Journal of Natural Resources and Environmental Management
http://dx.doi.org/10.29244/jpsl.14.3.451

RESEARCH ARTICLE

OPEN ACCESS

Check for updates

Nature-Based Solutions in Urban Landscapes: Determinants Influencing Willingness to Participate in Composting in Metropolitan Jakarta, Indonesia

Laili Fitria[a], Rachmat Mulyana[b], I Wayan Koko Suryawan[c], Nova Ulhasanah[c], Iva Yenis Septiariva[d], Wisnu Prayogo[b], Sapta Suhardono[e], Mega Mutiara Sari[c], Nur Novilina Arifianingsih[f], Dwinto Martri Aji Buana[g]

[a] Department of Environmental Engineering, Faculty of Engineering, Universitas Tanjungpura, Pontianak 78124, Indonesia
[b] Department of Building Engineering Education, Universitas Negeri Medan, Medan, 20221, Indonesia
[c] Department of Environmental Engineering, Faculty of Infrastructure Planning, Universitas Pertamina, Jakarta, 12220, Indonesia
[d] Civil Engineering Study Program, Faculty of Engineering, Universitas Sebelas Maret, Surakarta, 57126, Indonesia
[e] Environmental Sciences Study Program, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, Surakarta, 57126, Indonesia
[f] Department of Environmental Engineering, Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, 40132, Indonesia
[g] Department of Management, Widyatama University, Bandung, 40125, Indonesia

Article History
Received
06 November 2023
Revised
18 November 2023
Accepted
22 February 2024

Keywords
compostin, nature-based solutions, willingness to participate

ABSTRACT

Amidst the rapid urbanization of Jakarta, the adoption of Nature-based Solutions (NbS) such as composting offers a sustainable pathway for waste management and environmental rejuvenation. This research endeavors to discern the critical factors impacting the willingness of Jakarta's metropolitan population to participate in composting. This study identified key determinants through a comprehensive analysis, including the availability of composting facilities, expertise of trained cadres, adoption of advanced composting technologies, and routine field monitoring. Furthermore, demographic nuances, specifically marital status, and age, emerged as influential parameters. Singles and the younger age bracket (20 to 29 years) exhibited distinct attitudes towards composting, hinting at underlying generational and lifestyle-based disparities. These findings provide a foundation for tailoring policies and interventions that cater to Jakarta's unique urban fabric, promoting a more inclusive and influential composting culture.

Introduction

As the world grapples with the accelerating impacts of climate change, urbanization, and dwindling natural resources, sustainable practices have moved from mere buzzwords to necessary interventions [1,2]. The concept of Nature-based Solutions (NbS) is at the forefront of these solutions. According to the International Union for Conservation of Nature (IUCN) [3,4], NbS involves actions to safeguard, sustainably manage, and restore natural or modified ecosystems to address societal challenges, providing both human well-being and biodiversity benefits. Jakarta, a bustling metropolis, symbolizes rapid urban expansion in Asia [5]. However, with its mounting population, the city also bears the brunt of increasing waste generation, predominantly from organic waste. The by-products of this waste accumulation are manifold, from the emission of greenhouse gases such as methane to the clogging of urban drain systems and the resultant floods. Against this backdrop, composting has emerged not just as a waste management technique but also as an embodiment of NbS in an urban setting.

Composting, the biological decomposition of organic substrates under controlled conditions to a stable state [6,7], fits perfectly into the NbS framework. It transforms organic waste into a valuable resource, diverting significant waste from landfills, reducing greenhouse gas emissions, and enhancing soil health [8,9]. Moreover, compost is a carbon sink, locking the carbon that would otherwise be released into the atmosphere, thus playing a pivotal role in urban carbon management. In recent years, global and local policies

Corresponding Author: I Wayan Koko Suryawan i.suryawan@universitaspertamina.ac.id Department of Environmental Engineering, Faculty of Infrastructure Planning, Universitas Pertamina, Jakarta, Indonesia.

have begun to recognize the paramount importance of composting in the broader NbS discourse [10,11]. It reduces waste footprints and revitalizes urban green spaces, ensuring that they are resilient and adaptive to changing climatic conditions [12]. By improving soil structure and water retention, and increasing soil organic carbon content, composting prepares urban green patches to face extreme weather events. Whether in community gardens, urban farms, or green rooftops, composting is the backbone to make these spaces sustainable and, in turn, make cities more livable [12,13].

Composting to become a mainstream NbS in urban settings such as Jakarta demands a systemic shift and convergence of policy, practice, and people. On the policy front, composting requires recognition not only as a waste management tool but also as an NbS initiative that deserves funding, research, and infrastructural support. Strategies that incentivize community- or household-scale composting provide technological solutions for efficient composting [14], promoting compost use in public spaces, which can help institutionalize this practice. Practically, these challenges are multi-faceted. Owing to the need for trained cadres who understand composting intricacies to meet the demand for community networks that foster environmental education [15], composting as an NbS requires ground-level mobilization. Furthermore, continuous monitoring, appreciation, and incentives can drive community participation, making composting a collective endeavor.

In the rapidly urbanizing environment of Jakarta [16], the role of NbS in composting has gained significant attention in the rapidly urbanizing environment of Jakarta. However, several gaps in our understanding and implementation remain. For example, despite the recognized benefits of composting, there is a conspicuous absence of comprehensive studies detailing its wide-ranging impact in metropolitan areas, such as Jakarta. Furthermore, although the environmental merits of composting have been highlighted, their economic feasibility remains under scrutiny. There is a pressing need for in-depth economic analyses that juxtapose the costs of initiating composting with the tangible and intangible benefits it bestows on urban environments. This economic perspective is even more pertinent given the disconnect between policy propositions and grassroots-level realization. The level of comprehension, appreciation, and, consequently, the willingness of Jakarta residents to actively participate in composting efforts is an area that demands further investigation. In the broader spectrum of NbS, the symbiotic relationship between composting and other nature-based interventions, such as green roofs or urban forests, is another dimension warranting deeper insight. How these solutions can be harmonized to produce compounded benefits remains a fertile ground for research.

