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The Role of Communication Channels in Promoting Sustainable Wood Waste Management in the Czech Republic

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Abstract

Sustainable wood waste management is critical for achieving the Sustainable Development Goals (SDGs), mainly responsible consumption and production (SDG 12) and climate action (SDG 13). This study investigated the role of communication channels in promoting sustainable wood waste management practices in the Czech Republic, utilizing survey data from 1050 respondents. Based on ordinary least squares (OLS) regression, the findings reveal that television is the most influential media source, significantly enhancing engagement in wood waste management practices ($\beta = 0.0273$, $p < 0.10$). Socio-economic characteristics, such as age ($\beta = -0.0033$, $p < 0.001$), gender ($\beta = -0.0277$, $p < 0.10$), and place size ($\beta = 0.0150$, $p < 0.001$), also play significant roles, with younger individuals and residents of larger communities showing higher engagement. However, the predominance of alternative disposal methods, such as burning, raises environmental concerns. The study emphasizes the importance of taking legislative measures that target the youth demographic, increase waste management infrastructure, especially in rural regions, and use television as a medium for information communication. These results contribute to the conversation about the bioeconomy and sustainable waste management while providing stakeholders and policymakers with valuable information.

Keywords: wood waste; communication channels; bioeconomy; circular economy; Sustainable Development Goals

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1. Introduction

The global emphasis on sustainability has placed the circular bioeconomy at the forefront of efforts to achieve the United Nations Sustainable Development Goals (SDGs), particularly those related to responsible consumption and production (SDG 12) and climate action (SDG 13) [1–3]. Within this framework, sustainable waste management practices have gained significant attention as critical environmental and economic sustainability drivers [3]. Wood waste—generated from forestry operations, construction, furniture manufacturing, and other industries—represents a significant resource stream that, if managed effectively, can contribute to a circular bioeconomy. However, the rising volume of wood waste and inadequate management practices pose substantial challenges to sustainable development. This study investigated the role of communication channels in promoting sustainable wood waste management practices, focusing on the Czech Republic.

Wood waste is a byproduct of various industries, including forestry, construction, and manufacturing. About 25%–30% of all biomass waste produced worldwide comes from forestry and agricultural activities, with wood waste accounting for a sizable amount of this total [4,5]. The construction and demolition industry contributes significantly to the worldwide waste stream, with wood materials making up a sizable portion [6]. Ref. [7] asserted that construction waste is a major contributor to solid waste in landfills across developing countries. However, global roundwood production has been projected to increase by 4%–8% between 2022 and 2030, with a volume that ranges from 240 million m^3 to 1200 million m^3 [8]. This highlights the urgent need for effective and sustainable management of wood waste.

Efficient disposal and resource use, particularly in wood waste management, are critical to reducing environmental degradation and building a sustainable circular economy that values material recovery and reuse. At the epicenter lies the need for effective communication channels that enable stakeholders to share information, technologies, and best practices. Effective communication is pivotal in addressing the barriers to efficient waste management, particularly in wood waste, where a lack of information and coordination among stakeholders often leads to suboptimal practices. For instance, ref. [9] noted that less than 15% of high-value wood waste from agricultural products is effectively reintegrated into the agricultural production system. This gap represents an environmental problem and an untapped bioeconomic opportunity.

Several studies have underscored the importance of communication in waste management [10–12]. Nevertheless, all highlighted the critical role of inter-stakeholder communication and coordination in construction and demolition waste management. Poor communication channels create significant barriers to exchanging best practices, innovative solutions, and policy actions, resulting in inefficient waste management. Information dissemination and knowledge transfer are particularly challenging in the agricultural sector, which can generate and benefit from wood waste. For example, wood waste resources in Europe have an estimated bioeconomic potential of 60–80 million tons of available biomass annually, yet much of this potential remains untapped due to information and knowledge transfer barriers [4,5]. Farmers, foresters, and other stakeholders often operate in environments with limited access to technical information, leading to information asymmetries that impede bioeconomic development [13].

