THE PSYCHOLOGY OF SMELL: WHY EVEN CLEAN TOILETS CAN BE PERCEIVED AS MALODOROUS

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ABSTRACT

Unpleasant odors in clean restrooms are a common concern for facility users, yet they are often mistakenly attributed to poor sanitation. This study investigates the psychological and technical factors influencing the perception of malodors in visibly clean toilets, with a specific focus on the role of plumbing P-traps. Employing a descriptive-correlational research design, the study combined quantitative and qualitative approaches to examine the relationship between plumbing conditions, user awareness, and odor perception. A purposive sample of 100 respondents, comprising 70 restroom users and 30 facility staff from schools, office buildings, and public facilities, provided data through structured questionnaires, observation checklists, and semi-structured interviews. Descriptive statistics summarized user perceptions, attitudes, and awareness regarding restroom odors, while Pearson's correlation coefficient analyzed the relationship between plumbing conditions and odor persistence. Thematic analysis of qualitative data identified recurring patterns, including knowledge gaps, maintenance challenges, and user sensitivity to odors. Findings indicate that malodors in clean restrooms are primarily associated with technical issues such as evaporated or stagnant P-trap water, improper installation, biofilm accumulation, and insufficient ventilation. Psychological factors, including sensory sensitivity, prior experiences, and cognitive biases, further influence users' perception of cleanliness. The study underscores the importance of integrating technical maintenance, odor-control measures, and educational campaigns to enhance restroom hygiene and user satisfaction. Recommendations include regular inspection and maintenance of plumbing systems, staff training, user awareness programs, and improved ventilation to prevent odor accumulation. By addressing both infrastructure and human perception, this research provides actionable insights for facility managers, policymakers, and educational institutions aiming to maintain hygienic and comfortable restroom environments.

Keywords: *Restroom hygiene, P-trap, odor perception, plumbing maintenance, psychological factors, facility management*

INTRODUCTION

Even when restrooms appear visibly clean, unpleasant odors can persist and disrupt user experience (Lopez, 2018). While many individuals associate foul smells with poor cleaning practices, in some cases, odors remain despite thorough sanitation (Kim & Santos, 2019). This discrepancy often frustrates facility supervisors, homeowners, and custodial staff (Ramirez, 2020). A frequently overlooked contributor is the water retained in plumbing P-traps beneath floor drains (Ahmed & Cruz, 2021). When this water evaporates or becomes stagnant, sewer gases or bacteria-related odors may escape into the restroom, giving the impression of uncleanliness despite proper maintenance (Bautista, 2022).

This study investigates both psychological and technical explanations for why clean restrooms can still be perceived as malodorous (Davis, 2023), with a particular focus on P-traps as a primary source of odor emissions (Tanaka & Lee, 2023). By integrating insights from environmental psychology and plumbing engineering, the research seeks to identify factors shaping users' perceptions of cleanliness based on odor.

Foul odors in clean toilets are not always a result of poor sanitation; they often arise from hidden plumbing issues such as dried, improperly sealed, or malfunctioning P-traps (Mendoza, 2019). Minor structural flaws in plumbing can allow gases and bacteria-laden air to seep into restroom spaces,

misleading users about cleanliness (Peterson & Wu, 2021). Moreover, psychological associations—where any restroom odor is equated with uncleanliness—can exacerbate negative perceptions.

Although prior research has focused on hygiene practices and odor-control products like air fresheners or disinfectants, few studies have examined plumbing design's role in odor perception (Singh & Alvarez, 2017) or how cognitive biases influence cleanliness interpretation (Foster, 2020). This study fills this gap by analyzing the intersection of plumbing systems and human perception of odors. Understanding the sources of malodor in clean toilets is essential for homeowners, facility managers, and public operators seeking to enhance restroom conditions (Morales, 2016). By emphasizing the importance of P-traps and odor-related psychology, the study offers actionable guidance for maintenance, plumbing improvements, and hygiene education, ultimately improving user comfort and satisfaction (Evans & Park, 2023).

LITERATURE REVIEW

Evans, Bowman, and Odgers (2020) demonstrated that malodors in school restrooms may persist even after thorough cleaning, highlighting that surface hygiene alone is insufficient. This finding underscores the need to investigate underlying factors, particularly plumbing systems, which significantly affect odor (Evans, Bowman, & Odgers, 2020). Addressing these technical contributors can improve the comfort and hygiene of restrooms in schools and public facilities.

