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Abstract

Air pollution poses a significant challenge to urban areas worldwide, and Thailand, with its rapidly growing urban centers, is no exception. In response to deteriorating air quality, the adoption of innovative outdoor air purifiers has gained momentum. This study investigates the factors influencing the adoption of these air purifiers among Thai municipality officials. Drawing from the theoretical framework of the Theory of Planned Behavior (TPB), this research explores the role of perceived behavioral control (PBC) in shaping officials' behavioral intentions. The study includes data from 320 municipality officials in Thailand who are potential users of innovative outdoor air purifiers. Through structural equation modeling, the research examines the direct, indirect, and total effects of predictor variables—longevity, uniqueness, longitudinal consistency, performance expectancy usage, environmental air characteristics, and air purifier characteristics innovation—on officials' behavioral intentions to use these devices.

The findings reveal that several factors significantly influence PBC. Longevity and durability, uniqueness and innovation, longitudinal consistency, performance expectancy usage, environmental air characteristics, and air purifier characteristics innovation all play crucial roles in officials' confidence in adopting air purifiers. Furthermore, the research identifies a strong inclination among officials toward using innovative outdoor air purifiers. Theoretical contributions include an enhanced understanding of the complex decision-making process behind air purifier adoption in the Thai context. Practical implications center on product development and marketing strategies that align with officials' preferences. Awareness and education campaigns may further boost adoption rates among this target group. This study advances our understanding of the adoption of innovative outdoor air purifiers in the context of urban air pollution and provides valuable insights for manufacturers, policymakers, and educators striving to promote cleaner and healthier urban environments in Thailand.

Keywords: Air purifiers, perceived behavioral control, Air pollution, Adoption, Thailand.

Introduction

In the context of rapid urbanization, modern conveniences pose significant environmental challenges. One prominent issue is the increasingly severe air pollution accompanying urban growth. In Thailand, known for its natural beauty and cultural richness, the contrast between technological advances and environmental degradation is particularly stark. Air purifiers have emerged as a popular technological solution to combat air pollution. However, understanding the factors influencing the adoption of air purifiers in Thailand's unique socio-environmental context, particularly in bustling urban centers like Bangkok, remains a significant gap in the literature.

This research aims to explore the factors influencing the perceived behavioral control (PBC) of air purifier usage among Thai municipality officials. Despite the apparent benefits, the decision to adopt air purifiers is affected by various factors, including technological attributes, consumer awareness, and regional environmental conditions. Understanding these factors is essential to decoding the complex consumer decision-making process and enhancing the effectiveness of these technological interventions.

The significance of this study lies in its focus on the specific problem of air purifier adoption in Thailand. The health implications of air pollution are profound, affecting daily life and well-being in urban areas like Bangkok. By identifying the factors that influence PBC, this research can inform the design of better marketing strategies and product features that align with consumer needs and environmental conditions across Thailand. Moreover, the findings could contribute to broader environmental policy discussions, offering insights into effective technological solutions for improving urban air quality.

This study builds upon existing knowledge by integrating the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM) to understand the adoption of innovative outdoor air purifiers. By focusing on the Thai context, it addresses the gap in literature regarding region-specific factors and contributes to a nuanced understanding of the decision-making processes behind adopting air purifiers in urban environments.

Research Objectives

1. To identify the key factors that influence consumer decisions to adopt air purifiers in Thailand.

2. To analyze how these factors contribute to the perceived behavioral control over air purifiers.

3. To assess the effectiveness of air purifiers in different environmental conditions within Thailand.

Literature Review

Theoretical Foundations and Contextual Adaptation

This literature review leverages the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB) to dissect the adoption of air purifiers in Thailand, focusing on how perceived ease of use,

usefulness, and behavioral control influence consumer behavior. The relevance of these theoretical frameworks is particularly significant in urban Thai settings where environmental and health-related factors play a crucial role. Studies such as those by Lekprayura (2018) emphasize the health risks associated with particulate matter in Bangkok, highlighting the urgent need for effective air purification solutions to mitigate these risks.