The accelerating impact of climate change on forestry and agricultural systems further justifies the urgent need to address these communication gaps. When wood waste is not managed correctly, it contributes to greenhouse gas emissions, exacerbating the effects of climate change. Conversely, sustainable wood waste management practices, such as composting and mulching, can enrich soil health, reduce the need for chemical fertilizers, and stimulate a circular bioeconomy [14]. However, current practices often fall short of these expectations due to poor inter-stakeholder communication and collaboration. This study sought to fill this gap by examining how various communication channels influence wood waste management practices, focusing on the Czech Republic.

The theoretical framework supporting this study was the diffusion of innovation theory [15], which posits that innovation adoption depends on communication channels and their perceived compatibility with local norms. In the Czech context, we hypothesized that television's dominance aligns with its historical role as a centralized and authoritative source [2], while digital platforms may lack observability. However, the theory highlights the importance of effective communication for disseminating sustainable practices in sustainable wood waste management. It suggests that stakeholders, including industry professionals, policymakers, and the community, must be engaged through various communication channels to promote effective waste management solutions. The theory emphasizes variables such as interpersonal networks, community meetings, social media, and

the perceived benefits of adopting sustainable practices, which can significantly influence stakeholder engagement [16]. This framework has been applied in various contexts, including waste management in Nigeria [17], where targeted communication campaigns and community participation effectively shifted norms toward sustainable practices.

Even though numerous studies have indicated that areas with a denser communication infrastructure tend to engage in more advanced wood waste management activities [18], we still lack a comprehensive understanding of how communication networks influence these behaviors. This knowledge gap hinders the development of communication-driven initiatives that effectively shape attitudes towards wood waste management practices. Addressing this gap is crucial for designing policies and strategies that leverage communication channels to enhance waste management practices, primarily in the context of the bioeconomy.

This study aimed to contribute to scholarly and practical insights by examining how different communication channels influence wood waste management practices in the Czech Republic. Specifically, it sought to answer the following research questions:

1. What are the primary communication channels to disseminate information on wood waste management in the Czech Republic?
2. How do this communication channels influence the adoption of sustainable wood waste management practices among different demographic groups?
3. What are the policy implications of these findings for promoting sustainable wood waste management in the context of the bioeconomy?

By addressing these questions, this study provides actionable insights for policymakers, industry stakeholders, and communal leaders on designing and implementing communication strategies that support sustainable wood waste management practices. Furthermore, the findings contribute to the broader context of bioeconomy strategies by highlighting the importance of effective communication channels for achieving the Sustainable Development Goals (SDGs) in various sectors. Furthermore, this study is guided by the Czech National Bioeconomy Strategy (2021–2030), which emphasizes sustainable material flows and enhanced resource efficiency and supports [19] in using forest products in Czech bioeconomy contexts.

In summary, this study is situated at the intersection of environmental sustainability, communication, and bioeconomy. It builds on existing literature by examining the role of communication channels in promoting sustainable wood waste management practices, focusing on the Czech Republic. The findings will advance scholarly understanding of this topic and provide practical recommendations for policymakers and stakeholders seeking to enhance waste management practices in the circular bioeconomy.

2. Materials and Methods

This study was conducted as part of a comprehensive national survey embedded within two overarching research projects: Advanced Research Supporting the Adaptation of the Forestry and Wood-Processing Sector to Global Change, and the Fourth Industrial Revolution and Diversification of the Bioeconomy's Impact on Strategic Documents of the Forestry-Wood Sector as a Basis for State Administration and Strategic Goal Formulation. The research was carried out in collaboration with REMMARK, a.s., a Prague-based market research agency, and employed a mixed-method approach to ensure robust data collection and analysis.

2.1. Study Area

The Czech Republic was chosen as the study area due to its significant forest coverage, constituting approximately 34.1% of the nation's total land area [20] The forest

composition is dominated by coniferous species, predominantly Norway spruce (*Picea abies*), which accounts for 50.3% of the total forested area. Deciduous species, such as oak (*Quercus* spp.) and European beech (*Fagus sylvatica*), make up 27% of the forest cover, while the remaining 1.1% consists of treeless woodland areas [19,21]. This diverse forest ecosystem provides a rich context for examining wood waste management practices and the role of communication channels in promoting sustainability.

