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RESEARCH ARTICLE

AN EXPLORATION INTO BEHAVIORAL DETERMINANTS OF WATER-SAVING ATTITUDES AND THEIR SOCIODEMOGRAPHIC INFLUENCES IN JAKARTA, INDONESIA

Rachmat Mulyana[a], I Wayan Koko Suryawan[b*], Iva Yenis Septiariva[c], Wisnu Prayogo[b], Sapta Suhardono[d], Mega Mutiara Sari[b], Nur Novilina Arifianingsih[e]

[a]Department of Building Engineering Education, Universitas Negeri Medan, Medan, Indonesia
[b]Department of Environmental Engineering, Faculty of Infrastructure Planning, Universitas Pertamina, Jakarta, 12220, Indonesia
[c]Civil Engineering Study Program, Faculty of Engineering, Universitas Sebelas Maret, Surakarta, 57126, Indonesia
[d]Environmental Sciences Study Program, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, Surakarta, 57126, Indonesia
[e]Department of Environmental Engineering, Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Jl. Ganesha no. 10, Bandung 40132, Indonesia
[*]Corresponding Author Email: i.suryawan@universitaspertamina.ac.id

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ABSTRACT

In the face of escalating global water scarcity, this study zeroes in on Jakarta, Indonesia, intending to elucidate the behavioral determinants driving water-saving attitudes and how these are interwoven with sociodemographic characteristics. Leveraging a comprehensive methodology, two salient attitudinal determinants emerged: Proactive Water Saving and Mindful Water Usage. Cluster analysis further delineated the respondents into Passive Water Consumers and Active Water Stewards. Notable associations were identified between water-saving behaviors and sociodemographic factors such as income, marital status, and housing type. Intriguingly, no discernible linkage with housing ownership was observed, signaling a potential avenue for investigating deeper societal or cultural determinants. Integrating Nature-Based Solutions (NBS) into the discourse, the research underscores their potential in reinforcing urban water conservation practices, with Jakarta as a case in point. The revelations of this investigation bear significance for Jakarta's urban water management strategies and enhance our understanding of sustainable urban development, aligning closely with the targets of the Sustainable Development Goals.

KEYWORDS

water-saving, behavioral determinants, sociodemographic influences, urban sustainability, sustainable development goals.

1. INTRODUCTION

The world's population is booming, and the water demand has skyrocketed (Howell, 2001; Boretti and Rosa, 2019). Today, urban areas are expanding unprecedentedly, and these concrete jungles rely heavily on diverted water supplies. By saving water, we can ensure that a growing number of people in urban environments have access to safe and clean drinking water (Zvobgo and Do, 2020). It's not just about quenching thirst but providing water for cooking, cleaning, and sanitation. Altered precipitation patterns, melting glaciers, and rising temperatures have started reshaping the global water map (Ali et al., 2023). Areas once water-rich are facing droughts, while others are confronting floods. Water-saving behavior is not just about conserving the amount; it's about preserving ecosystems, combating desertification, and ensuring that natural habitats remain intact. When communities save water, they reduce the stress on local ecosystems, leading to more resilient environments (Sadok et al., 2021).

Water scarcity, a pressing global challenge, stems from physical insufficiencies such as diminished rainfall or groundwater depletion, and economic scarcities related to a lack of infrastructural or technological investments (Oki and Quiocho, 2020). Rapid urbanization, climate change, booming populations, expanding industries, and inefficient agricultural practices exacerbate the challenge (Balogun et al., 2022). In response, governments globally are actively crafting and implementing many policy tools, public outreach campaigns, and strategic objectives centered on water conservation. Governments understand that addressing the issue requires a two-pronged approach: managing demand and augmenting supply. On the demand side, efforts range from launching public awareness campaigns advocating water-saving behaviors to incentivizing households and businesses to adopt water-saving technologies. Some governments also employ pricing mechanisms that impose higher water tariffs beyond a specific consumption threshold to disincentivize excessive use (Mbavarira and Grimm, 2021).

Nature-based solutions (NBS) and water-saving behaviors share a symbiotic relationship intertwined within the tapestry of sustainable water management. At the heart of NBS is using nature's systems and processes to address societal and environmental challenges (Nelson et al. 2020; Sowińska-Świerkosz and García, 2022). This dovetails seamlessly with the ethos of water-saving behaviors, which promote the judicious use of available water resources, thereby diminishing the strain on our natural water systems. From the vantage of ecology, the resonance between NBS and water-saving behaviors becomes palpable. NBS, such as wetland

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restoration, reforestation, and the creation of groundwater recharge zones, play a pivotal role in the natural replenishment of our water sources (Trémolet et al., 2021; El Moll, 2023). In parallel, when individuals and communities inculcate water-saving habits, the overall water demand decreases. This synergy ensures natural systems have adequate time and capacity to recover and replenish.

Delving deeper into the urban milieu, the relationship between NBS and water-saving behaviors takes on an added dimension. Urban planners and environmentalists champion the cause of green infrastructures like green roofs, permeable pavements, and urban gardens (Kimic and Ostrysz, 2021; Green et al., 2021). These NBS act as sponges to capture and store rainwater and reduce the demand for conventional municipal water supplies. When this is juxtaposed with water-saving behaviors, the resultant effect is a palpable alleviation of the pressures that urban water infrastructures often grapple with. However, for these concepts to truly resonate with the public, education, and awareness are paramount. NBS often entails robust community engagement and outreach campaigns (Wilk et al., 2021). As communities become more enlightened about the intrinsic value of natural water systems and the myriad benefits of NBS, there's a natural gravitation towards adopting water-saving behaviors. This underpins the direct environmental advantages and underscores the broader implications for societal well-being. However, a comprehensive study aiming to understand citizens' attitudes toward water-saving behaviors can illuminate several critical gaps and offer novel insights into this area. The current state of understanding often rests on existing studies about citizens' attitudes, government initiatives for water-saving, and the actual water-saving behaviors demonstrated by the public (Yu et al., 2021; Zhu et al., 2021; Liu et al., 2022). Much research has provided fragmented insights into these areas, yet a consolidated view remains elusive. Current government campaigns are developed based on this fractured knowledge, making assumptions about citizen awareness and perception.