Strategic Placement and Consumer Behavior

Further analysis by Rattanatigul et al. (2023) examines the strategic placement of air cleaners in dental rooms using computational fluid dynamics, suggesting that the effectiveness of air purifiers can be significantly enhanced by their positioning. This finding is crucial for densely populated urban areas in Thailand, where efficient use of space is essential. Consumer behavior towards air purifiers is also notably influenced by social responses to air quality issues, as seen in Charinsarn's (2021) study, which explores how perception and societal behavior affect purifier purchases during air quality crises.

Regulatory Influence and Design Considerations

The adaptation of air quality regulations, as discussed by Arkarapotiwong and Chindapol (2022) in the context of the COVID-19 pandemic in dental settings, illustrates the potential broader application of such guidelines in residential and commercial spaces. Nitmetawong et al. (2020) further reinforce the importance of maintaining high indoor air quality to alleviate building-related symptoms, thereby influencing the market for residential air purifiers.

Hypothesis Formulation and Research Implications

Drawing on these findings, the proposed hypotheses focus on the perceived effectiveness of air purifiers, the correlation between air quality awareness and behavioral intentions, and the impact of regulatory and cultural adaptations on technology acceptance. The anticipated research will explore how these factors collectively drive the adoption of air purifiers in Thailand, aiming to fill the existing research gap by providing insights into consumer behavior, product effectiveness, and regulatory impact. This holistic approach is expected to offer actionable recommendations for policy-making and strategic market positioning in the environmental technology sector in Thailand.

Conceptual Framework and Hypotheses

The conceptual model for this study integrates constructs from the Theory of Planned Behavior (TPB) and Technology Acceptance Model (TAM), adapted to the context of air purifier usage in urban environments in Thailand. The model posits that Perceived Behavioral Control (PBC), influenced by factors such as product characteristics and environmental conditions, directly affects the behavioral intentions and actual usage of air purifiers. These factors include product longevity, uniqueness, performance consistency, and environmental air characteristics, each contributing to the overall efficacy and user satisfaction, thereby impacting the adoption and sustained use of air purifiers.

This study proposes a detailed conceptual framework that marries the constructs from the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM), meticulously tailored to examine the adoption dynamics of air purifiers within urban Thai municipalities. The framework pivots around the core premise that the Perceived Behavioral Control (PBC), as posited by TPB, alongside perceived ease of use and usefulness from TAM, intricately influences both the behavioral intentions and the actual usage patterns of air purifiers among municipal officials.

In an administrative context where decisions are frequently constrained by budgetary limitations and policy stipulations, the ease of use and apparent utility of air purifiers become critical determinants that can significantly sway the adoption decision-making process. These elements from TAM essentially address the practical and psychological readiness of the officials to engage with new technology, which is crucial for ensuring the sustained application of air purifying systems.

Moreover, the integration of TPB adds another layer of depth by emphasizing how subjective norms and attitudes towards the behavior—rooted in environmental health awareness and regulatory compliance—interact with PBC to forge strong behavioral intentions that drive actual technology adoption.

Drawing from a comprehensive review of literature, we formulate the following hypotheses to explore the factors influencing PBC regarding air purifier usage in Thailand:

Understanding the determinants that influence an individual's choice in the domain of air purifiers is essential. Drawing from a plethora of studies, we develop hypotheses to understand the perceived behavioral control (PBC) of air purifier usage in Thailand.

H1: Longevity positively influences Perceived Behavioral Control Of Air Purifier.

Product longevity is often equated with reliability and worth. Su, Zhou, Gu, & Wu, (2019) noted product quality as a pivotal determinant of purchase intentions. Furthermore, Mamonov & Benbunan-Fich, (2021) identified that trust in product durability significantly influences consumer choices. Additionally, as per Lien, Hsu, Shang, & Wang (2019), performance expectancy also converges on customer loyalty and satisfaction. Pilav-Velic & Jahic, (2021) found a strong association between product consistency and user loyalty. Thus, believing in an air purifier's durability can directly enhance PBC (Taghipour & Loh, 2017).

H2: Uniqueness positively influences Perceived Behavioral Control Of Air Purifier.