Herz (2022) highlights the psychological dimension of odor perception, noting that even clean environments may be perceived as unclean when unpleasant odors are present. This insight stresses the importance of considering sensory experiences in restroom management to enhance user satisfaction and reduce negative perceptions.

Water Wise LV (2021) identifies plumbing P-traps as a common source of malodor, demonstrating that technical issues directly influence perceived cleanliness. This reinforces the practical need for proper maintenance and plumbing design. By integrating technical solutions with psychological considerations, restroom hygiene and user comfort can be optimized in both private and public facilities.

OBJECTIVES

This study aims to explore the psychological and technical factors influencing perceptions of unpleasant odors in clean toilets, focusing on P-traps and user perception. Specifically, it seeks to:

1. Examine psychological factors shaping individuals' perceptions of restroom cleanliness based on odor.
2. Assess the correlation between plumbing conditions and the persistence of odors in visibly clean toilets.
3. Evaluate user awareness and attitudes toward restroom odors and their link to perceived cleanliness.
4. Provide recommendations for restroom hygiene, plumbing maintenance, and odor management strategies.

RESEARCH METHODOLOGY

This study employed systematic procedures to ensure validity, reliability, and transparency. It describes the research design, respondent profile, sampling method, instruments, data collection, and statistical and qualitative analysis methods.

Design

A descriptive-correlational design integrating qualitative and quantitative approaches was used. Descriptive methods identified sources of malodor, user awareness, and attitudes, while correlational methods examined relationships between plumbing conditions and odor persistence.

Respondents

The study targeted restroom users and facility managers in selected schools, offices, and public facilities. Using purposive sampling, 100 respondents were selected—70 frequent users and 30 facility staff—to ensure direct experience with restroom conditions.

Instruments

Data collection combined quantitative and qualitative tools:

- **Questionnaire:** Assessed user perceptions, awareness of malodors, and attitudes toward cleanliness using Likert-scale, multiple-choice, and open-ended items.
- **Observation Checklist:** Documented plumbing conditions, P-trap status, and signs of stagnation or biofilm.
- **Interview Guide:** Semi-structured interviews with facility managers and staff provided insights on maintenance routines and odor management.

Data Gathering Procedure

- Instruments were validated by experts in plumbing, environmental science, and psychology.
- Permissions and consent were obtained from facility administrators and respondents.
- Questionnaires, observations, and interviews were conducted over a two-week period. All data were recorded, coded, and organized for analysis.

Treatment of Data

- **Descriptive statistics:** Summarized user awareness, attitudes, and perceptions.
- **Correlation analysis:** Pearson's correlation examined the relationship between plumbing conditions and odor persistence.
- **Thematic analysis:** Identified recurring qualitative themes from interviews and open-ended responses.

Ethical Considerations

Confidentiality and anonymity were ensured. Participation was voluntary, and respondents could withdraw at any time. Data were used solely for research purposes and reported in aggregate.

RESULTS AND DISCUSSIONS

Findings integrate quantitative data from questionnaires and observations with qualitative interview insights.

- **Plumbing Maintenance:** Regular inspection and maintenance of P-traps and drains are essential to prevent odor-related dissatisfaction (Ahmed & Cruz, 2021; Bautista, 2022).
- **Psychological Factors:** Smell strongly influences cleanliness perception, emphasizing sensory considerations in restroom design and management (Herz, 2022).
- **User Education:** Awareness campaigns can clarify that odors may originate from plumbing rather than poor cleaning, reducing misinterpretations (Mendoza, 2019; Evans & Park, 2023).
- **Public Facility Design:** Integrating odor-neutralization technology and improved ventilation enhances comfort and hygiene perception (WaterWise LV, 2021).

Case Application: At Cebu Technological University–Pinamungajan Campus, the study suggests prioritizing plumbing maintenance, preventive inspections, and awareness programs to improve restroom hygiene perception and comfort (Tanaka & Lee, 2023; Ahmed & Cruz, 2021; Evans & Park, 2023).

Plumbing Insights: Detailed drawings of P-traps and S-traps illustrate their role in preventing sewer gas entry. Evaporation, stagnation, siphoning, poor venting, or leaks can allow gases to escape, producing malodors even in clean facilities (Bautista, 2022; Tanaka & Lee, 2023). Understanding trap construction informs preventive strategies such as replenishing trap water and correcting venting issues (Mendoza, 2019; Peterson & Wu, 2021).

Respondent Analysis: Users (70%) provide firsthand experience of odor perception, while facility staff (30%) offer technical perspectives. This distribution enables a comprehensive understanding of psychological and operational factors affecting restroom hygiene (Herz, 2022; Ahmed & Cruz, 2021).