In an ideal scenario, all citizens would be well-informed about the significance of water-saving. Their attitudes would inherently be inclined toward conserving water, recognizing its immediate and long-term implications. The desired state is not just about curtailed water usage; it's about an ingrained mindset where conservation becomes second nature (Jana et al., 2021). However, there exist several gaps. The awareness gap emerges when we juxtapose the current understanding of citizens about water conservation against the comprehensive knowledge they should ideally possess. There's a chasm between fragmented awareness, often limited to generalities and a detailed understanding of the impact of individual water usage patterns. Next, the attitudinal gap reflects the discrepancy between present attitudes, which might be a mix of indifference, skepticism, or proactive interest, and an ideally consistent positive attitude across the populace. The behavioral gap is perhaps the most tangible, discernible in the stark difference between current water consumption patterns and desired water-saving behaviors.

This objective clearly emphasizes the study's focus on citizens' attitudes and how this understanding can serve as a basis for future conservation initiatives. This shift in focus offers a more holistic, ground-up perspective. Further depth is added when the study delves into the dynamics of attitude formation. Beyond gauging attitudes, understanding the factors shaping them cultural nuances, socioeconomic backgrounds, educational levels, or personal experiences can offer a multidimensional lens through which water-saving behaviors can be understood and, more importantly, influenced. A significant novel aspect is the potential for predictive analysis. When mapped with socioeconomic and demographic data, insights into current attitudes can potentially forecast future water consumption trends. Such predictions can be invaluable for policymakers and urban planners, enabling them to preemptively strategize for changing water demands. With clarity on attitudinal gaps, the study can catalyze the creation of tailored communication strategies. Instead of generic public service messages, campaigns can be designed to address specific misconceptions, amplify motivations, or target specific demographic segments, making them more effective and resonant.

2. METHOD

2.1 Study Location

Jakarta, the sprawling capital city of Indonesia, is located on the northwestern coast of the country's Java Island (Figure 1). With its rich history, Jakarta has become a political and economic hub and a melting pot of cultures, traditions, and lifestyles. According to recent estimates, the city boasts a population of approximately 10.56 million residents. This diverse demographic makeup, combined with the unique urban challenges that Jakarta faces, especially concerning water scarcity and overuse, makes it an ideal locale for a study on attitudes toward water-saving behaviors. The dynamics of Jakarta's population are unparalleled. With a blend of native Betawi, Javanese, Sundanese, Chinese, and Indian communities, Jakarta has become diverse. Each community brings forth its traditions, beliefs, and water usage patterns, influenced by cultural, socioeconomic, and environmental factors. Understanding these diverse patterns is pivotal in the larger context of water conservation, making Jakarta a focal point of interest for this study.

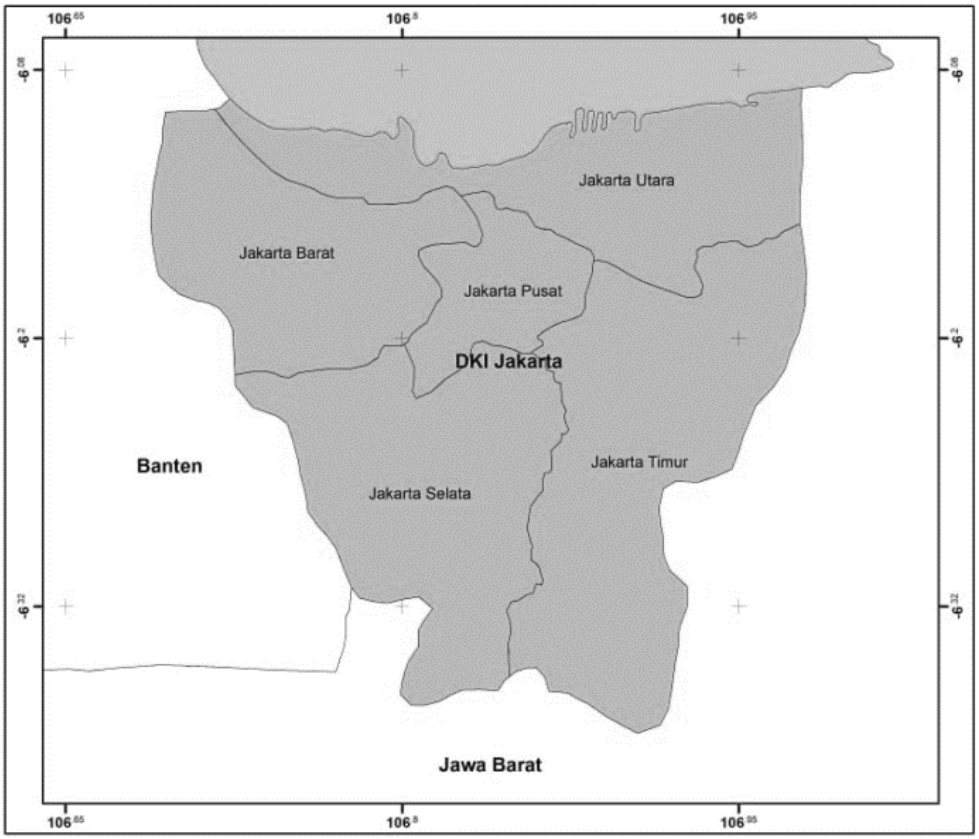

Figure 1: Study location (Suryawan et al., 2023)

As an urban hub, Jakarta also experiences challenges common to many metropolitan areas, such as rapid urbanization, inadequate infrastructure, and increased demand for limited resources, including water. These challenges, coupled with the city's geographical disposition of being prone to flooding and groundwater extraction issues, underscore the urgency of water conservation in the region. Selecting a representative sample is a meticulous task for a city as vast and varied as Jakarta. It's imperative that the chosen sample accurately reflects the city's diversity to ensure the validity of the study findings. Given the population size and the need for precision, a well-structured approach was essential.