This study aimed to bridge critical knowledge gaps by evaluating the factors influencing Jakarta's metropolitan populace's willingness to participate in composting activities. Specifically, our study seeks to: while the global narrative on NbS has evolved from a governance perspective, Jakarta-specific policy frameworks, especially those custom-designed to its unique challenges, are in their embryonic stages. Another aspect that has not been fully explored is the potential incentives to catalyze community and private composting initiatives. Finally, community buy-in played an essential role. The success of composting, like any NbS, depends on community perceptions and willingness to participate (WTP). Socioeconomic factors, such as gender, marital status, age, education level, and income, can influence WTP, making it crucial for policymakers and practitioners to understand these dynamics.

Materials and Methods

Study Location and Survey Execution

Jakarta was chosen as the study location because of its distinctive urban dynamics, in which rapid urbanization and environmental concerns intermingle. With its blend of cultures, demographics, and lifestyles, this city has served as a microcosm to delve deeper into composting practices, especially given the pressing environmental challenges that it faces. The core of our data-collection process relied on a meticulously designed questionnaire. Recognizing the importance of capturing genuine and insightful responses, the questionnaire was structured as exhaustive and engaging. The questionnaire began with preliminary demographic questions to understand the backgrounds of the respondents. The subsequent sections delve into their understanding, practices, and willingness to engage in composting. We incorporated closed- and open-ended questions for the statistical analysis to capture nuanced insights.

Before the full-scale distribution, the questionnaire underwent a pilot phase to identify and rectify ambiguities. Our data analysis followed a multipronged approach. We began with descriptive statistics to understand the fundamental trends and patterns. This was supplemented with inferential statistics, where we applied models such as probit and logit to deduce the relationships between various factors and willingness to participate in composting. The choice of these models was driven by their ability to handle binary outcomes, making them suitable for our research objectives.

Table 1 and Figure 1 provide a detailed overview of the essential attributes that influence attitudes and sociodemographic factors related to composting practices. These include the availability of both community—and private-scale composting facilities, the provision of funding for composting programs, and the role of trained cadres proficient in composting techniques.

Table 1. Attributes for attitude and sociodemographic characteristics for composting.

No	Attribute	Code	Question
1	Availability of community or private scale composting facilities [17]	Availability	Do you believe the availability of community-scale composting is important for the community?
2	Funding from government or sponsors for composting programs [18]	Funding	Do you believe funding from the government or sponsors for composting programs is important for the community?
3	Trained cadres in understanding composting techniques [19]	Cadres	Do you believe having trained individuals who understand composting techniques is important for the community?
4	Ability to adopt efficient and environmentally friendly composting technology [20]	Adopt	Do you believe that the ability to adopt efficient and environmentally friendly composting technology is important for the community?
5	Existence of an active community network for composting and environmental education [21,22]	Network	Do you believe that having an active community network for composting and environmental education is important for the community?
6	Community training and education programs on composting [21,23]	Education	Do you believe community training and education programs on composting are important for the community?
7	Continuous understanding of the community [24]	Continuous	Do you believe that continuous understanding and education for the community is important?
8	Routine field monitoring of composting practices [25]	Routine	Do you believe routine field monitoring of composting practices is important for the community?
9	Appreciation and incentives for household scale [24] composting	Incentives	Do you believe providing appreciation and incentives for household-scale composting is important for the community?
10	Socio-economy	Gender	What is your gender?
		Marital	What is your marital status?
		Age	In which age range do you fall?
		Higher education	What is the highest level of education you have completed?
		Occupation	What is your occupation?
		Income	What is your monthly income range?

For the sample selection, we adopted a stratified random sampling approach. Considering Jakarta's socioeconomic diversity, we ensured comprehensive representation across various demographic groups. Our target respondents ranged from individual households to commercial establishments, emphasizing a balanced perspective from both the residential and commercial sectors. We aimed for a sample size that was both manageable and statistically significant, ensuring that our results would have broader applicability to the entire city. When analyzing the WTP in composting in Jakarta based on various factors, 'Age' stands out with a p-value of 0.01, indicating a significant influence on composting practices across different age groups. 'Marital Status' and 'Higher Education' have p-values close to the typical significance threshold, hinting that they might somewhat impact composting willingness, albeit not as strongly as age. Meanwhile, 'Gender,' 'Occupancy,' and 'Income' show no significant relation to WTP, suggesting that these factors don't primarily determine composting behaviors in Jakarta.

Our decision to focus on specific variables, such as the availability of composting facilities, the role of trained cadres, and the adoption of environmentally friendly technology, was driven by preliminary observations and literature reviews. These variables were identified as potentially influential factors based on previous studies [22,24]. The choice of a mixed-method approach, combining quantitative survey data with qualitative interviews, was intended to provide a comprehensive view of the community's attitudes and behaviors towards composting. This approach allowed us to capture nuanced insights that might not be evident using purely quantitative or qualitative methods.

