values obtained suggest that the fit of the model to the data is at a satisfactory level.

Additionally, an analysis of beta path coefficients was conducted, which allowed us to determine the strength of the influence of individual variables on the intentions to use and actual behaviors. The expected economic and ecological benefits had the greatest influence on the intentions to use ($\beta = 0.35$), followed by the perceived ease of sorting ($\beta = 0.275$) and social

pressure (β = 0.153). In turn, actual behaviors were determined to the greatest extent by the intentions to use (β = 0.644). All these relationships were positive. The weakest predictor turned out to be promotion, whose path coefficient was only (β = 0.091), and in addition this predictor turned out to be statistically insignificant, which indicates its limited importance in explaining actual behaviors.

Table 5.
Hypothesis testing results

Hypotheses		Original Est.	Bootsrap Mean	Bootsrap SD	t Stat	2.5% CI	97.5% CI	Supported
H1a	ECO → INT	0.350	0.351	0.066	5.294	0.223	0.482	Yes
H1b	EOU → INT	0.275	0.276	0.061	4.489	0.155	0.393	Yes
H1c	SP → INT	0.153	0.153	0.068	2.250	0.021	0.288	Yes
H2a	Prom →AB	0.091	0.092	0.056	1.635	-0.009	0.205	No
H2b	INT →AB	0.644	0.644	0.042	15.307	0.556	0.722	Yes

Note: statistically insignificant model parameters are marked in red.

Source: own study.

It was also checked whether the Origin variable with two values (Germany and Poland) moderates the relationships in the structural model. For this purpose, a moderation analysis was conducted with the Origin variable as the moderator (see table 6). The obtained results indicate that although the Origin variable itself is an important parameter of the model, it does not moderate any relationship in the structural model. Adding the Origin variable to the model increases the explained variance of intentions (R2 = 0.532, Adj.R2 = 0.518) and actual behaviours (R2 = 0.480, Adj.R2 = 0.469).

Table 6.
Verification of the moderating role of the Origin variable

Relationship	Original Est.	Bootstrap Mean	Bootstrap SD	t Stat	2.5% CI	97.5% CI
ECO → INT	0.273	0.271	0.069	3.977	0.127	0.404
EOU → INT	0.267	0.263	0.058	4.645	0.148	0.372
SP → INT	0.141	0.145	0.062	2.289	0.019	0.266
Origin → INT	0.368	0.373	0.053	6.933	0.273	0.476
Origin → AB	-0.264	-0.266	0.060	-4.420	-0.380	-0.151
ECO*Origin → INT	0.040	0.046	0.057	0.706	-0.062	0.162
EOU*Origin → INT	0.083	0.084	0.066	1.254	-0.046	0.209
SP*Origin → INT	-0.022	-0.027	0.064	-0.343	-0.153	0.097
INT → AB	0.703	0.703	0.060	11.653	0.579	0.813
PROM → AB	0.166	0.167	0.052	3.185	0.066	0.268
INT*Origin → AB	0.059	0.064	0.070	0.840	-0.070	0.209
PROM*Origin → AB	0.031	0.033	0.059	0.522	-0.085	0.152

Note: statistically insignificant model parameters are marked in red.

Source: own study.