Slovin's formula is a mathematical equation used to determine the sample size for a given population. In our context, the formula recommended a specific number based on a 4% margin of error, but the study decided on a rounded figure of 632 respondents. This number was seen as more pragmatic, considering field constraints and ensuring a more even representation across various demographics. After determining the sample size, the challenge was ensuring this sample was genuinely representative. For this, the study employed the simple random sampling method. The idea behind this is fairly straightforward - each individual in Jakarta's population had an equal and independent chance of being selected.

2.2 Questionnaire Design

The metropolis of Jakarta, with its burgeoning population, faces a myriad of water-related challenges. Amid the complexities of urban sprawl, effective water management has become paramount. To this end, the Water-Saving Behaviors Questionnaire was conceptualized to delve deep into the attitudes and behaviors of the city's residents (Appendix). This methodological narrative elucidates the meticulous approach undertaken to design the said questionnaire. As in most research undertakings, the initiation phase began with an extensive literature review. While water-saving is a global concern, it manifests uniquely in different locales due to cultural, infrastructural, and socioeconomic variations. Hence, a dual approach was adopted. First, global studies provided a macro view, revealing common patterns and broad behavioral insights.

Parallelly, preliminary interviews with a diverse group enriched the study's foundation. Engaging with residents gave firsthand insights into daily water usage behaviors, challenges faced, and measures taken (or not taken) to conserve water. On the other hand, policymakers shed light on the broader objectives and challenges of city-wide water management. Finally, discussions with water management experts provided a technical perspective, ensuring the research would be grounded and applicable. Transitioning from the preparatory phase to the actual design, the questionnaire was structured into two primary sections. The first addressed attitudes towards water-saving behaviors (Table 1), while the second delved into sociodemographic details. Given the research's objective, it was crucial to understand both proactive water-saving measures undertaken by residents and inadvertent behaviors potentially contributing to water wastage. Therefore, a 5-point Likert scale was employed. This nuanced scale, ranging from 'Strongly Disagree' to 'Strongly Agree', offers respondents the latitude to express varying degrees of agreement or disagreement, capturing a richer data set than a simple binary choice.

Table 1: Attitude for water-saving indicators

Code	Question	Indicator
A1	I frequently check faucets and water pipes to ensure there are no leaks.	Leaks
A2	I frequently make sure the faucet is turned off after use	Faucet off
A3	I do not let the faucet keep running when cleaning or rinsing vegetables, fruits, and dishes.	Rinsing
A4	I often use running water to thaw frozen food.	Thawing
A5	I frequently use the dishwasher.	Dishwasher
A6	I turn off the faucet/do not let the water run while brushing my teeth.	Brushing
A7	I have installed water-saving sensors on every faucet at home.	Sensors
A8	I do not use a hose when washing vehicles.	Vehicles
A9	I do not use a hose to water plants.	Plants

Crafting the questions themselves required precision and clarity. Ambiguities were diligently avoided to prevent respondent confusion. Furthermore, neutrality was paramount; questions were carefully worded to circumvent any inherent bias, ensuring authentic responses were uninfluenced by the questionnaire's phrasing. For instance, rather than asking leading questions like "Do you think wasting water is bad?", neutral statements like "I frequently check faucets to ensure no leaks" were used, allowing respondents to express their agreement or dissent freely. The sociodemographic section, meanwhile, was constructed to provide context to the behavioral data. Insights from the literature review indicated that variables such as income, housing type, and education level could influence water-saving behaviors. For example, an individual in a high-rise apartment with modern water-saving fixtures might exhibit different behaviors than someone in a traditional home. Due to their efficiency and ease of analysis, multiple-choice questions were chosen for this section.

Before launching the questionnaire city-wide, it was piloted among a smaller subset of Jakarta's populace with 50 respondents. This was a formality and a crucial step to gauge its effectiveness, clarity, and comprehensiveness. Feedback from this group helped refine questions, eliminate potential redundancies, and enhance the overall user experience. Ensuring the questionnaire's ethical soundness was of utmost priority. Every participant was assured of their data's confidentiality. An introductory segment was incorporated to clarify the research's purpose and reiterate the anonymity of their responses. This not only fostered trust but also aimed to boost participation rates. Finally, regarding dissemination, a multi-pronged approach was deemed most effective for a city as diverse as Jakarta. Leveraging digital platforms would cater to the tech-savvy urban populace, while traditional paper-based methods would ensure inclusivity, reaching those less digitally inclined.

2.3 Data Analysis

The first stepping stone in the analytical process was factor analysis. Using SPSS 21, a renowned statistical software, the myriad of questions on water-saving behaviors were dissected to understand the latent structures or 'factors'. The rationale was to ascertain the key attitudinal determinants influencing water-saving behaviors. By subjecting the responses to a Principal Component Analysis (PCA) in SPSS, we could extract factors that cumulatively explained a significant portion of the variance in the data. The rotated component matrix then provided a clear picture of which behaviors loaded heavily on which factors. Upon deriving the factors, the next logical step was segmenting the population based on these factors, and this was achieved through the K-Means cluster analysis in SPSS. The method's objective is to partition respondents into 'k' number of clusters, where each individual belongs to the cluster with the nearest mean. The process began with determining the optimal number of clusters via the Elbow Method, and then respondents were grouped based on their factor scores.