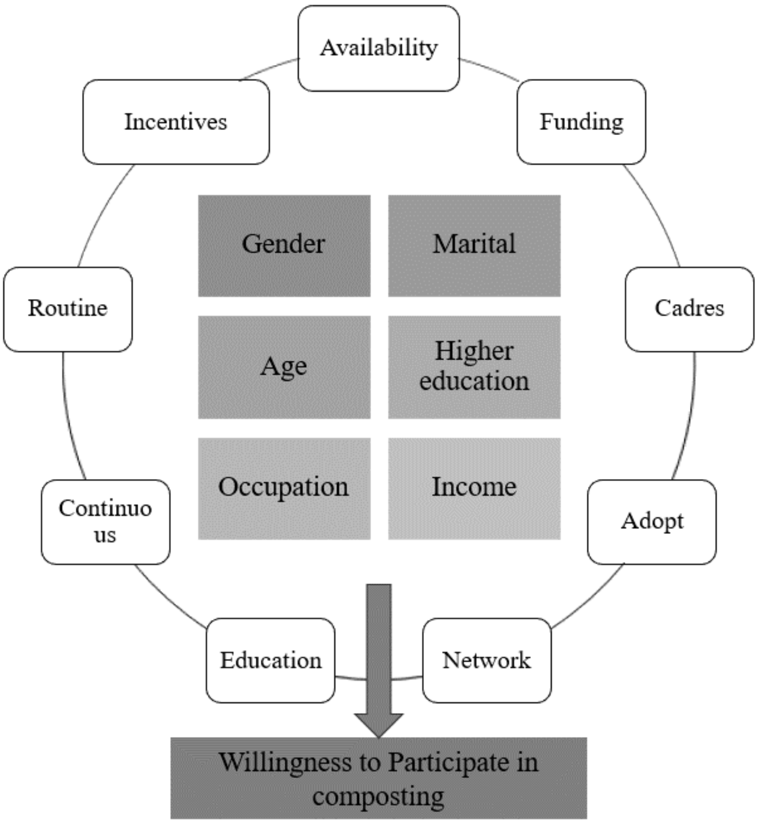

Figure 1. Research framework.

Data Analysis

For our research, the logit and probit models are powerful statistical tools to analyze the WTP in composting in Jakarta (Table 2). These models are particularly suited for dichotomous dependent variables, in this case the willingness (or lack thereof) of the compost. In models 1 to 3, the probit model estimates the probability that an observation with properties will fall into a specific one of the limited category depending on the given independent variables. The function's name comes from the "Probability Unit," representing the cumulative distribution function of the standard normal distribution. In this study, the probit model explores how factors such as the availability of composting facilities, funding, and cadre training influence the WTP for composting.

Table 2. Socio demography of respondents.

Attribute		Not WTP	Yes WTP	Pearson Chi-Square	Asymptotic significance (2-sided)
Gender	Male	113	95	2.081	0.149
	Female	118	74		
Marital status	Married	69	38	2.716	0.099
	Single	162	131		
Age	20–29	112	104	6.695	0.01
	30–49	119	65		
Higher Education	High school and below	104	61	3.209	0.073
	Bachelor's degree or above	127	108		
Occupancy	Formal	177	130	0.005	0.944
	Non-formal	54	39		
Income	Below IDR 5 million	58	39	5.173	0.160
	IDR 5–10 million	94	54		
	IDR 10.1–15 million	61	60		
	Above IDR 15 million	18	16		

Model 1, with the probit approach, focuses on the effects of various composting policies and practices on WTP. For instance, it assesses how the availability of community-scale composting or incentives may influence the decisions of individuals or entities to participate in composting. Model 2, still under the probit umbrella, focuses on demographic and socioeconomic factors. By considering aspects such as gender, marital status, age, education level, occupation, and income, this model reveals the socioeconomic dynamics that might play a role in composting decisions in Jakarta. Model 3 amalgamates the attributes of Models 1 and 2, providing a comprehensive probit model that factors in both policy aspects and socioeconomic attributes to paint a complete picture of the determinants of WTP for composting.

Models 4 to 6 mirror the structure and focus of Models 1 to 3 but leverage the logit model. The logit model, which is rooted in a logistic distribution, estimates the log odds of the probability of an event occurring. This is an alternative to the problem but offers a slightly different mathematical perspective [26,27]. Finally, a policy implication analysis was derived from the synthesized results. By juxtaposing our findings with existing literature and the ground realities of Jakarta, we sought to craft practical and impactful recommendations. This was not just an interpretation of numbers, but an endeavor to translate data-driven insights into actionable policy directives that could foster a composting-friendly environment in Jakarta.

Results and Discussion

Table 3 presents the mean values derived from the binary responses (yes or no) for various indicators associated with the composting policy. Upon examination, it is evident that the scores are closely bunched, with all indicators hovering around the 0.3 mark. Among the indicators, "Network" garnered the highest mean value at 0.358, suggesting that having an active community network for composting and environmental education might be slightly more valued or prevalent among respondents than other factors. This is closely followed by "Education" and "Adopt," with mean values of 0.345 and 0.338, respectively, signifying the importance of community training on composting and the ability to adopt efficient composting technologies.

On the other hand, "Funding" received the lowest mean score of 0.285, indicating that respondents might be less confident about the presence or significance of governmental or sponsor funding for composting programs in their communities. "Availability," "Continuous," and "Routine" are tightly packed with scores of 0.310, 0.315, and 0.313, respectively, reflecting similar sentiment levels among respondents towards the importance or prevalence of these factors. In comparison, "Cadres," "Incentives," and "Adopt" all have scores over 0.32, hinting that these factors, encompassing trained individuals, appreciation incentives for households, and adoption of new technologies, hold slightly higher value or presence in the community's view.

Table 3. Mean binary responses for various indicators associated with composting policy.

Indicator	Mean	t	Sig. (2-tailed)
Availability	0.310	13.389	0.000
Funding	0.285	12.611	0.000
Cadres	0.320	13.703	0.000
Adopt	0.338	14.257	0.000
Network	0.358	14.900	0.000
Education	0.345	14.497	0.000
Continuous	0.315	13.546	0.000
Routine	0.313	13.467	0.000
Incentives	0.323	13.782	0.000

Table 4 shows a meticulous investigation of the determinants of an individual's WTP in composting, approached using various models. Model 1 adopts a probit methodology, focusing on composting-specific factors. In this model, the availability of composting facilities, the existence of funding opportunities, trained personnel termed as 'Cadres,' the ability to adopt innovative composting technologies, a thriving community network, education programs, continuous learning, routine monitoring, and the presence of incentives are all encoded in a binary fashion. A response of 'Yes' towards any of these factors translates to a value of 1; otherwise, it is captured as 0. By employing this approach, Model 1 offers insights into how these composting attributes might influence an individual's inclination toward composting.

Table 4. Determinants of individual 'willingness to participate' (WTP) in composting.

Attribute	Probit						Logit					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	S.E	Coef.	S.E	Coef.	S.E	Coef.	S.E	Coef.	S.E	Coef.	S.E
Constant	-1.183***	0.106	0.033	0.269	-0.538	0.329	-2.047***	0.202	0.06	0.431	-0.881	0.587
Availability (Yes=1; otherwise =0)	0.831***	0.216			0.814***	0.221	1.393***	0.362			1.371***	0.373
Funding (Yes=1; otherwise =0)	0.374	0.266			0.44	0.272	0.627	0.441			0.759*	0.453
Cadres (Yes=1; otherwise =0)	0.431*	0.230			0.402*	0.236	0.747*	0.382			0.702*	0.394
Adopt (Yes=1; otherwise =0)	0.542**	0.236			0.527**	0.246	0.885**	0.392			0.872**	0.407
Network (Yes=1; otherwise =0)	0.264	0.209			0.275	0.219	0.475	0.354			0.505	0.373
Education (Yes=1; otherwise =0)	-0.033	0.225			0.023	0.231	-0.056	0.382			0.04	0.395
Continuous (Yes=1; otherwise =0)	0.289	0.235			0.288	0.241	0.509	0.393			0.506	0.409
Routine (Yes=1; otherwise =0)	0.396*	0.225			0.441*	0.231	0.681*	0.375			0.759*	0.390
Incentives (Yes=1; otherwise =0)	0.332	0.234			0.291	0.244	0.57	0.389			0.489	0.408
Gender (Male=1; otherwise =0)			-0.184	0.133	-0.066	0.170			-0.295	0.215	-0.113	0.305
Marital (Single=1; otherwise =0)			-0.311**	0.155	-0.337*	0.204			-0.503**	0.252	-0.641*	0.371
Age (20-29=1; above 29 =0)			-0.311*	0.164	-0.455**	0.212			-0.505*	0.266	-0.821**	0.379
Higher education (>bachelor's degree=1; otherwise =0)			0.112	0.164	-0.278	0.212			0.177	0.264	-0.52	0.376
Occupation (Formal employed=1; otherwise =0)			-0.077	0.189	-0.266	0.236			-0.123	0.303	-0.504	0.413
Income (>IDR 5 million; otherwise =0)			0.097	0.209	0.038	0.263			0.152	0.334	0.091	0.463
Properties												
LLR	220.757		13.766		229.438		220.149		13.773		229.239	
McFadden's Pseudo R2	0.860		1.363		0.869		0.862		1.363		0.869	
χ^2, sig 1%	14.683		10.644		22.307		14.683		10.644		22.307	

***, **, * are significant differences at p < 0.01, p < 0.05, and p < 0.1, respectively.

Transitioning to Model 2, the lens shifts from composting dynamics to socioeconomic attributes, while retaining the probit framework. In this model, gender is distilled into a binary representation, where males are denoted by 1. Marital status was simplified with 'Single' individuals encapsulated by a value of 1. Age was segmented with the bracket '20 to 29' represented by 1, and those above this range were assigned a 0. Education, notably higher education, demarcates those with qualifications surpassing a bachelor's degree, with 1. Formal employment and an income threshold above IDR 5 million were also captured in this binary schema. Through this lens, Model 2 delves into the socioeconomic fabric, probing how these underlying factors intersect with WTP for composting. Model 3 emerges as a confluence, weaving attributes from Models 1 and 2 but anchored within a probit equation. It embodies a holistic approach, casting a net wide enough to encapsulate composting-centric and socioeconomic facets and enriching the understanding of WTP dynamics.

Further diversifying the analytical approach, Model 4 leaves Model 1's book, but transitions from a probit to a logit model. It re-examines the composting-centric factors through the prism of the logit equation, offering an alternative perspective on their influence on the WTP. Simultaneously, Model 5 reinterprets Model 2 within the logit framework. Socioeconomic attributes remain consistent in their representation, but the logit backdrop offers a fresh avenue to gauge their potency in shaping WTP. Finally, Model 6 serves as a culmination, fusing the attributes of both preceding models but tethered to a logit equation. As a comprehensive analytical tool, it seeks to provide an enriched understanding of juxtaposing composting and socioeconomic variables within the logit model.

Table 4 provides a comprehensive analytical exploration of the determinants that influence an individual's WTP in composting. By studying these metrics, we can discern the comparative strengths and nuances of each model. There are stark contrasts in the realm of Akaike Information Criterion per Number of observations (AIC/N), which essentially gauge the quality of each model relative to the others (with a lower score indicating a better fit). Models 2 and 5 emerged as potential front runners, with the lowest values of 13.766 and 13.773, respectively. This indicates a superior fit to the data for these socioeconomic-centered models compared to the composting-centric and combined models, such as Model 1, with a value of 220.757 or more encompassing Model 3 at 229.438.

Turning our attention to Log-Likelihood Ratio (LLR) values, which serve as indicators of a model's goodness of fit compared with a null model, we observe consistency in the results. Models 1, 3, 4, and 6 all hover around the 0.4 mark. Models 2 and 5, which had previously exceeded the AIC/N metric, presented the lowest LLR values, both settling at 0.025. This might suggest that while these models are parsimonious (as indicated by AIC/N), they might not necessarily offer a markedly better fit than a model with no predictors. McFadden's Pseudo R2 is especially telling, acting as a mirror to the traditional R2 in regressions. This metric provides an insight into the proportion of variance in the dependent variable that the model elucidates.

Remarkably, Models 2 and 5 once again take the lead, with a score of 1.363, which is considerably higher than the 0.86 ballpark observed in Models 1, 3, 4, and 6. These hints at the possibility that the socio-economic factors encapsulated in Models 2 and 5 might wield a substantial influence, accounting for a significant chunk of the variance in WTP. Finally, the values at the 1% significance level offer insights into the overall significance of each model. Higher values suggest more pronounced significance. Here, the combined attribute models, Models 3 and 6, take the central stage with values of 22.307. These models, which combine composting-centric and socioeconomic attributes, seem to have a more profound effect on WTP, highlighting the multifaceted nature of the decision-making process.

The availability of community- or private-scale composting facilities stands out, with a positive coefficient that is consistently significant across all models at a high confidence level (p-value > 0.001). This suggests that the mere availability of such facilities plays a crucial role in increasing the willingness to participate. When the confidence level is high, it solidifies the importance of community- or private-scale composting setups to boost participation. The role of trained cadres in understanding composting techniques is as follows. Their influence was also positively significant, with a p-value > 0.01 across all models. The presence of knowledgeable individuals in the community, well-versed in composting techniques, is a strong motivator for increased participation.

The ability to adopt efficient and environmentally friendly composting technology also wields influence, as evidenced by its positive coefficient across all models, albeit at a slightly lower confidence level ($p > 0.05$). This implies that, while community values adopt environmentally friendly composting methods, they may not be as compelling a factor as the prior two. Routine Field Monitoring of Composting Practices showed a positive correlation with willingness to participate, holding its ground with a p-value > 0.01. This emphasizes the community's inclination towards regular oversight, suggesting that consistent monitoring might act as a reassurance or incentive for individuals to engage in composting activities. Conversely, certain socioeconomic factors paint a contrasting picture.

Marital status, specifically being single, correlates negatively with willingness to compost. The coefficient was negative across all models, but the confidence level was slightly reduced ($p > 0.05$). This could hint at many reasons, perhaps the constraints of singlehood, time management, or lifestyle choices, that make composting less appealing to this demographic. Similarly, the Age group 20 to 29 also demonstrates a negative correlation with a p-value > 0.01 across all models. This implies that younger individuals may be less inclined to participate in composting than their older counterparts are. The reasons could be manifold, ranging from differing priorities to residential circumstances or perhaps a lack of awareness or motivation.

Extant literature often points to the pivotal role of infrastructure in community participation in environmental efforts. Zamroni et al. [28] noted that communities with accessible recycling and composting facilities exhibited greater environmental participation. Thus, the accessibility and presence of these facilities can not only act as facilitators but also as solid determinants of environmental action. The presence of knowledgeable individuals or experts in communities has been acknowledged in previous studies. Mondala and Sannidhi [29] emphasized that community leaders and trained experts often serve as catalysts, invigorating collective actions and initiatives. Their presence and active role can galvanize community engagement and participation, stressing the importance of expertise in the realm of composting.

Past studies have highlighted that while communities and individuals express a keen interest in green technologies, actual adoption can be hindered. Factors such as financial constraints, lack of knowledge, and resistance to change can impede this adoption [30,31]. Despite interest, transitioning to newer and more sustainable practices may not always be straightforward. Accountability in environmental practices has been highlighted in literature as a significant driver of participation and adherence. For instance, Suryawan and Lee [24], Andeobu et al. [32] pointed out that systems with consistent monitoring and feedback mechanisms can significantly boost participation rates by ensuring trust, transparency, and best practice. Conventional academic wisdom has often positioned younger individuals as more eco-conscious, as suggested by studies Chen et al. [33], Kume and Sato [34]. However, actual participation and willingness can be influenced by various factors including lifestyle, financial constraints, and priorities at different life stages. Singles may also exhibit different environmental behaviors based on lifestyle, time constraints, and socioeconomic conditions.

NbS is fundamentally anchored in harmonizing human activities with natural processes to achieve robust environmental and societal outcomes [3]. Composting, an ecological means of waste reduction and soil enrichment, is a crucial avenue in this pursuit [35]. This evidence underscores the significance of the accessibility of composting facilities. As communities flourish around a quickly reachable composting infrastructure, policymakers must invest in both establishing and maintaining such facilities, especially in underserviced areas. This addresses waste management challenges and galvanizes community participation in sustainable endeavors. Training has emerged as a form of linchpin. A trained cadre embodies a repository of expertise and acts as a catalyst, radiating awareness and best practices in the community. To bolster this, policymakers should spearhead training initiatives, possibly collaborating with environmental organizations. Creating certification systems might further lend credibility and structure to these programs [36], ensuring a consistent and high standard of expertise.

However, the technological aspect cannot be sidestepped, even with expertise and infrastructure [37]. The inclination of the community towards adopting efficient and environmentally friendly composting technology is palpable, albeit with potential barriers. The onus falls on the policy directives that make these technologies affordable and intuitive. Introducing subsidies, fostering research on sustainable composting technology, and offering financial incentives can make a significant difference. Accountability and trust, two pillars of successful community initiatives [38,39], reiterate the need to monitor composting practices regularly. A transparent digital platform paired with a robust monitoring body ensures adherence to standards and community trust, thereby driving higher participation rates. Finally, delving deeper into demographic intricacies, tailored strategies for specific groups, such as younger individuals and singles, might be key to broader participation. Their unique lifestyles and priorities necessitate a more nuanced approach, potentially involving targeted educational campaigns, community events, or incentives crafted for their needs. By weaving these insights into policies, NbS can foster a holistic, community-driven approach to environmental stewardship.

The metropolitan landscape of Jakarta presents a unique blend of challenges and opportunities regarding environmental initiatives such as composting. The evident significance of the availability of composting facilities drives the need for readily accessible infrastructure. For a sprawling urban expanse, such as Jakarta, where space is at a premium and waste management is crucial, policymakers should prioritize establishing decentralized composting stations in community centers, residential complexes, or office premises. Such proximity can encourage more residents to actively engage in composting actively [40,41]. Similarly, the importance of trained cadres or experts indicates that mere infrastructure might not suffice, and there is an inherent need for guidance. Jakarta's diverse demographics could benefit immensely from local champions or experts who can tailor composting practices to the city's specific challenges, whether the tropical climate or various types of waste generated. Investing in regular training programs or workshops [24], perhaps in collaboration with local NGOs (Non Governmental Organization) or environmental bodies, could create a knowledgeable cadre to guide and inspire immediate communities.

Emphasis on adopting efficient composting technologies underscores the evolving nature of urban composting. Sticking outdated composting methods may not be viable in a metropolis that is continually growing and innovating. Therefore, city governance should facilitate the introduction and adoption of cutting-edge composting technologies, ensuring that they are both efficient and user-friendly, to encourage widespread adoption. Routine practices, particularly in Jakarta, often define success. Regular monitoring and feedback mechanisms in the composting process can bolster adherence and maintain enthusiasm [42,43]. This could range from digital platforms that track composting metrics to community-led initiatives that periodically review and refine the practices. Finally, the significance of marital status and age to WTP signals the need for demographically tailored strategies. For instance, younger residents, possibly living in shared spaces or working long hours, may benefit from communal composting systems or digital platforms that simplify the composting process. Conversely, families may have different needs, such as larger composting units or educational programs for their children. Recognizing and addressing these nuances can amplify the WTP across boards.

The significant positive impact of community- and private-scale composting facilities, as indicated by our data, compels us to look beyond infrastructure provision. While the presence of these facilities is crucial, our findings suggest that their effectiveness depends on how they are integrated within the community. For instance, proximity to residential areas and ease of access are likely to be key factors influencing their usage. Similarly, the role of trained cadres underscores the importance of human capital in environmental initiatives. However, this raises questions regarding ongoing training and support, as well as the scalability of such programs. The less pronounced influence of environmentally friendly technology on participation suggests a potential gap between community interest in sustainable practices and the practicality or accessibility of such technologies.

This points to a need for further investigation into barriers to adoption, such as cost, lack of awareness, or technological complexity. Our findings have direct implications for policy and community programme development. The importance of composting facilities suggests that urban planning and environmental policies should prioritize the integration of such infrastructure into community design. Collaboration with local organizations to provide ongoing education and training could enhance the effectiveness of these facilities. The crucial role of trained cadres highlights the need for investment in community education programmes. Policymakers might consider creating certification programs or continuous learning opportunities for community leaders to ensure that they remain effective and relevant.

Regarding technology adoption, our study indicates the need for policies that bridge the gap between interest and practical application. This could involve subsidizing environmentally friendly composting technologies or collaborating with technology providers to create more user-friendly and accessible solutions. By weaving these insights into policy and practice, we can foster a community-driven approach to environmental stewardship that aligns with NbS principles. Our study provides a framework for understanding the complex interplay between infrastructure, expertise, technology, and socioeconomic factors in environmental participation, offering a roadmap for more effective and inclusive environmental initiatives.

Conclusion

Several key factors stood out in our exploration of the determinants impacting WTP in composting in Jakarta's metropolitan area. The availability of community- or private-scale composting facilities has emerged as a pivotal element that reflects the importance of accessibility and infrastructure for encouraging composting practices. Furthermore, the role of trained cadres in understanding composting techniques is important. Their expertise and guidance can be instrumental in bridging the knowledge gap and enhancing their participation rates. This study also highlights the importance of adopting efficient and environmentally friendly composting technology. As urban regions grapple with space constraints and environmental challenges, adopting advanced composting methods can significantly influence the WTP. Routine field monitoring of composting practices further augments this willingness and underscores the importance of consistent monitoring and quality control. From a demographic perspective, marital status and age played important roles. Singles showed a different propensity to participate in composting than their married counterparts. Additionally, the age bracket of 20 to 29 demonstrated distinct attitudes, indicating generational differences in environmental consciousness or practical engagement with composting activities.

Author Contributions

LF: Conceptualization, Methodology, and Writing-Original Draft Preparation; **RM**: Investigation, data curation, writing-review, and editing; **IWK**: Supervision, Project Administration, Writing - Review and Editing; **NU**: Software, Validation, Writing - Review, and Editing; **IYS**: Formal analysis, resources, writing, reviewing, and editing; **WP**: Visualization, investigation, writing-review, and editing; **SS**: Data curation, methodology, writing-review, and editing; **MMS**: Investigation and Writing - Original Draft Preparation; **NNA**: Conceptualization; **DMA**: Conceptualization.

Conflicts of interest

There are no conflicts to declare.

Acknowledgements

We extend our heartfelt gratitude to all the respondents who generously participated in this study. Your willingness to share your experiences and insights has been invaluable for the success of our research. We are deeply appreciative of the time and effort you have contributed, which enabled us to gain a deeper understanding of the subject matter. Thank you for your invaluable contribution to our work.

References

1. Steenkamp, J.; Cilliers, E.J.; Cilliers, S.S.; Lategan, L. Food for Thought: Addressing Urban Food Security Risks through Urban Agriculture. *Sustainability* **2021**, *13*, 1–29.
2. Mahmood, A.; Farooq, A.; Akbar, H.; Ghani, H.U.; Gheewala, S.H. An Integrated Approach to Analyze the Progress of Developing Economies in Asia toward the Sustainable Development Goals. *Sustainability* 2023, *15*, 13645.
3. Sowińska-Świerkosz, B.; García, J. What Are Nature-Based Solutions (NBS)? Setting Core Ideas for Concept Clarification. *Nature-Based Solut.* **2022**, *2*, 100009.
4. Cohen-Shacham, E.; Andrade, A.; Dalton, J.; Dudley, N.; Jones, M.; Kumar, C.; Maginnis, S.; Maynard, S.; Nelson, C.R.; Renaud, F.G.; et al. Core Principles for Successfully Implementing and Upscaling Nature-Based Solutions. *Environ. Sci. Policy* **2019**, *98*, 20–29, doi:https://doi.org/10.1016/j.envsci.2019.04.014.
5. Hasibuan, H.S.; Mulyani, M. Transit-Oriented Development: Towards Achieving Sustainable Transport and Urban Development in Jakarta Metropolitan, Indonesia. *Sustainability* **2022**, *14*, 1–17.
6. Margina, Y.; Troegubov, A.; Kulikova, Y.; Sliusar, N. Composting Old Bark and Wood Waste in Cold Weather Conditions. *Sustainability* 2023, *15,* 10768.
7. Zuberer, D.A.; Zibilske, L.M. 24 - Composting: the microbiological processing of organic wastes. In *Principles and Applications of Soil Microbiology*, 3rd ed.; Gentry, T.J., Fuhrmann, J.J., Zuberer, D.A., Eds.; Elsevier: Amsterdam, 2021; pp. 655–679, ISBN 978-0-12-820202-9.
8. Hajam, Y.A.; Kumar, R.; Kumar, A. Environmental Waste Management Strategies and Vermi Transformation for Sustainable Development. *Environ. Challenges* **2023**, *13*, 100747, doi:https://doi.org/10.1016/j.envc.2023.100747.
9. Malone, Z.; Berhe, A.A.; Ryals, R. Impacts of Organic Matter Amendments on Urban Soil Carbon and Soil Quality: A Meta-Analysis. *J. Clean. Prod.* **2023**, *419*, 138148.
10. Chen, T.; Zhang, S.; Yuan, Z. Adoption of Solid Organic Waste Composting Products: A Critical Review. *J. Clean. Prod.* **2020**, *272*, 122712, doi:https://doi.org/10.1016/j.jclepro.2020.122712.
11. Zheng, X.; Aborisade, M.A.; Liu, S.; Lu, S.; Oba, B.T.; Xu, X.; Cheng, X.; He, M.; Song, Y.; Ding, H. The History and Prediction of Composting Technology: A Patent Mining. *J. Clean. Prod.* **2020**, *276*, 124232, doi:https://doi.org/10.1016/j.jclepro.2020.124232.
12. Hou, D.; Al-Tabbaa, A.; O'Connor, D.; Hu, Q.; Zhu, Y.-G.; Wang, L.; Kirkwood, N.; Ok, Y.S.; Tsang, D.C.W.; Bolan, N.S.; et al. Sustainable Remediation and Redevelopment of Brownfield Sites. *Nat. Rev. Earth Environ.* **2023**, *4*, 271–286, doi:10.1038/s43017-023-00404-1.

13. Salomon, M.J.; Cavagnaro, T.R. Healthy Soils: The Backbone of Productive, Safe and Sustainable Urban Agriculture. *J. Clean. Prod.* **2022**, *341*, 130808, doi:https://doi.org/10.1016/j.jclepro.2022.130808.
14. Patel, S.; Kollarath, R.M. Urban solid waste management for energy generation. In *Urban Energy Syst. Model. Simul. Smart Cities*; Kumar, D., Eds.; Scrivener Publishing: Baverly, USA, 2023, ISBN 978-1-119-84744-1.
15. Dhokhikah, Y.; Trihadiningrum, Y.; Sunaryo, S. Community Participation in Household Solid Waste Reduction in Surabaya, Indonesia. *Resour. Conserv. Recycl.* **2015**, *102*, 153–162, doi:10.1016/j.resconrec.2015.06.013.
16. Suryawan, I.W.K.; Mulyana, R.; Yenis Septiariva, I.; Prayogo, W.; Suhardono, S.; Sari, M.M.; Ulhasanah, N. Smart Urbanism, Citizen-Centric Approaches and Integrated Environmental Services in Transit-Oriented Development in Jakarta, Indonesia. *Res. Glob.* **2024**, *8*, 100181, doi:https://doi.org/10.1016/j.resglo.2023.100181.
17. Bruni, C.; Akyol, Ç.; Cipolletta, G.; Eusebi, A.L.; Caniani, D.; Masi, S.; Colón, J.; Fatone, F. Decentralized Community Composting: Past, Present and Future Aspects of Italy. *Sustainability* **2020**, *12*, 1–20.
18. Mahadi, Z.; Yahya, E.A.; Amin, L.; Yaacob, M.; Sino, H. Investigating Malaysian Stakeholders' Perceptions of the Government's Aim to Replace Conventional Plastic Bags with Biodegradable and Compostable Bioplastic Bags. *J. Mater. Cycles Waste Manag.* **2021**, *23*, 2133–2147, doi:10.1007/s10163-021-01278-5.
19. Cai, T.; Steinfield, C.; Chiwasa, H.; Ganunga, T. Understanding Malawian Farmers' Slow Adoption of Composting: Stories about Composting Using a Participatory Video Approach. *L. Degrad. Dev.* **2019**, *30*, 1336–1344, doi:https://doi.org/10.1002/ldr.3318.
20. Ayilara, M.S.; Olanrewaju, O.S.; Babalola, O.O.; Odeyemi, O. Waste Management through Composting: Challenges and Potentials. *Sustainability* **2020**, *12*, 1–23.
21. Christie, B.; Waller, V. Community Learnings through Residential Composting in Apartment Buildings. *J. Environ. Educ.* **2019**, *50*, 97–112, doi:10.1080/00958964.2018.1509289.
22. Suryawan, I.W.K.; Lee, C.-H. Community Preferences in Carbon Reduction: Unveiling the Importance of Adaptive Capacity for Solid Waste Management. *Ecol. Indic.* **2023**, *157*, 111226, doi:https://doi.org/10.1016/j.ecolind.2023.111226.
23. De Boni, A.; Melucci, F.M.; Acciani, C.; Roma, R. Community Composting: A Multidisciplinary Evaluation of an Inclusive, Participative, and Eco-Friendly Approach to Biowaste Management. *Clean. Environ. Syst.* **2022**, *6*, 100092, doi:https://doi.org/10.1016/j.cesys.2022.100092.
24. Suryawan, I.W.K.; Lee, C.-H. Citizens' Willingness to Pay for Adaptive Municipal Solid Waste Management Services in Jakarta, Indonesia. *Sustain. Cities Soc.* **2023**, *97*, 104765.
25. Torrijos, V.; Calvo Dopico, D.; Soto, M. Integration of Food Waste Composting and Vegetable Gardens in a University Campus. *J. Clean. Prod.* **2021**, *315*, 128175.
26. Suryawan, I.W.K.; Septiariva, I.Y.; Sari, M.M.; Ramadan, B.S.; Suhardono, S.; Sianipar, I.M.J.; Tehupeiory, A.; Prayogo, W.; Lim, J.-W. Acceptance of Waste to Energy (WtE) Technology by Local Residents of Jakarta City, Indonesia to Achieve Sustainable Clean and Environmentally Friendly Energy. *J. Sustain. Dev. Energy, Water Environ. Syst.* **2023**, *11*, 1110443.
27. Tehupeiory, A.; Mulyana, R.; Sianipar, I.M.J.; Suryawan, I.W.K.; Septiariva, I.Y.; Prayogo, W. The Environmental Challenges of Urban Living: Why Willingness to Pay for Apartments Matters. *Environ. Challenges* **2023**, 100766, doi:https://doi.org/10.1016/j.envc.2023.100766.
28. Zamroni, M.; Prahara, R.S.; Kartiko, A.; Purnawati, D.; Kusuma, D.W. The Waste Management Program Of 3R (Reduce, Reuse, Recycle) By Economic Incentive And Facility Support. *J. Phys. Conf. Ser.* **2020**, *1471*, 12048, doi:10.1088/1742-6596/1471/1/012048.
29. Mondala, M.M.; Sannidhi, D. Catalysts for Change: Accelerating the Lifestyle Medicine Movement Through Professionals in Training. *Am. J. Lifestyle Med.* **2019**, *13*, 487–494, doi:10.1177/1559827619844505.
30. Agrawal, R.; Wankhede, V.A.; Kumar, A.; Luthra, S. Analysing the Roadblocks of Circular Economy Adoption in the Automobile Sector: Reducing Waste and Environmental Perspectives. *Bus. Strateg. Environ.* **2021**, *30*, 1051–1066, doi:https://doi.org/10.1002/bse.2669.