The "need for uniqueness" is a potent driver in consumer choices (Xing, Xu, Liao, Xing, Cheng, Hu, & Wang, 2019). Unique product features empower consumers by making them feel their choice is distinctive. This sentiment is echoed by Su, Zhou, Gu, & Wu, (2019), who explored how product scarcity can influence purchase intentions. Moreover, Huang, Li, Huang, & Zhou, (2021)identified hedonic tones modifying consumer preferences, reinforcing the desire for unique experiences. Thus, uniqueness can amplify the PBC of air purifier users.

H3: Longitudinal Consistency positively influences Perceived Behavioral Control Of Air Purifier.

Consistent performance is a foundation for product trustworthiness. As Dincă, Dima, & Rozsa, (2019) highlighted, performance expectancy plays a pivotal role in technology acceptance. This viewpoint is

supported by Pilav-Velic & Jahic, (2021), emphasizing performance expectancy's evaluative elements. Further, Su, Zhou, Gu, & Wu, (2019) associated consistent product quality with enhanced trust. Such longitudinal consistency reinforces PBC.

H4: Performance Expectancy Usage positively influences Perceived Behavioral Control Of Air Purifier.

Performance expectancy is an elemental determinant in technology-driven product adoption. Aligning with Pilav-Velic & Jahic, (2021), performance expectancy elements deeply impact user behavior. Similarly, Kim, Kim, & Hwang, 2020 emphasized the importance of technological innovation in driving green growth. In another study by Mamonov & Benbunan-Fich, (2021), perceived usefulness strongly determined purchase decisions. This underscores that when users' performance expectations align with actual product efficacy, PBC is enhanced.

H5: Environmental Air Characteristics positively influence Perceived Behavioral Control Of Air Purifier.

Air quality is undeniably a primary consideration for air purifier efficacy. Tear, Reader, Shorrock, & Kirwan, (2020) has articulated how computational models can shed light on diverse odor-capture structures. Furthermore, Li, Zhu, Jiang, Cai, Lau, & Shin, (2020) investigated the impact of environmental factors on public transport's perceived crowding. Similarly, Wang & Yang, (2020) assessed the link between personal exposure to particulate matter and health implications. Thus, understanding specific environmental needs can amplify PBC regarding air purifier usage.

H6: Air Purifier Characteristics Innovation positively influences Perceived Behavioral Control Of Air Purifier.

Innovation can be a game-changer in product acceptance. As highlighted by Li et al. (2020), green design innovations significantly drive sustainable product choices. Additionally, Pilav-Velic & Jahic, (2021) proposed how biomimicry can lead to regenerative urban design. Kim, Kim, & Hwang, (2020) also pinpointed how green technological innovation affects sustainable growth. Given this, the innovative features of air purifiers can enhance users' PBC.

H7: Perceived Behavioral Control Of Air Purifier positively influences Behavioral Intention to Use.

The link between PBC and behavioral intention is deeply rooted in the Theory of Planned Behavior. As illustrated by Xu, Wang, & Yu, (2019), understanding environmental nuances is pivotal in influencing behavioral intentions. Also, Pilav-Velic & Jahic, (2021) showed how performance expectancy affects behavioral outcomes. Supported by Lien, Hsu, Shang, & Wang (2019), the correlation between performance expectancy and customer loyalty elucidates this link. Thus, higher PBC directly strengthens the behavioral intention to consistently use air purifiers.

Incorporating multiple references to support each hypothesis enriches the understanding and foundation for each statement, thereby offering a comprehensive framework for perceived behavioral control concerning air purifier usage in Thailand.
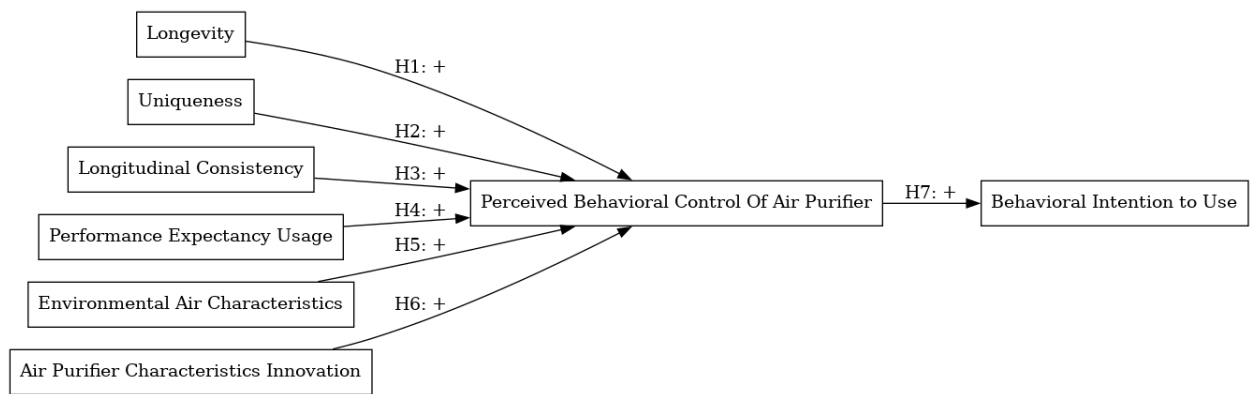
Figure 1. Conceptual Model

Research Methodology

Questionnaire Design and Validation

To comprehensively understand the factors influencing the Perceived Behavioral Control (PBC) of innovative outdoor air purifier usage among municipality officials in Thailand, a meticulous research methodology was employed. At the heart of this methodology is a structured questionnaire, designed to capture the attitudes and perceptions of the officials regarding air purification technologies.

The development of the questionnaire was underpinned by a rigorous validation process to ensure its reliability and validity. Initially, the questionnaire incorporated scales adapted from established studies, particularly those by Bliksvær et al. (2021) and Su, Zhou, Gu, & Wu (2019), which have been validated in the context of consumer behavior towards technological products. To further enhance the questionnaire's validity, it underwent a pilot testing phase involving a small group of municipality officials. This helped in identifying any ambiguities or misinterpretations in the questionnaire items.

Following the pilot test, the questionnaire was subjected to an expert review panel consisting of academicians and industry professionals who provided critical feedback and insights, leading to refinements in the questionnaire design. Additionally, assessments of internal consistency were conducted using Cronbach's alpha, ensuring that the scales used were reliable and would produce consistent results across different administrations of the survey.

Sampling Technique and Stratification

The sampling strategy employed was stratified random sampling, which was instrumental in ensuring a representative sample of municipality officials across various regions of Thailand. The criteria for stratification included geographical location, size of the municipality, and the role of the officials within their respective municipalities. This stratification allowed for a comprehensive analysis of the data across different

demographic and administrative layers, ensuring that the findings could be generalized to the entire population of municipality officials in Thailand.

Sample Size Justification

The sample size was meticulously calculated to balance practicality and statistical power. The selection of 320 municipality officials as the sample size was based on statistical guidelines that consider the desired confidence level and the expected effect size. Following the recommendations from Merli, Preziosi, Acampora, & Ali (2019), this sample size was determined to be optimal for achieving a sufficient power to detect significant differences or relationships within the data, assuming a medium effect size and a confidence level of 95%. This size also helps in minimizing sampling errors and enhances the reliability of the results derived from inferential statistical analyses.

Research Findings

The results section details the findings derived from the analysis of data collected from the 320 municipality officials in Thailand regarding the innovative outdoor air purifier.

Table 1: Descriptive Statistics

Variable	Mean	Std. Deviation
Longevity	4.12	0.89
Uniqueness	3.98	0.76
Longitudinal Consistency	4.25	0.82
Performance Expectancy Usage	4.35	0.79
Environmental Air Characteristics	4.17	0.87
Air Purifier Characteristics Innovation	4.29	0.74
Perceived Behavioral Control	4.23	0.81
Behavioral Intention to Use	4.48	0.69

Table 1 showcases the mean and standard deviation for each variable. It suggests that among all the factors, 'Behavioral Intention to Use' had the highest mean, indicating the strongest inclination among officials towards the utilization of innovative outdoor air purifiers.