This technique sheds light on distinct behavioral profiles. Some clusters might represent highly proactive water-savers, while others could indicate passive or wasteful patterns. Understanding these segments allows for tailored intervention strategies, ensuring more impactful policy implementations. The chi-squared analysis was a vital bridge, connecting the dots between water-saving behaviors and sociodemographic variables. This test of independence, executed on SPSS, determined whether there was a significant association between different categorical variables. By comparing observed frequencies to expected ones, the chi-squared test unearthed patterns, revealing, for instance, if specific behaviors were more prevalent in certain demographic segments.

Transitioning from SPSS, the analysis employed the N-Logit software for the logit and probit models. These models are specialized tools ideal for predicting binary outcomes based on a set of predictor variables. In this context, the outcome was the likelihood of a respondent falling into a specific behavioral cluster (positive or negative towards water-saving). The choice of N-Logit for this purpose was deliberate, given its adeptness in handling choice modeling. These models provided probabilities by inputting the factor scores derived from SPSS and the sociodemographic

data. They probabilistically understood how attitudes and demographic factors influenced citizens' propensity to save water.

3. Result

Table 2 in our study offers a comprehensive breakdown of the factor loadings associated with each indicator, highlighting the robustness and relevance of the data collected. To establish the adequacy of our data for factor analysis, the Kaiser-Meyer-Olkin Measure (KMO) was employed. The obtained value of 0.766 exceeds the commonly recommended threshold of 0.6, reinforcing the suitability of the data for this form of analysis. Concurrently, Bartlett's Test of Sphericity was statistically significant with a value of 1498.472, further verifying the factorability of our dataset. Following the initial validation, the extraction method unveiled two predominant factors responsible for the variance observed in water-saving behaviors. The Extraction Sums of Squared Loadings revealed that these two factors accounted for a considerable proportion of the total variance. The first factor, "Proactive Water Saving," explained 34.762% of the variance. This factor encapsulated behaviors such as using sensors for water conservation, avoiding hoses for vehicle cleaning and plant watering, preference for dishwashers, thawing foods using running water, and regularly checking water infrastructure to prevent leaks. These behaviors portray an active, intentional approach to water conservation, indicating a readiness to adopt practices and technologies that can result in tangible water savings (Mango et al., 2017; Khoza et al., 2021).

In contrast, the second factor, "Mindful Water Usage", reflected a passive, conscious awareness of water conservation, accounting for 18.066% of the total variance. This factor covered behaviors like ensuring faucets are turned off when not in direct use, being conscious during teeth brushing sessions, and being attentive during rinsing. These actions might seem mundane, but their cumulative impact can be significant. They reflect an ingrained awareness of water conservation, even in daily, seemingly insignificant actions (Akram et al., 2023).

Table 2: Factor Analysis Results – Indicators and Corresponding Variance for Water-Saving Behaviors

Code	Indicator	Factor Loading	
		1	2
A7	Sensors	0.801	-0.061
A8	Vehicles	0.801	-0.045
A9	Plants	0.765	0.043
A5	Dishwasher	0.754	-0.324
A4	Thawing	0.512	-0.39
A1	Leaks	0.48	0.473
A2	Faucet off	-0.092	0.686
A6	Brushing	0.217	0.64
A3	Rinsing	0.381	0.508
KMO and Bartlett's Test			
KMO of Sampling Adequacy.		0.766	
Bartlett's Test of Sphericity		1498.472	
df		36	
Sig.		0	
Extraction Sums of Squared Loadings			
Total		3.129	1.626
% of Variance		34.762	18.066

Table 3, derived from the K-means cluster analysis, vividly portrays Jakarta's diverse populace with their water-saving behaviors. This analytical approach facilitates the compartmentalization of respondents based on behavioral similarities, ensuring a granular understanding of water-saving tendencies within the city. The analysis discerns two primary clusters. Firstly, we have the "Passive Water Consumers" (Cluster 1), identifiable through their negative relationships with the established factors. These individuals, possibly due to a deficit in awareness or lack of accessibility to specific infrastructure, have not actively integrated water-saving habits into their daily lives. This behavioral pattern, which leans away from active water conservation, suggests a segment that might not prioritize the judicious use of water. This cluster underlines the importance of targeted interventions—public awareness campaigns, educational programs, or infrastructural improvements—to address and rectify this passive approach.

On the other end of the spectrum is the "Conscientious Water Savers" group (Cluster 2). Members of this cluster exhibit behaviors that resonate positively with the "Proactive Water Saving" and "Mindful Water Usage" factors. Their proactive engagement with water conservation is evident, ranging from tangible actions such as adopting water-saving technologies to more subtle, mindful practices observed in daily routines. This cluster embodies the positive impact and potential of dedicated water conservation efforts, highlighting the segments of the population who are not only aware of but also actively contribute to the cause. Adding a layer of statistical credence to these findings, an ANOVA test was executed. The results were compelling, with the model's significance level resting below the 1% threshold. This outcome substantiates the distinctions between the two clusters and underlines the robustness of this segmentation approach.

Table 3: K-means Cluster Analysis - Differentiation of Passive Water Consumers and Active Water Stewards

Factor	Cluster		Mean Square	F	Sig.
	1 (n=263)	2 (n=369)			
1(Proactive Water Saving)	-2.19624	0.86152	445.446	1512.394	0
2 (Mindful Water Usage)	-3.657	2.03248	7.332	7.406	0.007
	Passive Water Consumers	Active Water Stewards			

Table 4 is a testament to the nuanced ways in which different sociodemographic attributes can influence water-saving behaviors. By employing the $\chi 2$ (Chi-squared) analysis, a more precise understanding emerges regarding the correlation between these attributes and the categorization of respondents as either "Passive Water Consumers" or "Active Water Stewards." The income of the respondents emerges as a significant determinant. This could indicate that higher-income individuals might have better access to water-saving technologies or greater awareness due to their socioeconomic environment. Conversely, those in lower income brackets might have other pressing priorities that overshadow water-saving behaviors.

