INTEGRATED MANAGEMENT GUIDELINES FOR REDUCING AIR POLLUTION FROM VEHICLES IN BANGKOK

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Received: 9 April 2025 / Revised: 29 June 2025 / