

Research article

Impact of COVID-19 on Subjective Well-being and Community Importance-Performance in Sanitation Programs in Jakarta, Indonesia

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Abstract

This research investigates the critical impacts of the COVID-19 pandemic on subjective well-being and evaluates community responses to sanitation programs within three urban villages in Koja, Jakarta. Utilizing Importance-Performance Analysis (IPA), the study comprehensively assesses community perceptions and engagement levels with key sanitation aspects including access to defecation and treatment, treatment quality, aesthetic quality, monitoring practices, and socialization efforts in drainage and treatment. Advanced statistical models, such as probit and logit regressions, are employed to explore how demographic variables like housing stability, gender, and active involvement in community-based sanitation programs influence these perceptions and actions toward sanitation. The findings reveal significant disparities in satisfaction levels with existing sanitation services, pinpointing areas such as monitoring and treatment services that are critically underperforming and require immediate improvement. This study highlights the urgency of addressing these issues in the face of the ongoing pandemic, reflecting on the novel insights into the complex dynamics between demographic factors and the effectiveness of sanitation programs. Our approach aims to elevate the standard of sanitation services to enhance the resilience and well-being of urban communities against the multifaceted impacts of COVID-19. These strategic improvements are vital for sustaining public health and promoting a safer, healthier living environment in densely populated urban areas, where effective sanitation is crucial for mitigating health risks and enhancing public safety.

Keywords: subjective well-being; sanitation programs; community engagement; importance-performance analysis; public health; urban sanitation, pandemic response.

1. Introduction

The COVID-19 pandemic has brought unprecedented challenges to global health systems and urban infrastructures (Scholz, Schauer, and Latzenhofer, 2022; Capolongo *et al.*, 2020; Malik 2022), catalyzing a reevaluation of public health strategies. Among these challenges, the efficacy of sanitation programs has emerged as a crucial factor in mitigating the spread of the virus and enhancing the subjective well-being of communities (Matatiele, Stiegler, and Bouchard, 2021; Humphreys and Enqvist, 2022). As a megacity, Jakarta has always grappled with the dual challenges of rapid urbanization and the sustainable management of its sanitation infrastructure (Edelman and Gunawan, 2020; Rosdiana and Sardjono, 2020). The COVID-19 pandemic has intensified these issues, highlighting the essential role of effective sanitation in controlling disease spread (Patel *et al.*, 2024; Angelakis *et al.*, 2023). Sanitation in urban health involves not only the management of waste and wastewater but also broader environmental conditions that impact public health outcomes (Scott and Cotton, 2020; Peal *et al.*, 2020). Inadequate sanitation facilities can lead to various health issues, including respiratory infections and gastrointestinal diseases, which are devastating during a pandemic (Gwenzi, 2021).

The urban villages of Koja exemplify Jakarta's broader sanitation challenges (Cecilia *et al.*, 2023a). High population densities, diverse socio-economic profiles, and varying access to public health facilities characterize these areas. The pandemic has exacerbated existing vulnerabilities (Mukumbang, Ambe, and Adebiyi, 2020; Thomas, Jang, and Scandlyn 2020), making effective sanitation a matter of public health and social justice. In response, the Indonesian government and local authorities in Jakarta have implemented several initiatives to improve public health outcomes and mitigate the impact of COVID-19 (Roziqin, Mas'udi, and Sihidi, 2021; Desdiani *et al.*, 2022). These initiatives include enhancing waste management infrastructure, promoting hygiene practices, and increasing the frequency and scope of sanitation services. However, the success of these initiatives hinges on their acceptance and valuation by local communities, influenced by various demographic and socio-economic factors. Understanding these factors is crucial for tailoring effective and equitable public health interventions.

Despite the understanding that factors such as housing stability, gender, and community involvement significantly influence the perceptions and effectiveness of public health interventions



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(Joseph, Burn, and Anderson, [2023](#); Kamruzzaman *et al.*, [2024](#); Ocaña-Ortiz *et al.*, [2024](#); Li, Tian, and Ouyang, [2022](#); Palimaru *et al.*, [2023](#)), there exists a gap in comprehensive empirical studies specifically addressing how these factors interplay during unprecedented public health crises like the COVID-19 pandemic. This research gap becomes particularly noticeable when examining urban settings where varying degrees of access to sanitation services can have differentiated impacts on public health outcomes. While existing literature acknowledges the impact of stable housing on health outcomes (Rolfe *et al.*, [2020](#); Sims *et al.*, [2020](#); Majeed and Ozturk, [2020](#); Nuwematsiko *et al.*, [2022](#)), there is a paucity of focused research evaluating how the permanence of residence influences community members' engagement and trust in public health measures during a health crisis. The role of home ownership, implying a longer-term investment in local infrastructure and community welfare (Gibb and Christie, [2024](#); Lawson, Troy, and van den Nouwelant, [2024](#)), needs further exploration to understand how it affects the adoption and perceived efficacy of sanitation programs during pandemics.

Given this backdrop, this study employs Importance-Performance Analysis (IPA) to evaluate the impact of COVID-19 on the subjective well-being of residents in the targeted urban villages through their interactions with local sanitation programs. IPA is a strategic tool that helps identify how well services meet the needs and expectations of the community by assessing the importance residents place on various attributes of the service and their satisfaction with the performance of these attributes (Nguyen *et al.*, [2024](#); López, Ruiz-Benítez, and Vargas-Machuca, [2019](#); Zhou *et al.*, [2023](#); Lin and Lee, [2023](#)). This approach provides insights into the current performance of sanitation programs and highlights areas requiring urgent attention and improvement. Moreover, by incorporating advanced statistical models such as probit and logit regressions, the study aims to dissect the nuances of how different demographic factors influence perceptions and engagement with sanitation services. This analysis is pivotal in understanding the complex dynamics influencing community responses to public health interventions during a pandemic. It offers a granular view of which factors predict positive engagement and perception, allowing policymakers and public health officials to tailor their strategies to meet different community segments' specific needs and preferences. This research provides actionable insights that can help enhance the design and implementation of sanitation programs in urban settings like Jakarta. By understanding the factors that influence community perceptions and engagement, authorities can develop more targeted, effective, and equitable public health strategies that address the immediate challenges posed by the COVID-19 pandemic and strengthen urban populations' overall resilience and well-being.

2. Research Methods

2.1. Theoretical framework

The COVID-19 pandemic has dramatically reshaped the landscape of public health and sanitation, thrusting the latter into the spotlight as a critical determinant of community well-being. In this context, the role of sanitation in mediating the psychological and societal impacts of the pandemic has become a focal point for public health research. This delves into the relationship between sanitation programs and individuals' subjective well-being during the COVID-19 crisis, as outlined in Table 1 of our study. This serves as a foundational framework for assessing the various impacts of these programs, categorized by their broad effects on community health and quality of life.

Sanitation access is universally recognized as fundamental to public health, particularly during a pandemic when inadequate hygiene facilities heighten the risk of transmission (Howard *et al.*, 2020). Studies have shown that access to basic sanitation facilities is crucial for preventing the spread of diseases and fostering a sense of security and normalcy among populations (Pessoa Colombo *et al.*, [2023](#); McGranahan, [2015](#)). During the COVID-19 pandemic, the disruption of these services in certain areas has increased stress and anxiety among affected populations, highlighting the direct link between sanitation access and psychological well-being (Arab *et al.*, [2023](#); Rahman *et al.*, [2021](#)). The functionality and performance of sanitation systems play a pivotal role in shaping residents' perceptions of their living conditions and, by extension, their overall satisfaction with life. Research has documented that well-maintained sanitation facilities significantly contribute to higher life satisfaction by reducing incidences of illness and promoting healthier living environments (D'Alessandro *et al.*, [2020](#); Awang *et al.*, [2022](#)). Moreover, during the pandemic, the perceived effectiveness of these systems in controlling the spread of COVID-19 has been directly associated with increased trust in public health measures.

Monitoring and maintaining sanitation facilities are crucial for ensuring their effectiveness, particularly during a health crisis (Thakur, [2022](#); Mavrouli *et al.*, [2022](#); Panahi *et al.*, [2022](#)). Effective

monitoring can prevent the escalation of sanitation-related issues into public health disasters, a concern that has been magnified during the COVID-19 pandemic (Di, 2021; Chakraborty, *et al.*, 2022). The success of sanitation programs is often contingent upon community engagement and the establishment of supportive social norms (Nelson *et al.*, 2021; McGranahan and Mitlin, 2016). The pandemic has underscored the importance of community-driven approaches in sanitation, where collective participation and adherence to sanitation norms have been crucial in mitigating the spread of the virus. Furthermore, such engagement has been shown to enhance the community's cohesion and collective efficacy, contributing positively to the subjective well-being of its members (Roy *et al.*, 2018; Chen and Zhang, 2022). Leveraging these indicators to assess the impact of sanitation programs offers researchers and policymakers valuable insights into the areas requiring improvement. These programs' medium and long term effects, their heterogeneous consequences across different community segments, and the underlying mechanisms through which they affect quality of life are critical for designing effective and culturally congruent interventions. Additionally, understanding the variations in how these impacts are measured and perceived can guide more tailored and responsive public health strategies.

Table 1. Indicators of sanitation programs affecting subjective well-being during COVID-19.

No	Category	Indicator	Description
1	Sanitation access	Defecation	Measures the accessibility and adequacy of facilities for safe defecation (Sun and Han, 2021; Wang and Liu, 2021).
2	Sanitation access	Treatment	Evaluate the availability and accessibility of waste treatment solutions (Qi <i>et al.</i> , 2021; Younas <i>et al.</i> , 2021; Stefanakis, 2022).
3	Sanitation quality	Treatment quality	Assesses the effectiveness and thoroughness of waste treatment processes (Zhao <i>et al.</i> , 2023; Triviño-Pineda and Sánchez Ramírez, 2023; Singh, Chakraborty, and Sehgal 2023).
4	Sanitation quality	Aesthetic Quality	Considers sanitation facilities' cleanliness and physical appeal (Ross <i>et al.</i> , 2021; Larson, 2022).
5	Monitoring and maintenance	Monitoring Practices	Involves the regular checking and maintenance of sanitation infrastructure to ensure functionality and hygiene (Thakur, 2022; Mavrouli <i>et al.</i> , 2022; Panahi <i>et al.</i> , 2022).
6	Socialization and community engagement	Drain socialization	Reflects community practices and norms regarding the maintenance and use of drainage of their septic tank or sanitation facilities (Odagiri <i>et al.</i> , 2021.).
7	Socialization and community engagement	Treatment socialization	Involves community engagement and educational efforts to promote effective wastewater treatment practices (Perry, Smith, and Mulvaney, 2020).
8	Socialization and community engagement	Treatment service	Measures the quality and responsiveness of services provided for sanitation treatment (Hill <i>et al.</i> , 2020; Tortajada, 2020).

2.2. Study location

This research utilizes a cross-sectional survey design to thoroughly investigate the impacts of COVID-19-related sanitation programs on the subjective well-being of residents in three distinct Kelurahan (urban villages) in Koja, North Jakarta : Kelurahan Lagoa, Kelurahan Rawabadak Selatan, and Kelurahan Rawabadak Utara. The primary objective is to explore how these public health interventions, initiated in response to the global pandemic, have affected residents' perceptions of their well-being. Additionally, the study assesses residents' satisfaction with the measures local government authorities have implemented to manage sanitation during the pandemic. This survey design is structured to collect data at a single point in time, providing a snapshot of the community's current views and experiences, which is essential for evaluating the immediate effects of these sanitation initiatives.

The participant sample in this study reflects a balanced gender distribution and spans a broad age range, allowing for a comprehensive analysis of how different demographic groups are impacted by public health measures. Most of the respondents reside in permanent housing, with nearly half owning their homes. This aspect of housing stability is significant as it influences individuals' engagement with and perceptions of the effectiveness of local sanitation efforts. Educational levels among participants vary widely, ranging from elementary to master's degrees, with a majority falling into the lower to middle-income brackets. This diversity in educational and economic backgrounds provides valuable insights into how these factors may influence responses to sanitation measures. Furthermore, the variation in response rates across the three Kelurahan underscores the localized differences in how residents interact with and perceive the sanitation programs, suggesting that public health strategies need to be customized to meet the specific needs of different communities. These nuanced local variations are critical for tailoring interventions that effectively address the unique challenges faced by each Kelurahan, thereby enhancing the overall efficacy of sanitation programs during the pandemic. The detailed demographic and socio-

economic profiling of the study areas ensures that the findings are relevant and can inform targeted public health policies aimed at improving community well-being and sanitation standards during ongoing and future health crises.



Figure 1. Map depicting the specific urban and residential zones surveyed in Koja, Jakarta.

2.3. Sample and study execution

The sample size was 396 individuals to ensure a comprehensive analysis. This figure is derived from statistical calculations aiming for a 95% confidence level with a margin of error of 5%, ensuring that the results are reliable and valid for generalizing the broader population. Such a sample size is sufficient to capture a wide array of experiences and opinions prevalent among the population of the targeted urban villages from March – June 2022, thereby providing a robust basis for the study's conclusions. The study utilizes a stratified random sampling technique to achieve a balanced representation of each Kelurahan involved. The overall population for the study will be segmented into strata corresponding to the three Kelurahans. Within each stratum, individuals will be selected randomly. This sampling technique is particularly advantageous as it ensures that each population segment is fairly represented in the sample, reflecting the diverse demographic and socio-economic backgrounds within these urban villages. By employing stratified random sampling, the study aims to minimize sampling bias and enhance the representativeness of the survey results, making them more reflective of the community's actual conditions and perceptions. This methodological approach, combining a well-defined study design with a rigorously calculated sample size and a systematic sampling technique, is designed to provide meaningful insights into the impact of COVID-19 sanitation measures on the well-being of residents in Koja, Jakarta. The findings are expected to offer valuable perspectives on public health effectiveness and community satisfaction, aiding policymakers and health officials in refining and

adapting their strategies to better meet the needs and expectations of the community during ongoing and future public health challenges.

Ethical considerations were paramount in the design and execution of this research, especially given its focus on human subjects within urban communities impacted by the COVID-19 pandemic. Prior to initiating the study, we secured approval from the appropriate ethics committee, ensuring adherence to international research ethics standards and the specific ethical requirements prevalent in Jakarta, Indonesia. Informed consent was a fundamental aspect of our methodology. We ensured that all participants were thoroughly informed about the aims of the study, their role within it, and their rights, which included the unequivocal right to withdraw from the study at any time without any repercussions. This crucial information was provided in the local language to guarantee comprehensive understanding and accessibility for all participants. We upheld strict confidentiality measures throughout the research process. All data collected were anonymized and securely stored, with access restricted solely to the research team for the purpose of analysis. These data will not be utilized beyond the scope of this study without explicit, informed consent from the participants. Furthermore, to ensure ethical rigor in questionnaire design, researchers are required to obtain certification from the Center for Taiwan Academic Research Ethics Education (AREE). This certification process helps ensure that researchers are well-versed in the ethical standards necessary to conduct sensitive research involving human participants within specific cultural and regulatory contexts.

2.4. The Importance-Performance Analysis

The Importance-Performance Analysis (IPA) is a crucial component in analyzing the data collected from the surveys in this study on the effects of COVID-19 sanitation programs on subjective well-being in Koja, Jakarta. The IPA is an effective analytical tool designed to evaluate the perceptions of service attributes among stakeholders, in this case, the residents of the Kelurahan of Lagoa, Rawabadak Selatan, and Rawabadak Utara. By assessing the importance and performance of various sanitation programs, the IPA allows for a structured interpretation of the data, providing clear indications of where these programs are succeeding and falling short. During the survey, respondents will be asked to rate different facets of the sanitation programs according to two specific criteria: their importance and how well they are perceived to be managed or executed. These criteria reflect the dual focus of the IPA, combining subjective priorities with objective performance assessments. The collected ratings will be plotted on an IPA grid, a visual tool that divides attributes into four distinct quadrants based on their scores in terms of perceived importance and performance (Table 1).

The first quadrant, labeled high importance and high performance (keep up the good work), will include attributes valued highly by the community and perceived as being managed effectively. Attributes falling into this quadrant are seen as strengths of the sanitation programs, indicating that the current efforts should be maintained to continue meeting community expectations. The second quadrant, high importance, low performance (concentrate here), will highlight crucial areas of the sanitation programs considered important by residents but perceived to be underperforming. This quadrant is critical for policymakers and program implementers as it identifies key areas where improvements are necessary to enhance public satisfaction and well-being.

The third quadrant, low importance, high performance (possible overkill), includes aspects managed well but not considered particularly important by the community. Attributes in this quadrant may suggest that resources are being allocated to areas that do not align closely with community priorities, possibly indicating opportunities to reallocate resources more effectively. The fourth quadrant, low importance, low performance (low priority), encompasses attributes that are neither perceived as important nor performed well. While improvements in these areas might not be urgent, they could be considered if additional resources become available or align more closely with broader program goals. The study will employ advanced statistical modeling techniques to deepen the understanding of factors influencing citizens' willingness to participate (WTP) in community-based sanitation programs in response to COVID-19 in Koja, Jakarta. Binary logistic regression models will be utilized to explore the relationship between demographic factors and citizens' WTP for these programs. These models will help elucidate how various demographic traits impact perceptions and behaviors towards these public health measures.

2.5. Modelling

The analysis will incorporate probit and logit models to investigate nuances in response behaviors based on binary choice theory. This dual-model approach allows for a comprehensive examination of how residents respond to the initiative, catering to the discrete nature of the dependent variable willingness to participate (WTP). Model I (Probit Model): This model will serve as the

baseline for our analysis, with WTP in community-based sanitation programs as the dependent variable. It will include demographic variables such as age, income, and nationality to assess the direct impact of these factors on WTP. Additionally, this model will incorporate variables that measure residents' awareness of and behaviors toward the sanitation programs alongside the respondents' overall importance scores of these sanitation efforts. This comprehensive approach allows for understanding how awareness and perceived importance influence willingness to engage financially with sanitation initiatives. Model II (Probit Model) : Like Model I, this model uses the same dependent variable but shifts the focus from the overall importance of sanitation solutions to their perceived performance. By substituting the overall importance mean with the overall performance mean, Model II assesses how the effectiveness of the sanitation efforts, as perceived by the residents, influences their WTP. This model is crucial for identifying whether performance perceptions override the importance of sanitation measures in influencing resident support.

Model III and Model IV (Logit Models) replicate the structure of Models I and II but employ logistic regression techniques instead of probit analysis. Logit models and probit models are used to compare the predictive effectiveness of these two common approaches to modeling binary outcomes. By analyzing the data through both logit and probit lenses, the study aims to confirm the robustness of the findings and ensure that the conclusions drawn are not sensitive to the choice of the statistical model. Using both probit and logit models allows for a nuanced analysis of binary choice data in the context of public health and community engagement. Each model will be assessed using standard model fit and effectiveness metrics, such as the pseudo-R² and Akaike Information Criterion (AIC). Furthermore, the significance of individual coefficients will be tested to determine which factors are statistically significant predictors of WTP.

3. Result and Discussion

3.1. Result

Table 2 presents a comprehensive analysis of various demographic factors and their influence on the willingness to participate in community-based sanitation programs as part of a study assessing the impacts of COVID-19 on individuals' subjective well-being. Starting with gender, the table shows a higher percentage of males and females willing to participate in sanitation programs, though females slightly edge out males in participation rates, indicating a possibly higher level of community engagement among women. The statistical significance is notable (p-value = 0.003), suggesting that gender significantly influences willingness to participate. Age distribution reveals a mixed response, with the 30-39 age group showing the highest willingness to participate. Although the overall p-value of 0.094 indicates that age as a factor is not statistically significant at traditional levels, it points toward a trend where middle-aged residents are more engaged, potentially due to greater awareness or stakes in community health.

Type of house is another critical factor, with those living in permanent houses showing significantly higher participation (p-value = 0.001). This might reflect stability in living conditions, which correlates with a greater investment in local community initiatives. Homeownership also impacts participation rates. Homeowners show a much higher willingness to engage in sanitation programs than renters, with a p-value of 0.025, indicating a significant difference. This could be due to homeowners having a longer-term interest in the community's well-being. Education level significantly affects participation, with higher education correlating with increased willingness. Particularly, individuals with a bachelor's degree or higher are more involved in sanitation initiatives (p-value = 0.011). This trend supports the idea that education enhances understanding and valuation of public health measures. Monthly income levels also demonstrate a strong correlation with participation willingness. Higher-income groups show a greater tendency to engage in these programs, with the statistical test yielding a p-value <0.0001, emphasizing income as a potent determinant of engagement.

Table 3 provides detailed statistics on various indicators related to the sanitation programs assessed in the study of COVID-19's impact on subjective well-being. Defecation is rated as the most important indicator with a mean importance score of 4.543, but its performance is slightly lower at 4.043, leading to a gap of 0.500. The high t-value of 9.131 indicates that this gap is statistically significant, suggesting that while defecation facilities are considered very important, their performance does not fully meet community expectations. Access to sanitation, which includes the availability and convenience of facilities, has a lower importance score of 4.109 and an even lower performance score of 3.419. The gap here is 0.689, with a significant t-value of 11.639, highlighting a substantial discrepancy between the community's expectations for accessible sanitation and the actual conditions. Treatment processes involved in sanitation receive a high

importance rating of 4.402 but a lower performance score of 3.619, resulting in a gap of 0.783 and a t-value of 12.322, indicating a critical area where improvements are necessary to match the community's needs.

Table 2. Segmentation of willingness to participate analysis of different demographic segments based on their willingness to participate in sanitation programs.

Variables		Willingness to Participate			
		No		Yes	
Gender	Male	39	9.85%	134	33.84%
	Female	81	20.45%	142	35.86%
$\chi^2 = 8.758$; df=1; p-value=0.003					
Age	20-29	26	6.57%	74	18.69%
	30-39	85	21.46%	163	41.16%
	50-59	8	2.02%	29	7.32%
	> 60	1	0.25%	10	2.53%
$\chi^2 = 6.392$; df=3; p-value=0.094					
Type of house	Permanent	114	28.79%	223	56.31%
	Semi-permanent	6	1.52%	31	7.83%
	Not permanent	0	0.00%	22	5.56%
$\chi^2 = 15.024$; df=2; p-value=0.001					
Homeownership	Own	95	23.99%	188	47.47%
	Rent	25	6.31%	88	22.22%
$\chi^2 = 5.008$; df=1; p-value=0.025					
Highest education	Elementary	3	0.76%	21	5.30%
	Junior High	8	2.02%	13	3.28%
	Senior High	88	22.22%	162	40.91%
	Bachelor's	20	5.05%	66	16.67%
	Master's	1	0.25%	14	3.54%
$\chi^2 = 13.034$; df=4; p-value=0.011					
Monthly income	< 5 million IDR	100	25.25%	178	44.95%
	5 - 10 million IDR	19	4.80%	68	17.17%
	10.1 - 15 million IDR	1	0.25%	26	6.57%
	> 15 million IDR	0	0.00%	4	1.01%
$\chi^2 = 17.964$; df=3; p-value<0.0001					
Administration area	Kelurahan Lagoa	90	22.73%	55	13.89%
	Kelurahan Rawabadak Selat	10	2.53%	103	26.01%
	Kelurahan Rawabadak Utara	20	5.05%	118	29.80%
$\chi^2 = 110.235$; df=2; p-value<0.0001					

Note: 1 USD = IDR 15,985.9 (20 May 2024).

Aesthetics, which concern the cleanliness and visual appeal of sanitation facilities, also show a notable gap between their importance (4.356) and performance (3.773), with a t-value of 8.731, suggesting that while aesthetics are highly valued, their execution could be enhanced to satisfy community standards better. Monitoring sanitation facilities is considered very important, with a score of 4.442, but has a performance score of 3.652, leading to a gap of 0.790. The high t-value of 12.380 emphasizes the community's dissatisfaction with the current level of sanitation monitoring, indicating a need for more rigorous and frequent inspections to ensure standards are maintained. Drain Socialization has an importance score of 4.374 and a performance score of 3.689, with a gap of 0.684 and a t-value of 11.652. This highlights the community's expectation for better socialization efforts around effectively maintaining and using drainage systems, suggesting that more educational and community engagement initiatives are required. Treatment Socialization, which involves community education and engagement in waste treatment processes, scores 4.364 in importance and 3.801 in performance, with a gap of 0.563 and a t-value of 10.006. This indicates a need for enhanced communication and involvement strategies to increase community participation and awareness in waste treatment practices. Lastly, treatment service, related to the

quality of services provided for waste treatment, has an importance score of 4.149 and a performance score of 3.682, resulting in the smallest gap of 0.467 and a t-value of 7.735. Although this gap is the smallest among the indicators, it still signifies a significant disparity between the expected and actual service quality, suggesting room for improvement in service delivery.

Table 3. Paired sample t-test results for sanitation program indicators: statistical comparison of residents' perceived importance and actual performance of various sanitation program indicators during COVID-19.

No	Indicator	Importance		Performance		GAP (I-P)	t-value
		Mean	Std. Deviation	Mean	Std. Deviation		
1	Defecation	4.543	0.621	4.043	0.903	0.500	9.131***
2	Access	4.109	0.754	3.419	1.027	0.689	11.639***
3	Treatment	4.402	0.677	3.619	1.045	0.783	12.322***
4	Aesthetics	4.356	0.724	3.773	1.090	0.583	8.731***
5	Monitoring	4.442	0.693	3.652	1.051	0.790	12.380***
6	Drain Socialization	4.374	0.716	3.689	0.971	0.684	11.652***
7	Treatment Socialization	4.364	0.704	3.801	0.980	0.563	10.006***
8	Treatment Service	4.149	0.999	3.682	0.889	0.467	7.735***

Figure 3 displays the IPA grid from the study examining the effects of COVID-19 on subjective well-being through sanitation programs. This grid categorizes various sanitation-related attributes according to their perceived importance to the community and their actual performance as assessed by participants. Keep up the good work, defecation falls into this category, showing that it is highly valued and well-performed. This indicates that the services provided for defecation are satisfactory to the residents and are perceived as efficiently managed, aligning well with the community's expectations. The concentration here includes attributes like monitoring and treatment, which are deemed crucial by the community but are currently underperforming. These are areas where improvement is needed as they are essential for the community's health and well-being but are not meeting the expected performance standards. In the possible overkill quadrant, aesthetics and treatment socialization are seen as exceeding the necessary performance, given their perceived importance. This suggests that while these aspects of the sanitation program are performing well, they do not align as closely with the core concerns or priorities of the community. Lastly, low priority quadrant contains treatment service and access, indicating that these areas are less important and underperforming. This suggests that while improvements could be made, they are not urgent and unlikely to impact community satisfaction or well-being significantly.

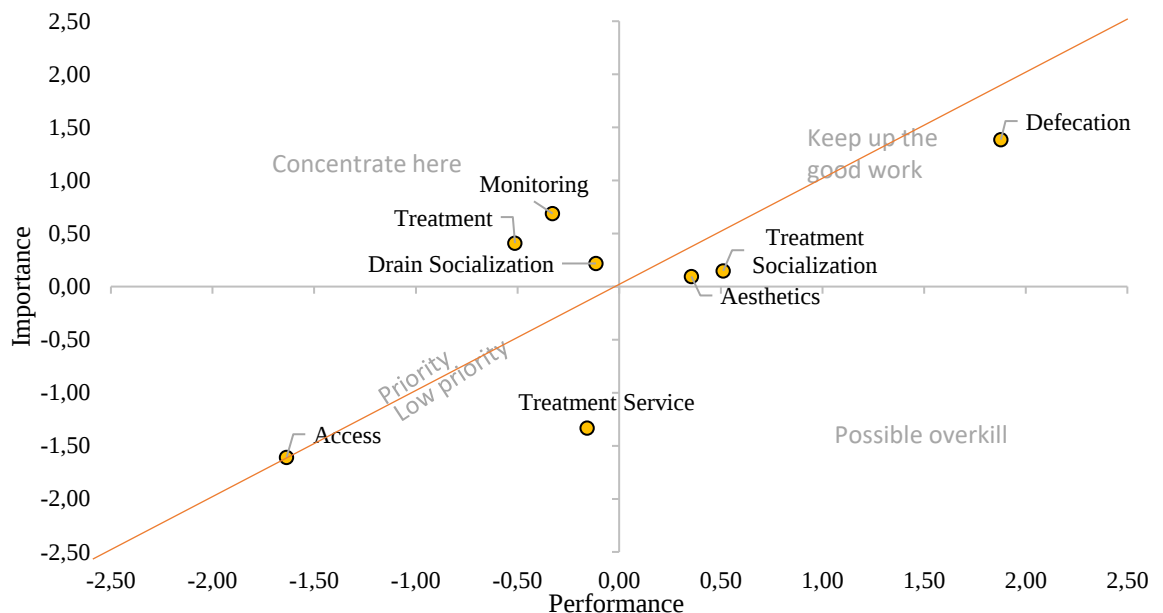


Figure 3. IPA Grid for Sanitation Programs: Visual representation of various sanitation program indicators' importance and performance scores, highlighting strengths and areas needing improvement.

Table 4 presents a detailed analysis of the results from both probit and logit models, analyzing the impact of various variables on the importance and performance of sanitation programs related to COVID-19's effects on subjective well-being. In Probit Model 1, which assesses the importance of sanitation interventions, key findings include significant coefficients for permanent housing, gender, involvement in community based-sanitation programs, and the mean importance of these

programs. The coefficient for permanent housing (0.644) suggests that individuals in permanent homes rate the importance of sanitation interventions higher, likely due to a greater awareness of or dependence on community sanitation infrastructure. The positive coefficient for gender (0.510) indicates that females may perceive sanitation programs as more crucial, aligning with broader public health engagement trends. Involvement in community based-sanitation programs also plays a significant role (0.459), reinforcing that direct engagement in local sanitation initiatives enhances their perceived importance.

Model 2 shifts focus to the performance of these programs, where permanent housing again shows a significant positive impact (0.863), suggesting those in stable housing conditions are likely to report better performance of sanitation services. The role of gender remains significant (0.649), indicating females may also perceive or experience better execution of these programs. The involvement in community based-sanitation programs shows a somewhat reduced yet significant coefficient (0.365), indicating active participants' slightly more favorable assessment of program execution.

Logit Model 3, similar to the Probit Model 1, highlights the same variables but with even higher coefficients for permanent housing (1.068) and gender (0.878), suggesting an even stronger perception of importance in these logistic regressions. Model 4, mirroring the performance assessment in the logit framework, shows that those in permanent housing (1.527) perceive the performance of sanitation programs exceptionally favorably, substantially more so than in the probit model. Across all models, the mean importance and mean performance scores from survey responses were included as predictors, showing highly significant impacts in enhancing the explanatory power of these models. These variables underscore the direct relationship between respondents' general evaluations of program relevance and efficacy and their specific perceptions of importance and performance.

Table 4. Willingness to participate in sanitation programs: Results of logistic regression models assessing factors influencing willingness to participate in sanitation programs, focusing on their importance and performance during the pandemic.