Higher education is another attribute that displayed significance below the 1% threshold. A plausible interpretation is that educational institutions, especially at higher levels, might imbue students with a heightened environmental consciousness, emphasizing the importance of sustainable practices, including water conservation. Age plays a pivotal role as well. This finding could reflect generational differences in awareness and habits, suggesting that younger generations, having grown up amidst increasing global concerns about sustainability, might be more attuned to water conservation practices than older cohorts.

Marital status has shown a significant difference in water-saving behaviors. This might be rooted in the responsibilities and routines of different marital statuses. For instance, single individuals might have different water usage patterns compared to those who are married or those with families. Occupancy and the type of housing, both integral aspects of an individual's living conditions, have also demonstrated significant correlations with water-saving behaviors. The type of housing, in particular, might determine the kind of water facilities available, thereby influencing the conservation habits of its residents.

Interestingly, while the above attributes demonstrate clear significance, housing ownership status remains an outlier, showing no significant correlation. This might indicate that whether an individual owns a house or rents doesn't necessarily influence their water-saving habits. The reasons could be manifold: the infrastructure in place, personal values, or even external factors like community initiatives.

Table 4: $\chi 2$ Analysis of Sociodemographic Attributes: Differences between Passive Water Consumers and Active Water Stewards

Attribute		Passive Water Consumers		Active Water Stewards		Total	$\chi 2$	df	Asymptotic significance (2-sided)
Income	≤ Rp 2.500.000.00	178	28.16%	107	16.93%	285	94.941	4	0.000
	Rp 2.500.001 – Rp. 5.000.000	34	5.38%	92	14.56%	126			
	Rp. 5.000.001 - Rp. 7.500.000	21	3.32%	58	9.18%	79			
	Rp. 7.500.001 - Rp. 10.000.000	11	1.74%	55	8.70%	66			
	> Rp. 10.000.000	19	3.01%	57	9.02%	76			
Higher Education	High School and below	111	17.56%	104	16.46%	215	16.103	2	0.000
	Bachelor's Degree	141	22.31%	232	36.71%	373			
	Master's Degree and above	11	1.74%	33	5.22%	44			
Age	20-29	236	37.34%	173	27.37%	409	123.475	1	0.000
	Above 29	27	4.27%	196	31.01%	223			
Marital Status	Married	36	5.70%	143	22.63%	179	47.521	1	0.000
	Single	227	35.92%	226	35.76%	453			
Occupancy	Formal	78	12.34%	230	36.39%	308	86.208	2	0.000
	Non-Formal	48	7.59%	70	11.08%	118			
	Unemployed	137	21.68%	69	10.92%	206			
Type of housing	Apartment	25	3.96%	53	8.39%	78	56.296	4	0.000
	Kampung or Traditional Neighborhood	70	11.08%	43	6.80%	113			
	Boarding House or Lodging	61	9.65%	40	6.33%	101			
	Residential area	107	16.93%	221	34.97%	328			
	Low-Cost Apartment or Public Housing	0	0.00%	12	1.90%	12			
Housing ownership status	Office facilities	6	0.95%	9	1.42%	15	3.533	3	0.317
	Ownership	157	24.84%	243	38.45%	400			
	Staying with Relatives	20	3.16%	18	2.85%	38			
	Rent/lease	80	12.66%	99	15.66%	179			

In the comprehensive analysis outlined in Table 4, we employed probit and logit models to unpack the relationship between water-saving behaviors and various sociodemographic attributes. These models are valuable as they elucidate the likelihood of an event's occurrence under specific conditions. In this study, the event in question is whether a respondent aligns more with the "Passive Water Consumer" (coded as Cluster 1 or '0') or the "Active Water Steward" (coded as Cluster 2 or '1'). The variables were distinctly coded for clarity: Income of Rp 2,500,000 or below was coded '1', potentially hinting at a correlation with lower socioeconomic standing. Bachelor's degree holders or higher were coded '1', possibly indicating that higher education influences water-saving behaviors. The age bracket 20-29 years was represented by '1', pinpointing this younger demographic's unique behaviors. Married individuals were labeled '1', drawing attention to potential variances in water-saving behaviors between marital statuses. Those who were employed received a '1', suggesting that employment might correlate with specific water usage habits. Residents of conventional housing areas were coded '1', indicating that housing type can affect water conservation, and individuals with self-owned homes were designated '1', emphasizing the potential influence of homeownership on water-saving tendencies. The results were revelatory: Income, Marital Status, Occupancy, and Type of Housing emerged as significant determinants, with a correlation level of less than 1%, in molding water conservation behaviors. Thus, these findings underscore that one's economic standing, marital status, employment condition, and type of residence play pivotal roles in shaping their approach to water conservation. This granular insight can be instrumental in devising targeted strategies to foster a more water-aware society.