2.2. Study Design and Data Collection

The computer-assisted web interviewing (CAWI) method was utilized to collect data from a representative sample of 1050 respondents for this study. This technique aligns with best practices for online surveys, as outlined by [22], and ensures efficient data collection while preserving respondent anonymity. Participants were recruited through REMMARK's proprietary database, with survey invitations delivered through several online channels, including email and social media platforms. Respondents were chosen according to important demographic factors, such as age (18–65 years), gender, educational level, geographic location, and settlement size, to guarantee a representative sample.

The survey instrument consisted of closed-ended questions to gather socio-demographic data and insights into respondents' engagement with wood waste management practices. Furthermore, respondents were allowed to provide qualitative comments by selecting "other" and complementing their responses with written explanations. The open-ended responses were subsequently coded and classified to facilitate further quantitative research [23]. The survey was terminated upon reaching the predefined minimum sample size and all completed questionnaires were retained for analysis, resulting in a 100% response rate.

2.3. Data Analysis

The data were analyzed using both descriptive and inferential statistics. Descriptive statistics, including frequencies, means, and standard deviations, were used to summarize the demographic characteristics of the respondents and their engagement with wood waste management practices. Inferential statistics, specifically ordinary least squares (OLS) regression, predict a dependent variable based on continuous and/or categorical independent variables, where the dependent variable takes a continuous form [24]. The OLS in this study examined the relationship between media sources and wood waste management practices. The regression model included socio-economic variables (age, gender, place size, educational level) and media consumption habits (television, online news, social media, printed media, radio) as the independent variables, with the composite engagement score as the dependent variable. All practices were assigned equal weights based on normative assumptions of equal importance. Sensitivity analysis confirmed the robustness of this weighting scheme. Although some individual outcomes are binary, the composite engagement score is continuous, justifying using OLS. Robustness checks using logistic regression on individual behaviors yielded similar directional results. Multicollinearity among the independent variables was assessed using a correlation matrix, and no significant multicollinearity issues were detected.

Model Specification

The OLS regression model is specified as follows:

$$Y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + u$$

where Y^* is the dependent variable, which is given as the composite engagement score of respondents i in wood waste management practices. $X_1 \ldots X_k$ are the independent or

explanatory variables. β_0 is the intercept, $\beta_1 \ldots \beta_k$ are the estimated coefficients of the independent variables, and u is the error term, which is assumed to be normally distributed and captures the net effect of omitted factors. The media variables focus on exposure rather than usage intensity (e.g., time spent, content type).

2.4. Ethical Considerations

The study adhered to strict ethical standards, ensuring that all participants provided informed consent before participating in the survey. No personal identifiable information was collected, and all data were anonymized to protect respondent privacy. The research protocol was reviewed and approved by the ethics review board of the collaborating institution, ensuring compliance with international ethical guidelines for social science research.

3. Results

The results of this study provide valuable insights into the demographic characteristics of the respondents, their media consumption habits, and their engagement with wood waste management practices. The findings are presented in three main sections: (1) demographic characteristics, (2) media consumption habits, and (3) wood waste management practices.

3.1. Demographic Characteristics

The demographic profile of the respondents is summarized in Table 1. The sample consisted of 1050 respondents, with a balanced gender distribution (50.8% male and 49.2% female). The average age of the respondents was 42.4 years, with a standard deviation of 13.5 years, indicating a relatively wide age range. Most respondents were between 36 and 55 years old (43.6%), followed by those aged 18–35 (34.8%) and those over 55 (21.6%). Geographically, the sample was well distributed across the Czech Republic, with 53.5% of respondents residing in Bohemia, 32.6% in Moravia, and 13.9% in Prague, the capital city. In terms of education, most respondents had completed secondary education (37.7%), followed by high school (36.3%), university (15.6%), and primary school (10.4%). This distribution suggests that the sample was representative of the general population in terms of age, gender, and education, which enhances the generalizability of the findings.

Table 1. Distribution of the socio-economic characteristics of the sampled respondents.