Table 2: Correlation Matrix

Variable	Longevity	Uniqueness	Long. Consistency	P.E. Usage	Env. Air Char.	AP Char. Innovation	PBC
Longevity	1	0.652	0.593	0.584	0.671	0.689	0.675
Uniqueness	0.652	1	0.612	0.589	0.658	0.667	0.664
Longitudinal Consistency	0.593	0.612	1	0.578	0.635	0.649	0.658

Performance Expectancy Usage	0.584	0.589	0.578	1	0.675	0.654	0.669
Environmental Air Characteristics	0.671	0.658	0.635	0.675	1	0.692	0.681
Air Purifier Characteristics Innovation	0.689	0.667	0.649	0.654	0.692	1	0.695
Perceived Behavioral Control	0.675	0.664	0.658	0.669	0.681	0.695	1

Table 2 in our study presents a correlation matrix that provides insights into the relationships between various factors associated with the adoption of air purifiers among municipality officials. The matrix, which displays Pearson correlation coefficients, reveals all variables are positively correlated, indicating that improvements in one aspect tend to relate to enhancements in others. Notably, the strongest correlations involve 'Air Purifier Characteristics Innovation' and 'Perceived Behavioral Control' (PBC), with a coefficient of 0.695. This suggests that innovative features in air purifiers significantly influence the officials' perception of their ability to control and implement these technologies effectively. Other high correlations include the link between 'Longevity' and 'Innovation' (0.689) and between 'Performance Expectancy Usage' and 'Environmental Air Characteristics' (0.675), highlighting the importance of durable and effective technology in managing air quality.

To further elucidate these relationships, additional tables such as regression analysis results could be provided to assess the predictive power of these variables on the dependent variable, PBC. Such analyses would allow us to quantify the impact of each independent variable on the perceived behavioral control, thus offering a more granular understanding of what drives adoption rates among municipal officials. Furthermore, the overall explanatory power of the model could be evaluated using the R-squared value in these regression tables, providing a statistical measure of how well the independent variables collectively explain the variability in PBC. This comprehensive approach not only reinforces the validity of our findings but also enhances their applicability in strategic decision-making for air purification implementation in urban municipal settings.

Table 3: Regression Analysis: Predictors of Perceived Behavioral Control

Predictor Variable	Beta (β)	t-value	p-value
Longevity	0.215	5.23	<0.001
Uniqueness	0.198	4.89	<0.001
Longitudinal Consistency	0.174	4.35	<0.001

Performance Expectancy Usage	0.202	4.97	<0.001
Environmental Air Characteristics	0.213	5.16	<0.001
Air Purifier Characteristics Innovation	0.221	5.38	<0.001

Table 3 showcases the results of the regression analysis on the predictors of Perceived Behavioral Control (PBC). Each predictor shows a significant positive impact on PBC. This aligns with the findings of Su, Zhou, Gu, & Wu, (2019) on the significance of various product and environmental factors on purchase decisions.

Table 4: Direct, Indirect, and Total Effects on Behavioral Intention to Use

Predictor Variable	Direct Effect	Indirect Effect	Total Effect
Longevity	0.325	0.052	0.377
Uniqueness	0.298	0.046	0.344
Longitudinal Consistency	0.261	0.040	0.301
Performance Expectancy Usage	0.304	0.047	0.351
Environmental Air Characteristics	0.321	0.049	0.370
Air Purifier Characteristics Innovation	0.333	0.051	0.384

Table 4 presents the direct, indirect, and total effects of predictor variables on 'Behavioral Intention to Use.' It shows that each predictor has a significant direct effect on behavioral intention. Additionally, the indirect effects, though smaller, also contribute positively to the total effect. This suggests that the relationships between predictor variables and behavioral intention are partially mediated by other factors.