Table 5: Probit and Logit Model Results Influence of Sociodemographic Attributes on Water-Saving Behaviors

Attribute	Logit		Probit	
	Coef	S.E	Coef	S.E
Constant	-0.865***	0.210	-0.527***	0.127
Income (≤Rp 2.500.000 = 1; otherwise=0)	0.897***	0.232	0.548***	0.143
Higher Education (Bachelor's Degree and above = 1; otherwise=0)	-0.302	0.212	-0.181	0.127
Age (20-29 = 1; otherwise=0)	0.830***	0.264	0.490***	0.156
Marital Status (Married = 1; otherwise=0)	0.27	0.267	0.149	0.156
Occupancy (Employed = 1; otherwise=0)	0.716***	0.221	0.446***	0.136
Type of housing (Residential Area = 1; otherwise=0)	0.580***	0.202	0.339***	0.121
Housing ownership status (Self ownership = 1; otherwise=0)	-0.24	0.209	-0.148	0.126
Goodness of Fit				
LLR	141.592		142.167	
AIC/N	1.158		1.159	
Chi square value	$\chi 2$ (7, 0.01) = 18.48			

4. Discussion

In the quest to understand the public's attitude towards water conservation, in-depth statistical analyses provide profound insights. Our study's findings reflect the current state of water conservation awareness in Jakarta and hold potential implications for global urban centers grappling with similar concerns. Factor analysis, as we conducted, revolves around reducing a large number of variables into fewer numbers of factors. Our results, presented in Table 2, distinguished between "Proactive Water Saving" and "Mindful Water Usage." Such results mirror the findings of (Adapa 2018), who conducted a study in Australia's urban landscapes and found that individuals largely fell into categories that denoted proactive measures or daily, mindful decisions. This overlap between Jakarta's urban populace and Australia's suggests that urban settings foster similar water usage behaviors despite cultural or geographical differences.

Delving deeper into the constructs, the "Proactive Water Saving" category is particularly intriguing. It encapsulates behaviors beyond day-to-day decisions, suggesting a conscious effort to make long-term changes. Such behaviors have been linked to a high level of environmental awareness, who found that urban residents who engage in proactive behaviors often have more substantial environmental knowledge and feel a sense of urgency about conservation, as corroborated by (Chen et al., 2015; Johannessen et al., 2019). In contrast, the "Mindful Water Usage" category represents moment-to-moment decisions in daily life. While these might seem trivial, highlighted their cumulative significance in their research on Spain's water-saving behaviors (Arbués et al., 2016). Over time, these small acts, from turning off the faucet while brushing teeth to using water-saving appliances, can lead to substantial water conservation. Our cluster analysis brings further depth to our understanding. Table 3 shows two primary clusters: "Passive Water Consumers" and "Active Water Stewards". Others suggesting that these clusters could be ubiquitous, transcending geographical or cultural bounds (Paul, 2021).

The cluster analysis offers valuable insights. Jakarta's acute water challenges, coupled with initiatives and campaigns by local bodies (Luo et al., 2019), might be amplifying public awareness and catalyzing more proactive behaviors. However, sociodemographic parameters cannot be ignored when assessing these behaviors. Our data, presented in Table 4, underscores the influence of factors such as income, educational level, marital status, and housing type made a parallel observation in their study based in Brazil, reinforcing the theory that economic stability and educational attainment can amplify water-saving behaviors (de Andrade Santana et al., 2019).

Nevertheless, while income and education emerged as significant determinants, the non-significance of housing ownership status is noteworthy. This diverges from findings in some studies, suggesting that cultural, economic, or policy-related factors unique to Jakarta might influence this variable (Ustaoglu and Williams, 2017; Mollinga, 2019; Jamil, 2021). Finally, our dive into probit and logit models offers a more nuanced view. We gain a predictive edge by associating specific attributes with the likelihood of falling into one of the clusters. The significance of attributes like income, marital status, occupancy, and housing type is enlightening and paves the way for targeted interventions.

Understanding attitudes and behaviors in environmental research becomes a linchpin for devising effective strategies. The current research on citizens' attitudes toward water-saving behaviors in Jakarta presents intriguing insights that intertwine with the NBS framework. NBS, as we understand it, involves the strategic management and use of nature to address multifaceted socio-environmental challenges, including water scarcity. Our research results, particularly those from factor and cluster analyses, delineate two primary behavior clusters: Proactive Water Saving and Mindful Water Usage. The first group exemplifies proactive actions, typified by behaviors such as water-saving sensors, frequent checking of leaks, and mindful vehicle and plant washing. These individuals recognize the immediate benefits of water-saving and are also potentially aware of the broader ecological implications (McCarroll and Hamann 2020; Silvi and Padilla, 2021). Such proactive behaviors indirectly contribute to NBS by mitigating stress on local water sources, ensuring their sustainability and rejuvenation.

On the other hand, the 'Mindful Water Usage' cluster, characterized by actions like turning off faucets during inactive periods and being cautious during routine activities like brushing, suggests a more passive yet aware approach. While they may not take extensive measures, their mindful practices indicate a latent recognition of the environment's fragility. These behaviors, though subtle, contribute to the NBS ideology by emphasizing conscious consumption, which, if adopted on a large scale, can significantly alleviate environmental stress. Drawing parallels with other studies, such as (Nguyen et al., 2022; Suryawan and Lee, 2023; Sutrisno et al., 2023), we find common ground in acknowledging that localized behaviors can influence broader environmental paradigms. A studies observed that urban populations with higher education levels were likelier to engage in environment-friendly behaviors, echoing our findings wherein higher education and certain demographic facets, like housing type and marital status, played pivotal roles (Zhao et al. 2014; Xie et al. 2023).

The research dedicated to comprehending citizens' attitudes towards water-saving behaviors in Jakarta significantly intersects with the Sustainable Development Goals (SDGs) outlined by the United Nations. At the heart of these goals lies a resolute intention to confront multifaceted global dilemmas, from environmental degradation and poverty to peace and justice. Several profound connections emerge in examining this research through the lens of the SDGs. The most direct link is to SDG 6, which focuses on Clean Water and Sanitation. Target 6.4 of this goal aims for a substantial elevation in water-use efficiency by 2030, a directive that echoes the study's emphasis on proactive water-saving and mindful water utilization. By underscoring the societal benefits of efficient water use, the study aids in sketching a roadmap to combat water scarcity, weaving its findings into the broader tapestry of sustainable water management.