Variable Names	Probit Model Model 1 (Importance)		Model 2 (Performance)		Logit Model Model 3 (Importance)		Model 4 (Performance)	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Constant	-2.639***	0.742	-5.337***	0.592	-4.562***	1.265	-9.473***	1.125
Permanent house	0.644***	0.178	0.863***	0.198	1.068***	0.293	1.527***	0.340
Self-home ownership	0.297*	0.154	0.119	0.172	0.503**	0.256	0.212	0.293
Gender (Female)	0.510***	0.141	0.649***	0.157	0.878***	0.240	1.206***	0.279
Involvement in community based-sanitation programs	0.459***	0.158	0.365**	0.176	0.783***	0.263	0.626**	0.307
Mean importance	0.422**	0.165			0.736***	0.280		
Mean performance			1.236***	0.146			2.188***	0.274
Model Properties								
-2Log likelihood		56.796		141.702		57.533		143.689
McFadden's pseudo R2		0.116		0.290		0.118		0.294
Chi-square value								(df=5; 0.01) = 15.086

Note ***, **, * are significance differences at $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

3.2. Discussion

The placement of defecation services in the keep up the good work quadrant of the IPA grid reflects a high community satisfaction with these services. This sector's high valuation and strong performance indicate that the existing sanitation infrastructure and management practices are well-aligned with the community's needs. The effectiveness of these services is crucial, given their direct impact on public health, particularly in preventing diseases that can be exacerbated by poor sanitation during a pandemic (Howard *et al.*, 2020; Ly and Ly, 2022). The successful management of these services contributes positively to the community's overall well-being, reinforcing the necessity of maintaining these standards and potentially replicating this success in other sanitation areas. The positioning of monitoring and treatment services in the concentrate here quadrant highlights a significant gap between their importance and performance. This discrepancy underscores areas where urgent improvements are necessary. Effective monitoring is essential for early detection of sanitation issues (Ibrahim, 2020; Mao *et al.*, 2020), which can prevent potential

health crises, especially during the COVID-19 pandemic. Similarly, effectively treating sanitation waste is fundamental to preventing environmental contamination and ensuring public health safety (Schofield, 2022; Oishi and Sano, 2023). The underperformance in these areas suggests enhanced resource allocation, better management practices, or community engagement strategies to elevate these services to meet the community's expectations and needs (Barker *et al.*, 2020).

Services related to aesthetics and treatment socialization are categorized in the possible overkill quadrant, indicating that while performing well, they might not require the level of resources currently allocated. These findings suggest that while maintaining a clean and aesthetically pleasing environment is important (Zondi, Qwatekana, and Dube, 2023; Al-Ali, Maghelal, and Alawadi, 2020), the level of performance exceeds what is deemed necessary by the community. This mismatch might imply that resources could be reallocated to more critical areas like treatment and monitoring that directly impact community health. The placement in the low-priority quadrant for treatment service and access reflects lower importance and subpar performance, indicating these are areas that, while they could benefit from improvements, do not currently impact community satisfaction or well-being significantly. This suggests the potential to improve these areas satisfactorily without substantial investment or maintain current levels if resource constraints are a concern.

The consistent significance of permanent housing and self-home ownership across various models in predicting willingness to participate underscores the foundational role of stable housing in shaping residents' perspectives toward local sanitation services. Individuals residing in permanent homes or who own their homes are more inclined to perceive environmental efforts as important and effective (Sau-Ching Yim, 2021; Staunstrup *et al.*, 2022). This tendency can be attributed to a more profound connection with the community and a vested interest in the upkeep and improvement of local infrastructure. Homeowners have long-term stakes in the community's welfare (Record, 2021; Izuhara *et al.*, 2022; Keller, 2024), thus fostering a commitment to maintaining high public health and environmental cleanliness standards. Their ongoing investment in the area motivates a desire to see tangible improvements in local services (Chauhan, 2022; Perveen, 2023), including sanitation, directly affecting their quality of life and property values.

The analysis also highlights gender as a significant factor, with female respondents consistently rating the importance and performance of sanitation services more highly than males. This difference reflects broader social roles often placing women in direct charge of household health and hygiene (Indarti *et al.*, 2019; Cornish *et al.*, 2021). Women's heightened sensitivity to their immediate environment and community health can drive more acute perceptions of sanitation services' efficacy and necessity. This role often entails a greater interaction with the public health system and a direct impact from any shortcomings in sanitation, making their assessment particularly critical to understanding community needs. Active involvement in community based-sanitation programs is another potent predictor of positive perceptions toward sanitation services. Community based-sanitation, focusing on community-based sanitation solutions, directly involves residents in planning, building, and managing local sanitation facilities (Cecilia *et al.*, 2023b; Willetts, Mills, and Al'Afghani, 2020). This engagement boosts knowledge about sanitation processes and fosters a greater appreciation for the efforts undertaken to manage waste and maintain hygiene standards. Engaged individuals are more likely to observe and value the intricacies of effective sanitation management, leading to higher ratings of both the importance and performance of these services. This increased awareness and participatory experience underscore the effectiveness of involving local communities in health and sanitation initiatives (Nelson *et al.*, 2021; Nourredine *et al.*, 2023; Bhang and Huh, 2023), as it enhances accountability and satisfaction with the outcomes.