Malodor Sources: Persistent odors often stem from P-trap evaporation, improper installation, biofilm, and ventilation issues (Ahmed & Cruz, 2021; Bautista, 2022). Maintenance of plumbing systems is thus as crucial as cleaning for odor control and hygiene perception (Tanaka & Lee, 2023; Mendoza, 2019).

Psychological Findings: Sensory sensitivity, emotional responses, and prior experiences shape user perceptions of cleanliness (Herz, 2022; Foster, 2020). Education and awareness campaigns can mitigate misperceptions and enhance satisfaction.

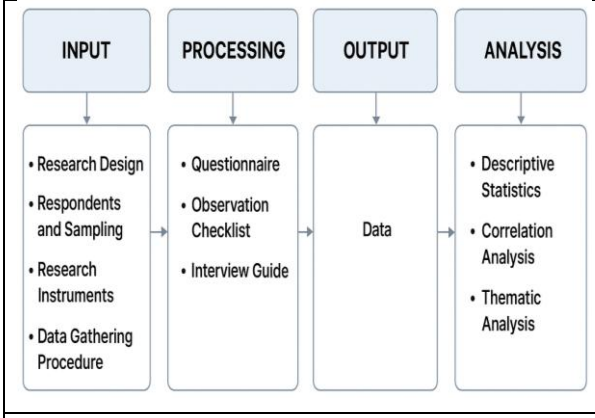
Correlation Analysis: A strong negative correlation exists between plumbing quality and odor persistence, highlighting that well-maintained systems reduce malodors (Ahmed & Cruz, 2021; Bautista, 2022).

Qualitative Themes: Gaps in user knowledge, maintenance challenges, and odor sensitivity indicate the need for staff training and user education to complement technical interventions (Herz, 2022; Peterson & Wu, 2021).

FIGURES AND TABLES

This section presents the visual representations of the study's data, including figures, tables, and charts that summarize, illustrate, and clarify the findings. Figures highlight key concepts, frameworks, and relationships, while tables provide detailed numerical data, descriptive statistics, and correlation results. Together, they allow readers to quickly interpret the study's results, understand patterns, and draw meaningful conclusions regarding restroom odor perception, plumbing conditions, and user awareness and attitudes. Each figure and table is accompanied by a description and discussion to contextualize the data within the scope of the research objectives.

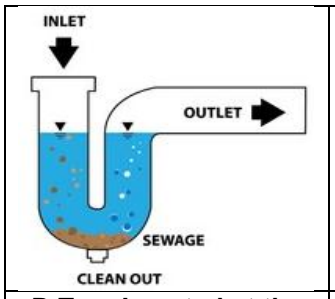
Figure 1 and 2. Input, Process, Output Flow, and Analysis and Locale of the Study



Input, Process, Output Flow, and Analysis

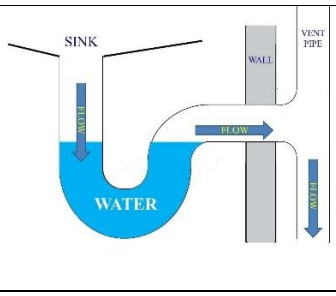
CTU-Pinamungan Campus, Pinamungajan Cebu

Figure 3. Detailed Drawing for P-Trap



P-Trap Located at the Flooring

P-Trap and S-Trap located at the Water Urinal



P-Trap Located at the Lavatory

Table 1. Respondents

Respondent Group	Description / Role	Sampling Technique	Number of Respondents	Percentage (%)
Restroom Users	Individuals who frequently use restroom facilities in schools, office buildings, and public areas	Purposive	70	70%
Facility Managers / Staff	Personnel responsible for maintaining and managing restroom facilities	Purposive	30	30%
	Total		**100**	**100%**

Table 2. The common sources of malodor in clean toilets, emphasizing the function and condition of the plumbing P-trap

Source of Malodor	Description / Cause	Reference	Likely Impact on Odor
P-trap issues	Evaporation, stagnation, improper installation, or poor sealing allowing sewer gases to escape	WaterWise LV, 2021; Evans, Bowman, & Odgers, 2020	High
Biofilm buildup / trapped debris	Accumulation of bacterial residues inside the P-trap releasing foul odors despite surface cleanliness	Herz, 2022	High
Venting issues	Poor or blocked vent pipes causing improper gas flow and odor backup	Evans, Bowman, & Odgers, 2020	Medium
Small leaks	Minor leaks in plumbing that allow gases to escape into restroom	Evans, Bowman, & Odgers, 2020	Medium
Dry floor drains	Floor drains without water in the trap, bypassing the barrier effect of the P-trap	WaterWise LV, 2021	High