Moreover, Jakarta's urban setting further ties the research to SDG 11, which is dedicated to creating Sustainable Cities and Communities. Urban areas like Jakarta often grapple with nuanced challenges tied to water. The study's revelations hold potential for shaping urban policies that pivot towards integrated water-saving approaches. The goal is to ensure that as Jakarta evolves, it does so with an eye toward water sustainability, merging citizen behavior and urban planning seamlessly. This research also resonates with SDG 12, which champions Responsible Consumption and Production. The study promotes a broader culture of responsible consumption by shedding light on behaviors oriented toward water conservation. Water conservation, a critical natural resource, directly mirrors the ethos of SDG 12, emphasizing resource sustainability.

Additionally, the overarching theme of climate action embodied in SDG 13 finds resonance in the study. Being susceptible to the vagaries of climate change, Jakarta can interpret the research as a clarion call for enhanced resilience. Water scarcity, a growing concern in the face of changing climate patterns, can lead to broader environmental challenges. The city can construct robust adaptive mechanisms against potential water crises by focusing on water-saving behaviors. Lastly, the essence of collaboration and partnership, captured in SDG 17, finds subtle echoes in the study. The findings suggest the imperative for collaborations across sectors and demographics. Through collective action, informed by the research, multi-stakeholder campaigns can be formulated, thereby amplifying the collective impact on the SDGs.

5. Conclusion

The investigation into the attitudes of Jakarta's citizens towards water-saving behaviors presents a series of insightful revelations that bear implications for both urban planning and broader sustainable development efforts. Central to the study's findings is the discernment of two primary attitudinal determinants: Proactive Water Saving and Mindful Water Usage. These determinants exemplify the range of attitudes prevalent in Jakarta and provide a template for understanding similar urban centers grappling with water conservation concerns. The segregation of these attitudes into clusters, namely Passive Water Consumers and Active Water Stewards, further illuminates the behavioral diversity inherent within the populace.

Interestingly, the interplay between these attitudes and sociodemographic variables like income, marital status, and type of housing underscores the nuanced influences shaping water-saving behaviors. Notably, housing ownership did not significantly impact water conservation attitudes, suggesting that broader societal, educational, or cultural factors might play a more pivotal role than previously assumed. Jakarta's citizens exhibit a unique blend of proactive and mindful behaviors. While cities like Mumbai and Sao Paulo emphasized proactive measures, Jakarta's populace showcased a balanced interplay between proactive and mindful approaches. This balance could be attributed to Jakarta's specific sociocultural dynamics, urban infrastructure, and exposure to water scarcity narratives. Furthermore, the study's alignment with the Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production), magnifies its relevance. The research does not merely map behaviors; it situates them within the larger paradigm of global sustainability, urging urban centers worldwide to introspect, adapt, and evolve.

References

Adapa S. 2018. Factors influencing consumption and anti-consumption of recycled water: Evidence from Australia. J Clean Prod 201: 624–635. https://doi.org/https://doi.org/10.1016/j.jclepro.2018.08.083

Akram F, Gill AR, Abrar ul Haq M, et al. 2023. Barriers to Enduring Pro-Environmental Habits among Urban Residents. Appl. Sci. 13

Ali A, Akhtar R, Hussain J. 2023. Unveiling High Mountain Communities' Perception of Climate Change Impact on Lives and Livelihoods in Gilgit-Baltistan: Evidence from People-Centric Approach. Environ Commun 17: 602–617. https://doi.org/10.1080/17524032.2023.2229044

Arbués F, Bolsa MÁ, Villanúa I. 2016. Which factors determine water saving behaviour? evidence from spanish households. Urban Water J 13: 511–520. https://doi.org/10.1080/1573062X.2014.994004

Balogun A-L, Adebisi N, Abubakar IR, et al. 2022. Digitalization for transformative urbanization, climate change adaptation, and sustainable farming in Africa: trend, opportunities, and challenges. J Integr Environ Sci 19: 17–37. https://doi.org/10.1080/1943815X.2022.2033791

Boretti A, Rosa L. 2019. Reassessing the projections of the World Water Development Report. npj Clean Water 2:15. https://doi.org/10.1038/s41545-019-0039-9

Chen M, Qian X, Zhang L. 2015. Public Participation in Environmental Management in China: Status Quo and Mode Innovation. Environ Manage 55: 523–535. https://doi.org/10.1007/s00267-014-0428-2

de Andrade Santana R, Marques Bezerra S de T, Melo dos Santos S, et al. 2019. Assessing alternatives for meeting water demand: A case study of water resource management in the Brazilian Semiarid region. Util Policy 61: 100974. https://doi.org/https://doi.org/10.1016/j.jup.2019.100974

El Moll A. 2023. Chapter 23 - Water resources and climate change: regional, national and international perspective. In: Vara Prasad MN, Smol MBT-S and CM of R and WT a GD (eds). Elsevier, pp 309–336

Green D, O'Donnell E, Johnson M, et al. 2021. Green infrastructure: The future of urban flood risk management? WIREs Water 8:e1560. https://doi.org/https://doi.org/10.1002/wat2.1560

Howell TA. 2001. Enhancing Water Use Efficiency in Irrigated Agriculture. Agron J 93: 281–289. https://doi.org/https://doi.org/10.2134/agronj2001.932281x

Jamil S. 2021. From digital divide to digital inclusion: Challenges for wide-ranging digitalization in Pakistan. Telecomm Policy 45: 102206. https://doi.org/https://doi.org/10.1016/j.telpol.2021.102206

Jana A, Sarkar A, Thomas N, et al. 2021. Rethinking water policy in India with the scope of metering towards sustainable water future. Clean Technol Environ Policy 23: 2471–2495. https://doi.org/10.1007/s10098-021-02167-z

Johannessen Å, Gerger Swartling Å, Wamsler C, et al. 2019. Transforming urban water governance through social (triple-loop) learning. Environ Policy Gov 29: 144–154. https://doi.org/https://doi.org/10.1002/eet.1843