Variable	Frequency	Percentage
Sex		
Male	533	50.8
Female	517	49.2
Total	1050	100.0
Age		
18–35	365	34.8
36–55	458	43.6
>55	227	21.6
Total	1050	100.0
Mean = 42.4, SD = 13.5		
County		
0	146	13.9
1	69	6.6
2	119	11.3
3	33	3.1

4	53	5.1
5	42	4.0
6	118	11.2
7	56	5.3
8	48	4.6
9	54	5.1
10	130	12.4
11	85	8.1
12	48	4.6
13	49	4.7
Total	1050	100.0
Region		
Prague (capital city)	146	13.9
Bohemia	562	53.5
Moravia	342	32.6
Total	1050	100.0
Place size		
Up to 1000 inhabitants	170	16.2
1001–5000 inhabitants	218	20.8
5001–20,000 inhabitants	191	18.2
20,001–100,000 inhabitants	226	21.5
>100,000 inhabitants	245	23.3
Educational level		
Elementary school	109	10.4
Secondary/vocational training	396	37.7
High school graduates	381	36.3
University	164	15.6
Frequency of forest visits		
Never	11	1.0
One or two times per year	229	21.8
Once a month	349	33.2
Once a week	283	27.0
Several times per week	178	17.0

N.B: County codes are defined as follows: 0 = Prague, 1 = South Bohemia, …, 13 = Zlín Region (see Appendix A for full details). Source: Authors' compilation from field survey, 2024.

3.2. Media Consumption Habits

Table 2 summarizes the respondents' engagement with different media sources. Television emerged as the most consumed media, with a mean engagement score of 0.55, indicating that over half of the respondents regularly watch television. This was followed by online news (mean = 0.32) and social media (mean = 0.30). In contrast, traditional media, such as printed media (mean = 0.13) and radio (mean = 0.14), had significantly lower engagement levels. These findings are consistent with recent studies that highlight the declining influence of traditional media in favor of digital platforms [25]. However, the continued dominance of television in the Czech Republic suggests that it remains a critical channel for disseminating information, particularly among older demographics.

Table 2. Distribution of respondents' engagement with media sources.

Variables	Count	Mean	Std. Dev.
Television	1050	0.55048	0.49768
Online news	1050	0.32191	0.46743

Social media	1050	0.29619	0.45679
Printed media	1050	0.13333	0.34010
Radio	1050	0.14571	0.35299

Source: Authors' compilation from field survey, 2024.

3.3. Wood Waste Management Practices

Table 3 presents the results of respondents' engagement with various wood waste management practices. Approximately 35% of respondents reported using carpenter workshops for wood waste management, while 27% utilized yard collection and 18% used containers. Only 6% of respondents indicated using dustbins for wood waste disposal. Notably, 46% of respondents reported having no wood waste, which could reflect effective waste management practices or limited wood usage. However, alternative disposal methods, such as burning, were also reported, raising concerns about the environmental impact of these practices. These findings align with recent studies highlighting the prevalence of informal waste disposal methods, particularly in rural areas [7].

Table 3. Distribution based on respondents' choice of wood waste disposal method.

Variables	Count	Mean	Std. Dev.
Carpenter workshop use	1049	0.35367	0.47834
Dustbin	1050	0.06000	0.23760
Yard collection	1050	0.27048	0.44442
Container	1050	0.18286	0.38673
No wood waste	1050	0.46191	0.49878
Other places' wood waste (I will burn)	177		

Source: Authors' compilation from field survey, 2024.

3.4. Effect of Media Sources on Wood Waste Management Practices

A composite engagement score was calculated based on respondents' engagement with various practices to examine the relationship between media sources and wood waste management practices. This score was generated by summing various engagement practices. This score reflected the level of farmers' engagement based on specific actions or behaviors related to wood waste management. This approach allowed for a quantifiable measure of engagement to be analyzed concerning the independent variables (media sources). The various media sources defined independent variables. Table 4 summarizes the engagement variable, its components, and how it was constructed. It provides insights into the distribution of each engagement practice, including the mean, standard deviation, and range of values. This information is crucial to understanding how the engagement score was constructed and its variability among the respondents.

Table 4. Construction of the composite score.

Variables	Count	Mean	Std. Dev.
Carpenter workshop use	1049	0.35367	0.47834
Dustbin	1050	0.06000	0.23760
Yard collection	1050	0.27048	0.44442
Container	1050	0.18286	0.38673
No wood waste	1050	0.46191	0.49878
Engagement score	1049	1.32889	0.68346

Source: Authors' compilation from field survey, 2024.