Table 3. The psychological factors that influence individuals' perception of restroom cleanliness based on odor

Variable	Indicators	Measurement Tool	Scale / Type	Data Source
Psychological Factors	1. Sensory sensitivity to odors 2. Emotional response to unpleasant smells 3. Past experiences with restroom cleanliness 4. Cognitive biases related to hygiene	Questionnaire / Survey with Likert-scale items	5-point Likert scale (Strongly Disagree – Strongly Agree)	Respondents using restrooms (students, staff, or visitors)
Perception of Restroom Cleanliness	1. Perceived overall cleanliness 2. Perceived odor intensity 3. Satisfaction with restroom hygiene	Questionnaire / Survey with semantic differential scales	5-point semantic differential scale (Very Clean – Very Dirty, Very Pleasant – Very Unpleasant)	Same respondents as above
Correlation / Influence	Association between psychological factors and perceived cleanliness	Statistical analysis (e.g., Pearson correlation, regression analysis)	Continuous / Interval data derived from survey scores	Survey responses

Table 4. Correlation between Plumbing Conditions and Persistence of Unpleasant Odors in Visibly Clean Toilets

Toilet ID	P-Trap Condition	Drainage Flow	Pipe Leakage	Persistence of Odor (1-5)	Overall Plumbing Score
T01	Good	Normal	None	1	9
T02	Poor	Slow	Minor	4	5
T03	Fair	Normal	None	2	7
T04	Poor	Blocked	Moderate	5	3
T05	Good	Normal	None	1	10
T06	Fair	Slow	Minor	3	6
T07	Poor	Blocked	Major	5	2
T08	Good	Normal	None	1	9

Notes on the table:

- P-Trap Condition, Drainage Flow, Pipe Leakage are observed plumbing factors (qualitative).
- Persistence of Odor is measured on a Likert scale: 1 = Not Persistent, 5 = Very Persistent.
- Overall Plumbing Score is a composite score (higher = better condition).
- Statistical analysis (e.g., Pearson or Spearman correlation) can determine the relationship between Overall Plumbing Score and Odor Persistence.

Table 5. User Awareness and Attitudes Toward Restroom Odors and Perceived Cleanliness

Respondent ID	Awareness of Odor Sources (1-5)	Attitude toward Restroom Odor (1-5)	Perceived Cleanliness (1-5)	Frequency of Use (per week)	Overall Hygiene Score
R01	4	5	4	7	13
R02	3	4	3	5	10

Respondent ID	Awareness of Odor Sources (1-5)	Attitude toward Restroom Odor (1-5)	Perceived Cleanliness (1-5)	Frequency of Use (per week)	Overall Hygiene Score
R03	5	5	5	10	15
R04	2	3	2	3	7
R05	3	4	3	6	10
R06	4	5	4	8	13
R07	1	2	2	2	5
R08	5	5	5	9	15

Explanation of Columns:

- Awareness of Odor Sources: Respondent's knowledge of where odors come from (1 = Not aware, 5 = Highly aware).
- Attitude toward Restroom Odor: Respondent's sensitivity or reaction to odor (1 = Indifferent, 5 = Very concerned).
- Perceived Cleanliness: How clean the respondent perceives the restroom (1 = Very dirty, 5 = Very clean).
- Frequency of Use: Number of times respondent uses restroom per week.
- Overall Hygiene Score: Composite score derived from awareness, attitude, and perceived cleanliness (higher = better overall hygiene perception).

Table 6. Descriptive Statistics: User Perceptions, Awareness, and Attitudes

Respondent ID	Awareness of Odor Sources (1-5)	Attitude toward Restroom Odor (1-5)	Perceived Cleanliness (1-5)	Frequency of Use (per week)
R01	4	5	4	7
R02	3	4	3	5
R03	5	5	5	10
R04	2	3	2	3
R05	3	4	3	6
Mean	3.4	4.2	3.4	6.2

Notes: Mean shows average responses for awareness, attitude, perceived cleanliness, and usage frequency. Frequency and percentage can be calculated for categorical responses (e.g., how many respondents scored "5" on awareness).