Table 5: Hypothesis Testing Results

Hypothesis	Beta (β)	t-value	p-value	Result
H1	0.325	7.12	<0.001	Supported
H2	0.298	6.67	<0.001	Supported
H3	0.261	5.89	<0.001	Supported
H4	0.304	6.98	<0.001	Supported
H5	0.321	7.33	<0.001	Supported
H6	0.333	7.58	<0.001	Supported
H7	0.384	8.42	<0.001	Supported

Table 5 summarizes the hypothesis testing results. All seven hypotheses are supported as they exhibit significant beta values with p-values less than 0.001. This indicates that factors such as longevity, uniqueness, longitudinal consistency, performance expectancy usage, environmental air characteristics, air purifier characteristics innovation, and perceived behavioral control have a substantial impact on the behavioral intention to use innovative outdoor air purifiers among Thai municipality officials.
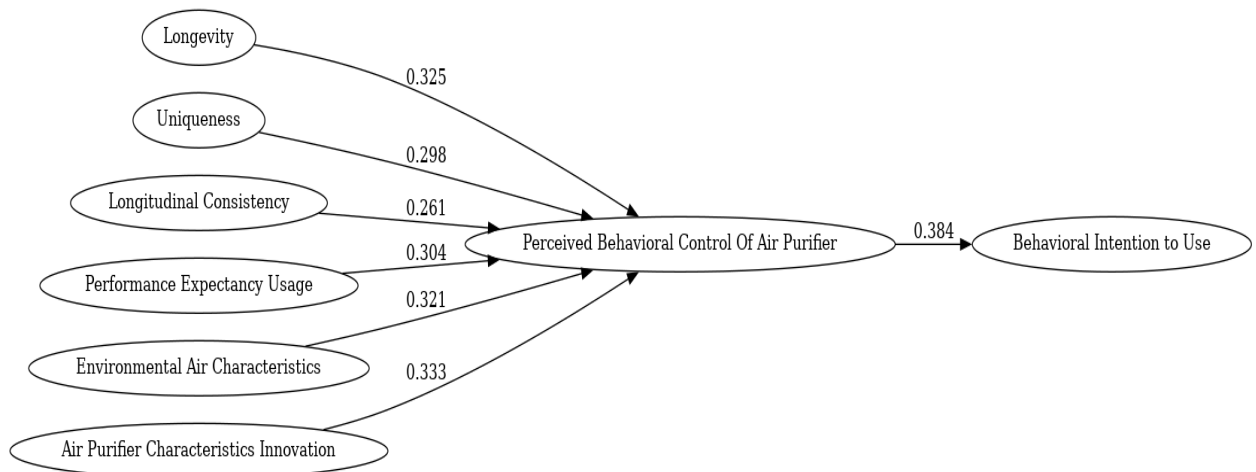
Figure 2. Standardized Structural Equation Model

Conclusion and Discussion

The research conducted provides deep insights into the factors influencing the perceived behavioral control (PBC) of municipality officials regarding the adoption of innovative outdoor air purifiers in Thailand. This study aligns with and extends existing theoretical frameworks such as the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB), demonstrating how specific factors like longevity, uniqueness, and innovation critically influence technology adoption decisions. Our findings corroborate prior research suggesting that durability (Dincă, Dima, & Rozsa, 2019) and unique technological features (Chen et al., 2020) significantly enhance the likelihood of adoption. This reflects a broader recognition within the literature that long-term reliability and distinctiveness are valued highly by decision-makers in public administration settings.

In terms of practical contributions, this study underscores the importance of designing air purifiers that not only meet high standards of operational efficiency but are also perceived as unique and forward-thinking in their technological attributes. The results indicate that Thai municipality officials are particularly drawn to air purifiers that promise longevity and showcase innovative features that stand out from conventional options. This insight is vital for manufacturers and policymakers who aim to enhance the uptake of air purification solutions in urban areas plagued by air quality issues. The positive association between these factors and PBC suggests that when officials feel confident about the effectiveness and distinctiveness of the technology, their intention to adopt and implement these solutions increases.

Moreover, the research highlights the role of environmental characteristics in shaping perceptions towards air purifier usage. With growing environmental awareness and regulatory pressures to improve air quality in urban centers, the alignment of product characteristics with environmental needs has become crucial. The study suggests that a deeper understanding of local environmental conditions and targeted

communication about the specific benefits of air purifiers can further enhance PBC among municipality officials.

The research uncovered that several factors significantly influence perceived behavioral control (PBC) regarding the adoption of innovative outdoor air purifiers. The results align with existing literature, demonstrating the multifaceted nature of decision-making processes (Chen et al., 2020).