Khoza S, de Beer LT, van Niekerk D, Nemakonde L. 2021. A gender-differentiated analysis of climate-smart agriculture adoption by smallholder farmers: application of the extended technology acceptance model. Gend Technol Dev 25: 1–21. https://doi.org/10.1080/09718524.2020.1830338

Kimic K, Ostrysz K. 2021. Assessment of Blue and Green Infrastructure Solutions in Shaping Urban Public Spaces—Spatial and Functional, Environmental, and Social Aspects. Sustainability 13

Liu L-Y, Brough CB, Wu W-N. 2022. When water conservation matters: Examining how water scarcity experiences create windows of opportunity for effective water-saving policy initiatives. Environ Sci Policy 137: 61–69. https://doi.org/https://doi.org/10.1016/j.envsci.2022.08.013

Luo P, Kang S, Apip, et al. 2019. Water quality trend assessment in Jakarta: A rapidly growing Asian megacity. PLoS One 14:e0219009

Mango N, Siziba S, Makate C. 2017. The impact of adoption of conservation agriculture on smallholder farmers' food security in semi-arid zones of southern Africa. Agric Food Secur 6: 32. https://doi.org/10.1186/s40066-017-0109-5

Mbavarira TM, Grimm C. 2021. A Systemic View on Circular Economy in the Water Industry: Learnings from a Belgian and Dutch Case. Sustainability 13

McCarroll M, Hamann H. 2020. What We Know about Water: A Water Literacy Review. Water 12

Mollinga PP. 2019. Cultural political economy and critical water studies: An introduction to the special themed section. Water Altern 12: 788–801

Nelson DR, Bledsoe BP, Ferreira S, Nibbelink NP. 2020. Challenges to realizing the potential of nature-based solutions. Curr Opin Environ Sustain 45: 49–55. https://doi.org/https://doi.org/10.1016/j.cosust.2020.09.001

Nguyen VV, Phan TTT, Chun-Hung L. 2022. Integrating multiple aspects of human–elephant conflict management in Dong Nai Biosphere Reserve, Vietnam. Glob Ecol Conserv 39: e02285. https://doi.org/https://doi.org/10.1016/j.gecco.2022.e02285

Oki T, Quiocho RE. 2020. Economically challenged and water scarce: identification of global populations most vulnerable to water crises. Int J Water Resour Dev 36: 416–428. https://doi.org/10.1080/07900627.2019.1698413

Paul S. 2021. Snāna in Early India: a Socio-religious Perspective. J Dharma Stud 4: 261–279. https://doi.org/10.1007/s42240-021-00109-y

Sadok W, Lopez JR, Smith KP. 2021. Transpiration increases under high-temperature stress: Potential mechanisms, trade-offs and prospects for

crop resilience in a warming world. Plant Cell Environ 44:2102–2116. https://doi.org/https://doi.org/10.1111/pce.13970

Silvi M, Padilla E. 2021. Pro-environmental behavior: Social norms, intrinsic motivation and external conditions. Environ Policy Gov 31: 619–632. https://doi.org/https://doi.org/10.1002/eet.1960

Sowińska-Świerkosz B, García J. 2022. What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. Nature-Based Solut 2:100009. https://doi.org/https://doi.org/10.1016/j.nbsj.2022.100009

Suryawan IWK, Lee C-H. 2023. Citizens' willingness to pay for adaptive municipal solid waste management services in Jakarta, Indonesia. Sustain Cities Soc 97:. https://doi.org/https://doi.org/10.1016/j.scs.2023.104765

Suryawan IWK, Septiariva IY, Sari MM, et al. 2023. 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 11:1004

Sutrisno AD, Chen Y-J, Suryawan IW, Lee C-H. 2023. Establishing Integrative Framework for Sustainable Reef Conservation in Karimunjawa National Park, Indonesia. Water 15

Trémolet S, Atwell B, Dominique K, et al. 2021. Chapter 15 - Funding and financing to scale nature-based solutions for water security. In: Cassin J, Matthews JH, Gunn ELBT-NS and WS (eds). Elsevier, pp 361–398

Ustaoglu E, Williams B. 2017. Determinants of Urban Expansion and Agricultural Land Conversion in 25 EU Countries. Environ Manage 60:717–746. https://doi.org/10.1007/s00267-017-0908-2

Wilk B, Säumel I, Rizzi D. 2021. Collaborative Governance Arrangements for Co-creation of NBS. In: Croci E, Lucchitta B (eds) Nature-Based Solutions for More Sustainable Cities – A Framework Approach for Planning and Evaluation. Emerald Publishing Limited, pp 125–149

Xie J, Yang G, Wang G, He S. 2023. How does social capital affect farmers' environment-friendly technology adoption behavior? A case study in Hubei Province, China. Environ Dev Sustain. https://doi.org/10.1007/s10668-023-03392-w

Yu J-H, Lin H-H, Lo Y-C, et al. 2021. Measures to Cope with the Impact of Climate Change and Drought in the Island Region: A Study of the Water Literacy Awareness, Attitude, and Behavior of the Taiwanese Public. Water 13

Zhao H, Gao Q, Wu Y, et al. 2014. What affects green consumer behavior in China? A case study from Qingdao. J Clean Prod 63:143–151. https://doi.org/https://doi.org/10.1016/j.jclepro.2013.05.021

Zhu J, Zhao X, Zhu T, Li L. 2021. Which factors determine students' water-saving behaviors? Evidence from China colleges. Urban Water J 18:860–872. https://doi.org/10.1080/1573062X.2021.1943459

Zvobgo L, Do P. 2020. COVID-19 and the call for 'Safe Hands': Challenges facing the under-resourced municipalities that lack potable water access - A case study of Chitungwiza municipality, Zimbabwe. Water Res X 9:100074. https://doi.org/https://doi.org/10.1016/j.wro a.2020.100074