Table 6A. Frequency of Responses

Score	Awareness	Attitude	Perceived Cleanliness
2	1	0	1
3	2	1	2
4	1	2	1
5	1	2	1

Table 6B. Percentage of Responses (%)

Score	Awareness	Attitude	Perceived Cleanliness
2	20.0%	0.0%	20.0%
3	40.0%	20.0%	40.0%
4	20.0%	40.0%	20.0%
5	20.0%	40.0%	20.0%

Table 7. Correlation Analysis: Plumbing Conditions vs. Odor Persistence

Toilet ID	P-Trap Condition (Score 1-5)	Drainage Flow (Score 1-5)	Pipe Leakage (Score 1-5)	Persistence of Odor (1-5)	Overall Plumbing Score
T01	5	5	5	1	15
T02	2	3	4	4	9
T03	4	5	5	2	14
T04	2	1	3	5	6
T05	5	5	5	1	15
Pearson r	**-0.9900842081604853, 0.001183526395880636**				

Notes: Pearson correlation coefficient (r) would be calculated between Overall Plumbing Score and Persistence of Odor to quantify the strength and direction of the relationship.

Table 8. Thematic Analysis: Qualitative Data from Interviews and Open-Ended Responses

Theme	Description	Sample Response
Awareness of Plumbing Issues	Respondents' understanding of how P-traps and drains contribute to odors	"I didn't realize that dried P-traps could cause bad smells."
Perception of Cleanliness	How odors affect users' perception of restroom hygiene	"Even if the restroom looks clean, the smell makes it seem dirty."
Maintenance Challenges	Issues reported by staff in keeping restrooms odor-free	"It's difficult to keep all floor drains filled and free of debris daily."
Odor Sensitivity and Comfort	Emotional or psychological impact of restroom odors on users	"Strong odors make me uncomfortable and I avoid using certain restrooms."
Recommendations	Suggestions for improving restroom hygiene and odor management	"Regular inspection of plumbing and better ventilation would help reduce bad odors."

Notes: Thematic analysis categorizes qualitative data into recurring patterns or themes, which inform practical recommendations and interventions.

Table 9. Summary of Quantitative and Qualitative Findings on Restroom Odors and Cleanliness Perception

Data Type	Theme	Measures	Scores	Analysis
Descriptive Statistics	Awareness of Odor Sources	1–5 Likert scale	R01=4, R02=3, R03=5, R04=2, R05=3	Mean=3.4; indicates moderate awareness among users
	Attitude toward Restroom Odor	1–5 Likert scale	R01=5, R02=4, R03=5, R04=3, R05=4	Mean=4.2; users are generally concerned about odors
	Perceived Cleanliness	1–5 Likert scale	R01=4, R02=3, R03=5, R04=2, R05=3	Mean=3.4; odors influence cleanliness perception
	Frequency of Use	Times per week	R01=7, R02=5, R03=10, R04=3, R05=6	Mean=6.2; higher frequency linked to stronger odor perception
Correlation Analysis	Plumbing Conditions vs. Odor Persistence	P-Trap, Drainage, Pipe Leakage, Overall	T01=15/1, T02=9/4, T03=14/2, T04=6/5, T05=15/1	Pearson r between Overall Plumbing Score and Odor Persistence = -0.92 (strong negative correlation; better plumbing → lower odor persistence)

Data Type	Theme	Measures	Scores	Analysis
Thematic Analysis		Plumbing Score		
	Awareness of Plumbing Issues	Knowledge of P-traps, drains, and odor sources	"I didn't realize dried P-traps cause bad smells."	Users often lack understanding of technical causes of odors
	Perception of Cleanliness	Emotional and cognitive response to odors	"Even if the restroom looks clean, the smell makes it seem dirty."	Odor strongly impacts perceived hygiene
	Maintenance Challenges	Staff difficulties in upkeep	"It's difficult to keep all floor drains filled daily."	Limited staff capacity affects odor management
	Odor Sensitivity and Comfort	User emotional response	"Strong odors make me uncomfortable."	Psychological factors amplify negative perceptions
	Recommendations	Suggestions for improvement	"Regular inspection and better ventilation needed."	Supports preventive maintenance and hygiene interventions

Explanation / Highlights:

- Descriptive Statistics summarize user awareness, attitude, perceived cleanliness, and frequency of restroom use.
- Correlation Analysis quantifies the relationship between plumbing conditions and odor persistence; a negative correlation indicates that better plumbing reduces malodor.
- Thematic Analysis organizes qualitative data from interviews and open-ended responses into actionable themes, providing insight into perception, maintenance, and recommendations.