The engagement score, which averaged around 1.33, indicates that respondents typically engage in a combination of the practices measured. Also, the variability in practices

such as "carpenter workshop use" and "dustbin usage" suggests differing levels of engagement among the surveyed population.

Subsequently, a correlation matrix was computed between the media sources and the new engagement score.

From Table 5 below, the correlation matrix for the media sources shows relatively low correlations among the independent variables, indicating that multicollinearity is not a significant issue. The highest correlation is between "television" and "radio," at approximately 0.216, which is not strong enough to cause multicollinearity problems. Therefore, the regression analysis was run given a sufficient variance and no multicollinearity.

Table 5. Correlations among variables.

Variables	Television	Online News	Social Media	Printed Media	Radio	Engagement Score
Television	1	0.06122	0.05368	0.13479	0.21585	0.12318
Online news	0.06122	1	0.07986	0.12553	0.17188	0.06819
Social media	0.05368	0.07986	1	0.07077	0.04542	0.05719
Printed media	0.13479	0.12553	0.07077	1	0.21122	0.11882
Radio	0.21585	0.17188	0.04542	0.21122	1	0.06347
Engagement score	0.12318	0.06819	0.05719	0.11882	0.06347	1

Source: Authors' compilation from field survey, 2024.

Table 6 shows the regression analysis evaluating the impact of media sources (television, online news, social media, printed media, and radio) on the composite engagement score.

Table 6. Effect of media source adoption on wood waste management practices.

Variables	Coefficient	Std. Error	$p > \|t\|$
Age	−0.0033 ***	0.001	0.000
Gender	−0.0277 *	0.015	0.058
County	−0.0004	0.002	0.819
Region	−0.0079	0.012	0.504
Place size	0.0150 ***	0.006	0.009
Educational level	−0.0127	0.008	0.132
Frequency of forest visits	−0.0028	0.007	0.697
Television	0.0273 *	0.015	0.069
Online news	−0.0077	0.016	0.634
Social media	0.0170	0.017	0.304
Printed media	−0.0150	0.022	0.497
Radio	0.0172	0.022	0.425
Friends and family	−0.0114	0.015	0.448

*** Significant at 1%; ** significant at 5%; * significant at 10%. R-squared: 0.053, Adj. R-squared: 0.041, F-statistic: 4.488, Prob (F-statistic): 1.75×10^{-7}, $n = 1050$.

The results of the ordinary least squares (OLS) regression analysis are presented in Table 6. Approximately 5.3% of the variance (adjusted R-squared = 4.1%) was explained by the model, which is consistent with behavioral studies where communication channels alone explain modest variance [26]. Future research should integrate structural variables (e.g., recycling infrastructure proximity) to account for unobserved barriers.

Among the socio-economic variables, age, gender, and place size were statistically significant predictors of engagement in wood waste management practices. Age had a negative coefficient ($\beta = -0.0033$, $p < 0.001$), indicating that younger respondents were more likely to engage in sustainable practices. This finding agrees with [25], who suggested that younger populations are environmentally conscious and more likely to adopt

sustainable behaviors. Gender also had a significant effect, with females showing lower engagement ($\beta = -0.0277$, $p < 0.10$), which may reflect differences in access to information or resources. Place size had a positive coefficient ($\beta = 0.0150$, $p < 0.001$), suggesting that respondents in larger communities were more likely to engage in wood waste management practices, possibly due to better access to waste management infrastructure.

Among the identified media sources, television was positively significant in the effect on engagement ($\beta = 0.0273$, $p < 0.10$), indicating that increased exposure to television was associated with higher engagement in wood waste management practices. This finding is in tandem with recent literature studies highlighting traditional media's role in disseminating environmental information, particularly in regions with limited digital infrastructure [27,28]. However, digital media (online news, social media) showed non-significant effects, potentially due to survey limitations in capturing usage intensity (e.g., passive scrolling vs. active engagement in eco-groups) or generational trust gaps. Qualitative follow-ups could clarify this paradox.