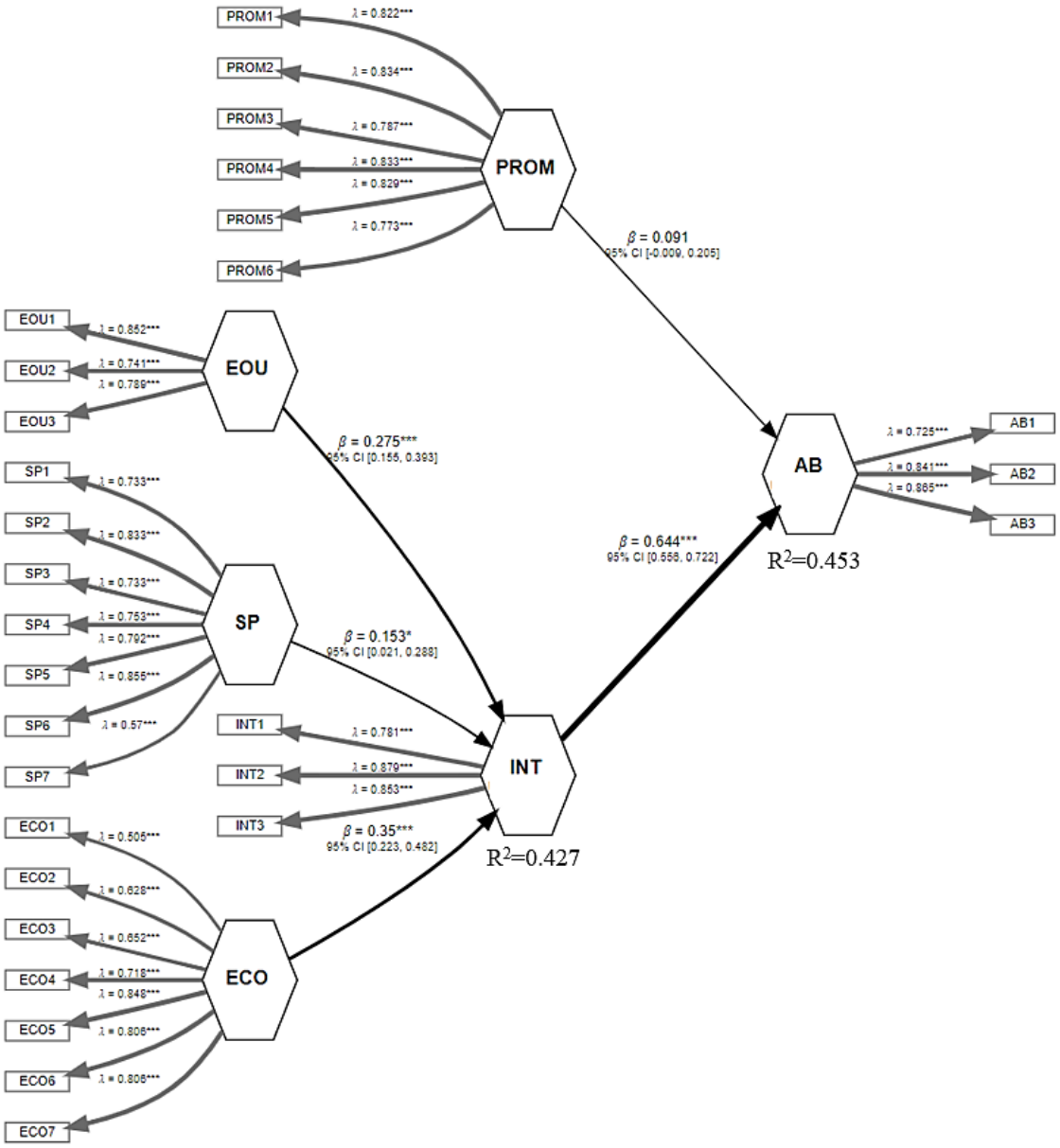

Figure 3. The model of bio-waste segregation.

Source: own study.

5. Discussion and conclusion

The obtained results of the structural model analysis provide valuable information on the factors influencing intentions and actual behaviors related to the correct sorting of bio-waste. The obtained coefficient of determination of actual behavior can be considered moderate but satisfactory, especially in the context of research on complex pro-ecological behaviors, which are usually conditioned by many factors, both individual and contextual (Ajzen, 1991). Additionally, intentions to properly separate bio-waste were explained by the expected

economic and ecological benefits, the perceived ease of sorting, and social pressure. This result confirms the importance of both rational premises (e.g. economic benefits) and social and cognitive factors in shaping pro-ecological attitudes.

In particular, the expected environmental and economic benefit had the greatest impact on intentions, which is confirmed by the literature, where instrumental motives are often indicated as key to environmental behavior (Steg et al., 2014). Perceived ease of sorting was also an important factor, which is consistent with the assumptions of the theory of planned behavior (Ajzen, 1991), emphasizing the role of perceived control over action. Social pressure, although it had a smaller impact, also turned out to be a significant predictor, which confirms the importance of social norms in the context of pro-environmental behavior.

Actual behaviors were determined to the greatest extent by prior intentions, which strongly confirms the mechanism postulated in models of rational action, where intentions are a direct predictor of behaviors. The high value of the path coefficient for this relationship emphasizes that the willingness to act itself is a key step towards realizing a pro-ecological attitude. In turn, the construct with the weakest and statistically insignificant impact on actual behaviors was promotion. This result suggests that traditional promotional activities may be insufficient to induce real behavioral change if they are not supported by other factors, such as internal motivation, benefits or social norms. This may indicate the need for more integrated educational campaigns, also taking into account the behavioral and psychological aspects of recipients (Schultz, 2014).

Our moderation analysis showed that the determinants of correct sorting of bio-waste and the determinants of the intention to do so are not moderated by the Origin variable, which concerned the country of origin of the surveyed respondents. In this way, we showed that the determinants of the studied constructs do not differ significantly in Poland and Germany. We consider this result to be very optimistic due to the fact that German society is considered to be well-developed in terms of waste separation.

However, our research is not free from limitations. First, the study was not conducted on a representative sample, and second, our sample was not very large. Therefore, the results we obtained cannot be generalized to the entire population. However, our research can be treated as a pilot study providing a preliminary verification of our hypotheses.

It is also worth noting that in our research we developed and validated valid and reliable scales measuring several constructs constituting a coherent research tool for examining factors determining bio-waste segregation. This tool can be used for future research.

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