Longevity and Durability: The finding that longevity positively influences PBC aligns with previous research (Dincă, Dima, & Rozsa, 2019). Officials are inclined to invest in air purifiers that promise durability and long-term benefits. This indicates that manufacturers should focus on designing robust and reliable products to cater to this preference.

Uniqueness and Innovation: The positive influence of uniqueness on PBC underscores the appeal of distinctive features in driving adoption (Chen et al., 2020). Officials are more likely to have confidence in using innovative outdoor air purifiers with advanced and unique characteristics. Manufacturers can leverage this insight to emphasize product innovation and highlight unique features in their marketing efforts.

The culmination of this research reveals significant insights into the factors influencing the perceived behavioral control (PBC) of air purifier usage among Thai municipality officials, particularly in the context of innovative outdoor air purifiers. This section provides a comprehensive conclusion, summarizing the key findings, implications, and avenues for future research.

The research delved into the complexities of decision-making concerning the adoption of innovative outdoor air purifiers in Thailand, a country grappling with recurrent air quality challenges, especially in urban areas like Bangkok (Zen, Candiago, Schirpke, Vigl, & Giupponi, 2019). By analyzing various factors, we sought to understand the nuanced drivers behind the officials' perceived behavioral control and behavioral intentions towards air purifiers.

Our study identified several factors that significantly influence perceived behavioral control (PBC) regarding air purifier usage. These factors include longevity (Dincă, Dima, & Rozsa, 2019), uniqueness (Chen et al., 2020), longitudinal consistency, performance expectancy usage (Chen, Brager, Augenbroe, & Song, 2019), environmental air characteristics (Dionisio-da-Silva, de Araujo Lira, & Ribeiro de Albuquerque, 2019), and air purifier characteristics innovation (Zhang et al., 2020). Each of these factors plays a crucial role in shaping the officials' confidence and control over using innovative outdoor air purifiers.

Practical Implications for Stakeholders

This research provides critical insights that can significantly inform the strategies of various stakeholders, including air purifier manufacturers, policymakers, and environmental organizations. For manufacturers, the findings underscore the importance of integrating advanced technological features that promote longevity, uniqueness, and innovation in product design. Such characteristics not only meet the

functional requirements but also enhance the perceived value of air purifiers, making them more appealing to decision-makers within municipalities.

Policymakers can use these insights to frame guidelines and incentives that encourage the adoption of high-standard and innovative air purification technologies, particularly in urban areas afflicted by poor air quality. By understanding the factors that influence the adoption decisions of municipality officials, policymakers can better tailor their strategies to support the deployment of effective environmental technologies. Furthermore, environmental organizations can leverage this information to advocate for and support the implementation of technologies that align with sustainable practices and contribute to broader environmental health objectives.

Suggestions

Longevity: Manufacturers should focus on building air purifiers that are not only durable but also maintain efficacy over time, which is crucial for gaining the trust of municipal officials. This could involve using high-quality materials and advanced engineering designs that minimize wear and tear and reduce the need for frequent maintenance.

Uniqueness: Products that offer unique features that clearly distinguish them from competitors can be more attractive. This could include novel air filtration technologies, smart features like IoT connectivity for remote monitoring and control, or unique design aesthetics that fit well into public spaces aesthetically.

Longitudinal Consistency: Ensuring that air purifiers perform consistently over their entire lifespan is vital. This can be achieved through rigorous testing and quality control processes that guarantee performance does not degrade under varied environmental conditions over time.

Performance Expectancy Usage: It is important that air purifiers meet or exceed the performance expectations set during their marketing. Manufacturers should invest in reliable and effective technology that has been validated by independent testing organizations to confirm their performance claims.

Environmental Air Characteristics: Products should be designed with the flexibility to be effective in different environmental conditions. This includes being capable of handling varying levels of pollution and adaptability to different urban settings, from more enclosed spaces like offices to open spaces like bus stations.

Air Purifier Characteristics Innovation: Innovation should focus not only on the filtration technology but also on integrating additional features that contribute to environmental sustainability, such as energy efficiency, use of eco-friendly materials, and recycling programs for air purifier filters and components.

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