The study points out that overall perceptions of importance and performance, as composite meta-variables, significantly influence individual willingness to participate in sanitation efforts. These overarching perceptions can alter community members' engagement levels, indicating that broad-based community sentiments towards sanitation impact collective and individual actions. Enhancing sanitation efforts' perceived value and effectiveness through comprehensive community outreach and transparent communication can amplify engagement and satisfaction (Figure 4). This approach can lead to a virtuous cycle, where improved perceptions foster increased participation, enhancing service outcomes and community well-being. The implications of these findings are profound for public health policy and community-based health initiatives. By identifying and understanding the elements influencing community engagement and satisfaction with sanitation services, policymakers, and program designers can tailor interventions that address specific community needs and leverage factors like housing stability, gender sensitivity, and active participation to maximize program effectiveness. Strategic enhancements in these areas can significantly improve the quality of sanitation services, leading to better health outcomes and elevated community

well-being, which are especially crucial during ongoing challenges such as the COVID-19 pandemic.

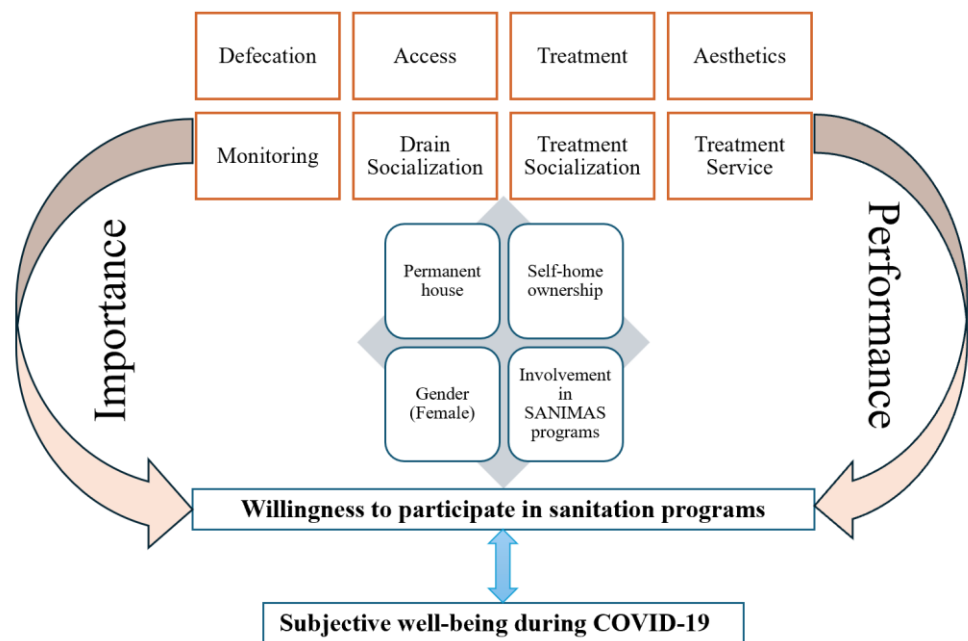


Figure 4. Evaluation framework for sanitation programs related to COVID-19's effects on subjective well-being: conceptual model illustrating the evaluation process for sanitation programs, integrating various indicators and analytical methods to assess their impact on subjective well-being during the COVID-19 pandemic.

4. Conclusion

The findings from the IPA grid show a diverse range of performance across various sanitation attributes, with services like defecation management performing well and aligning closely with community expectations. At the same time, areas such as monitoring and treatment require significant improvements to meet the community's critical needs. This disparity points to the need for targeted interventions to elevate underperforming areas vital for public health, especially during the pandemic. Statistical analysis using probit and logit models has further refined our understanding of the factors influencing these perceptions. Stable housing, gender, and active participation in community-based sanitation programs (community based-sanitation) emerged as significant predictors of how individuals perceive and engage with sanitation initiatives. These elements underscore the interconnectedness of social, economic, and participatory dynamics in shaping public health outcomes. The study has profound implications for public health policy and community engagement strategies. It emphasizes the importance of considering a broad range of factors when designing and implementing sanitation programs, particularly in urban settings affected by pandemics. Policies must address the specific needs and expectations of diverse community segments to enhance the effectiveness of sanitation services. Moreover, the research advocates for increased community involvement in sanitation efforts, suggesting that engagement and education are crucial for improving sanitation services' perception and reality. Programs can achieve better compliance and satisfaction by fostering a sense of ownership and responsibility within the community, especially among women and homeowners.

The limitations of this study are primarily associated with the use of IPA, which, while effective for assessing perceived importance and satisfaction with sanitation services, may not capture the broader contextual factors influencing these perceptions. Additionally, the study's focus on three urban villages in Koja may limit the generalizability of the findings to other areas of Jakarta or similar urban settings. The demographic variables included in the analysis, though comprehensive, do not encompass all potential factors that might influence community responses, such as cultural attitudes towards sanitation or longer-term behavioral changes due to the pandemic. Future research should aim to incorporate a broader geographic scope to enhance the generalizability of the findings. Implementing spatial analysis could provide deeper insights into how different urban environments influence community engagement and satisfaction with sanitation programs. Additionally, future surveys could explore more diverse demographic and psychosocial variables, including cultural norms, long-term behavioral shifts, and the impact of ongoing public health

interventions. Such studies would benefit from a longitudinal design to track changes over time and provide a more dynamic understanding of the impacts of COVID-19 on urban communities.

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Conflict of interest

All authors declare that they have no conflicts of interest.

Data availability

Data is available upon Request.

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