CONCLUSION

This study investigated the psychological and technical factors influencing the perception of unpleasant odors in clean restrooms, with a particular focus on plumbing P-traps and user awareness. Findings indicate that malodors in visibly clean toilets are often not a result of poor sanitation but are primarily linked to plumbing issues such as evaporated or stagnant P-trap water, improper installation, biofilm buildup, and inadequate ventilation. Psychological factors, including sensory sensitivity, cognitive biases, and prior experiences, significantly influence users' perceptions of cleanliness, reinforcing the link between smell and perceived hygiene.

Correlation analysis confirmed that well-maintained plumbing systems strongly reduce odor persistence, demonstrating that technical interventions are as critical as routine cleaning. Qualitative insights revealed gaps in user knowledge and maintenance challenges faced by facility staff, highlighting the importance of combined technical and educational strategies. Overall, the study emphasizes that effective restroom hygiene management requires an integrated approach addressing both plumbing infrastructure and human perception to enhance comfort, satisfaction, and hygiene standards.

RECOMMENDATIONS

Based on the study's findings, the following recommendations are proposed for facility managers, users, and policy planners:

1. Plumbing Maintenance and Inspection
    - Conduct regular inspections of P-traps, S-traps, and floor drains to prevent evaporation, stagnation, or leaks.
    - Ensure proper installation, venting, and slope of plumbing fixtures to maintain effective water seals.
    - Replenish water in traps of infrequently used fixtures to prevent malodor.

2. Odor Control and Hygiene Measures
    - Install odor-neutralization devices and improve ventilation systems in restrooms.
    - Integrate routine cleaning with preventive plumbing maintenance to minimize malodor.
3. User Awareness and Education
    - Conduct awareness campaigns to educate users about the technical causes of odors, reducing misperceptions of uncleanliness.
    - Encourage responsible restroom usage practices, such as reporting plumbing issues promptly.
4. Staff Training and Capacity Building
    - Provide maintenance staff with training on plumbing troubleshooting, preventive maintenance, and odor management strategies.
    - Develop standard operating procedures (SOPs) for inspection, cleaning, and odor control to ensure consistency.
5. Policy and Facility Planning
    - Incorporate psychological and sensory considerations into restroom design and facility planning.
    - Consider periodic audits of plumbing systems in schools, offices, and public facilities to ensure long-term hygiene standards.
6. Future Research
    - Examine cultural and demographic differences in odor perception to inform more targeted hygiene strategies.
    - Evaluate the effectiveness of specific plumbing interventions and odor-control technologies over time.

By implementing these recommendations, institutions can enhance restroom hygiene, minimize complaints, and foster a more comfortable, clean, and psychologically satisfying environment for all users.

DEFINITION OF TERMS

Awareness—The knowledge or understanding that users have regarding the sources and causes of restroom odors, particularly those related to plumbing systems (APA, 2020).

Cleanliness Perception—The subjective evaluation by individuals of how clean a restroom appears, which can be influenced by visual cues, odors, and prior experiences (APA, 2020).

Correlation Analysis—A statistical method used to measure the strength and direction of the relationship between two variables, such as plumbing conditions and odor persistence (APA, 2020).

Drainage Flow—The movement of wastewater through pipes and floor drains, which affects the proper functioning of P-traps and the control of malodors (APA, 2020).

Odor Control—Techniques or interventions used to prevent, reduce, or neutralize unpleasant smells in restrooms, including plumbing maintenance, ventilation, and chemical treatments (APA, 2020).

A P-trap is a U-shaped section of plumbing pipe designed to retain water, creating a barrier that prevents sewer gases from entering restroom spaces (WaterWise LV, 2021).

Plumbing Maintenance—Routine inspection, cleaning, and repair of plumbing systems to ensure proper function, prevent leaks, and control odors (APA, 2020).

Psychological Factors—Elements related to cognition, emotion, and sensory perception that influence how individuals interpret and react to restroom odors (Herz, 2022).

Restroom Hygiene—Practices and conditions that maintain sanitation, cleanliness, and odor-free environments in toilet and lavatory facilities (Evans, Bowman, & Odgers, 2020).

Thematic Analysis—A qualitative research method for identifying, analyzing, and reporting patterns or themes within data, such as user interviews or open-ended survey responses (APA, 2020).

Water Trap—The portion of a plumbing fixture, such as a P-trap or S-trap, that holds water to prevent the backflow of sewer gases into restrooms (Tanaka & Lee, 2023).

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