31. Abu, F.; Gholami, H.; Saman, M.Z.M.; Zakuan, N.; Streimikiene, D. The Implementation of Lean Manufacturing in the Furniture Industry: A Review and Analysis on the Motives, Barriers, Challenges, and the Applications. *J. Clean. Prod.* **2019**, *234*, 660–680, doi:https://doi.org/10.1016/j.jclepro.2019.06.279.
32. Andeobu, L.; Wibowo, S.; Grandhi, S. Artificial Intelligence Applications for Sustainable Solid Waste Management Practices in Australia: A Systematic Review. *Sci. Total Environ.* **2022**, *834*, 155389, doi:https://doi.org/10.1016/j.scitotenv.2022.155389.
33. Chen, L.; Matloob, S.; Sunlei, Y.; Qalati, S.A.; Raza, A.; Limón, M.L. A Moderated–Mediated Model for Eco-Conscious Consumer Behavior. *Sustainability* **2023**, *15*, 1–20.
34. Kume, S.; Sato, M. Psychological Variability and Environmental Behavior Evidence from Cases of Global Warming and Waste Problem. *J. Environ. Inf. Sci.* **2023**, *2022*, 13–22.
35. Harindintwali, J.D.; Zhou, J.; Muhoza, B.; Wang, F.; Herzberger, A.; Yu, X. Integrated Eco-Strategies towards Sustainable Carbon and Nitrogen Cycling in Agriculture. *J. Environ. Manage.* **2021**, *293*, 112856, doi:https://doi.org/10.1016/j.jenvman.2021.112856.
36. Purkiss, D.; Allison, A.L.; Lorencatto, F.; Michie, S.; Miodownik, M. The Big Compost Experiment: Using Citizen Science to Assess the Impact and Effectiveness of Biodegradable and Compostable Plastics in UK Home Composting. *Front. Sustain.* **2022**, *3*, 94272.
37. Rajendra, A. Skills in 'unskilled' work: a case of waste work in Central India. *Third World Quarterly* **2022**, *45*, 658–676, doi:https://doi.org/10.1080/01436597.2022.2086115.
38. Ssozi-Mugarura, F.; Blake, E.; Rivett, U. Codesigning with Communities to Support Rural Water Management in Uganda. *CoDesign* **2017**, *13*, 110–126, doi:10.1080/15710882.2017.1310904.
39. Sengupta, U.; Sengupta, U. Why Government Supported Smart City Initiatives Fail: Examining Community Risk and Benefit Agreements as a Missing Link to Accountability for Equity-Seeking Groups. *Front. Sustain. Cities* **2022**, *4*, 960400.
40. de Souza, L.C.G.; Drumond, M.A. Decentralized Composting as a Waste Management Tool Connect with the New Global Trends: A Systematic Review. *Int. J. Environ. Sci. Technol.* **2022**, *19*, 12679–12700, doi:10.1007/s13762-022-04504-1.
41. Rosenthal, S.; Linder, N. Effects of Bin Proximity and Informational Prompts on Recycling and Contamination. *Resour. Conserv. Recycl.* **2021**, *168*, 105430, doi:https://doi.org/10.1016/j.resconrec.2021.105430.
42. Michel, F.; O'Neill, T.; Rynk, R.; Gilbert, J.; Smith, M.; Aber, J.; Keener, H. Chapter 6 - forced aeration composting, aerated static pile, and similar methods. In *The Composting Handbook*; Rynk, R., Ed.; Academic Press-Elsevier: Amsterdam, 2022; pp. 197–269 ISBN 978-0-323-85602-7.
43. Jabbar, N.M.; Alardhi, S.M.; Mohammed, A.K.; Salih, I.K.; Albayati, T.M. Challenges in the Implementation of Bioremediation Processes in Petroleum-Contaminated Soils: A Review. *Environ. Nanotechnology, Monit. Manag.* **2022**, *18*, 100694, doi:https://doi.org/10.1016/j.enmm.2022.100694.