4. Discussion

The findings of this study contribute to the growing body of literature on the role of communication channels in promoting sustainable waste management practices. The significant effect of television on engagement corroborates studies that emphasize the importance of traditional media in disseminating environmental information, particularly in regions with limited digital infrastructure [28]. Conversely, the limited effect of digital media despite higher youth engagement is astounding, given the increasing reliance on these platforms for information dissemination [25,29]. This discrepancy may reflect differences in media consumption habits between the Czech Republic and other regions and the need for more targeted and engaging content on digital platforms. The media variables focus on exposure rather than usage intensity (e.g., time spent, content type). This may obscure nuances like passive social media scrolling versus active engagement in sustainability forums [25,27], partly explaining the youth–digital media contradiction. Future studies should employ granular metrics (e.g., platform-specific engagement logs) to unravel this paradox.

The finding that younger respondents were more likely to engage in sustainable practices conforms with the literature suggesting that younger populations are more environmentally conscious and likely to adopt sustainable behaviors [25]. Lower female engagement (e.g., open-ended responses cited gendered task division: "Woodwork is my husband's responsibility") suggests campaigns should highlight women-led upcycling initiatives to shift the norms. However, as stated by [29], this could be a psychological barrier rooted in cultural norms.

The positive influence of place size on engagement corresponds with studies highlighting infrastructure's role in promoting sustainable practices [12]. Larger communities are more likely to have access to waste management facilities and services, which may facilitate engagement in sustainable practices. However, the prevalence of alternative disposal methods, such as burning, in smaller communities raises concerns about the environmental impact of these practices. This highlights the need for targeted interventions in rural areas.

The findings of this study are in harmony with the literature on the role of communication channels in promoting sustainable waste management practices. For example, ref. [28], found that traditional media, such as television and radio, effectively promoted waste management practices in Nigeria, mainly in rural areas with limited digital infrastructure. Ref. [25] highlighted the importance of targeted communication strategies in promoting sustainable practices in developing regions, emphasizing the need for culturally relevant and accessible content. The significance of television ($\beta = 0.0273$) aligns with

[15] the diffusion theory of observability and authority because broadcast media have historically been seen by Czech audiences as credible for spreading normative behaviors [22]. Nevertheless, Czech consumers may find digital platforms less desirable to use due to compatibility issues, such as passive scrolling or a lack of locally relevant material [30].

However, this study's findings on digital media's limited impact contrasts with recent findings from other regions. For example, ref. [31] found that digital media tools, such as social media and online platforms, effectively promoted real-time information exchange and collaboration among stakeholders in urban development projects. This discrepancy may reflect differences in media consumption habits and infrastructure between the Czech Republic and other regions and the need for more engaging and targeted content on digital platforms. Unlike Nigeria's mobile-driven engagement [28], Czech reliance on TV reflects post-socialist media centralization. This divergence underscores that "one size fits all" communication strategies fail—a lesson for SDG 12 global frameworks.

Implications for Policy and Practice

The study's findings could lead to several conclusions for practitioners and policymakers who want to promote ecologically friendly approaches to wood waste management. Television has a significant impact. Thus, using conventional media to spread knowledge and increase awareness of sustainable practices makes sense. However, the limited influence of digital media emphasizes the need for more relevant and interesting material on these channels, particularly for younger and tech-savvy populations.

On the other hand, the findings that younger respondents were more inclined to adopt sustainable habits imply that educational campaigns and outreach programs should focus on younger audiences. These initiatives could use digital platforms like social media and online news to connect with younger audiences and encourage eco-friendly practices.

In conclusion, the favorable effect of place size on participation highlights how essential infrastructure is for encouraging sustainable practices. Policymakers must prioritize the construction of waste management services and infrastructure in smaller communities, especially in rural regions, to encourage the adoption of sustainable practices and lessen burning and other alternative disposal techniques.

5. Conclusions

Effective communication plays a crucial role in sustainable wood waste management. By bridging information gaps and suggesting effective communication channels, this study investigated the effect of media sources on wood waste management practices in the Czech Republic. The findings revealed a nuanced interplay between socio-economic factors, media consumption habits, and engagement behaviors of respondents in various wood waste management practices. The findings reveal that television remains a dominant and effective medium for disseminating information on wood waste management, particularly among older demographics. Younger respondents and those residing in larger communities exhibited higher engagement in sustainable practices, aligning with recent studies highlighting younger populations' environmental consciousness and the infrastructure's role in facilitating waste management [12,25]. However, the limited impact of digital media, such as online news and social media, suggests that these platforms require more targeted and engaging content to promote sustainable behavior effectively.

The findings of this study are consistent with recent research that emphasizes the role of communication channels in promoting sustainable waste management practices. For example, ref. [28] found that traditional media, such as television, effectively raised awareness about waste management in Nigeria, particularly in rural areas. Similarly, ref. [25] asserted the importance of targeted communication strategies in promoting sustainable

practices in developing regions, aligning with SDG 12. However, the limited impact of digital media in this study contrasts with the findings of [31], who demonstrated the effectiveness of digital tools in fostering collaboration and information exchange among stakeholders. This discrepancy underscores the need for context-specific strategies considering local media consumption habits and infrastructure.

The study also emphasizes the prevalence of alternative disposal methods, such as burning, particularly in smaller communities, which raises concerns about these practices' environmental and health impacts. This finding underscores the urgent need for interventions addressing rural information and infrastructure gaps and fostering stakeholder collaboration to promote sustainable wood waste management practices. Furthermore, the study operationalizes Rogers's theory by revealing how television's authority and observability drive practice adoption, while digital media's design fails to bridge compatibility gaps—a critical lesson for SDG 12 communication strategies.

In conclusion, this study provides actionable insights for policymakers and practitioners seeking to promote sustainable wood waste management practices in the Czech Republic. By leveraging effective communication channels, targeting key demographics, and improving infrastructure, stakeholders can contribute to achieving the Sustainable Development Goals and fostering a more sustainable and circular bioeconomy.

6. Recommendations

1. Leverage Television for Awareness Campaigns: Given the significant influence of television on engagement in wood waste management practices, policymakers and practitioners should prioritize this medium for public awareness campaigns. Partnering with Czech Television's Week in Forestry program to embed waste management segments mirrored their successful wildfire public service announcement. These campaigns should emphasize sustainable wood waste management's environmental and economic benefits and the risks associated with improper disposal methods, such as burning. This approach aligns with SDG 12 (Responsible consumption and production) by promoting sustainable resource use and waste reduction.
2. Target Younger Demographics through Digital Platforms: The higher engagement of younger respondents suggests that digital platforms, such as social media and online news, should be utilized to reach this demographic. Educational programs and outreach initiatives should be designed to cultivate environmental consciousness among young people, leveraging interactive and engaging content to promote sustainable behaviors. This strategy supports SDG 4 (Quality education) by fostering awareness and knowledge about sustainable practices.
3. Improve Waste Management Infrastructure in Rural Areas: The positive correlation between place size and engagement highlights the importance of infrastructure in promoting sustainable practices. Policymakers should prioritize the development of waste management facilities and services in smaller communities, particularly in rural areas, to reduce the prevalence of alternative disposal methods and enhance accessibility to sustainable options. This aligns with SDG 9 (Industry, innovation, and infrastructure) by promoting inclusive and sustainable industrialization.
4. Foster Stakeholder Collaboration**:** Effective communication among stakeholders, including government agencies, industry professionals, and local communities, is essential for promoting sustainable wood waste management practices. Policymakers should facilitate platforms for knowledge sharing and coordination, ensuring that best practices and innovative solutions are disseminated widely. This approach supports SDG 17 (Partnerships for the goals) by fostering multi-stakeholder partnerships for sustainable development.

5. Conduct Further Research: Future studies should explore how digital media can be more effectively utilized to promote sustainable practices, particularly in regions with limited digital infrastructure. Additionally, research should investigate gender-based differences in engagement and identify strategies to address these disparities.

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Appendix A. County Codes

County Code	County Name
0	Prague
1	South Bohemia
2	South Moravia
3	Karlovy Vary
4	Hradec Kralove
5	Liberec
6	Moravia-Silesia
7	Olomouc Region
8	Pardubice
9	Pilsner
10	Central Bohemia
11	Ustec
12	Vysocina
13	Zlin Region

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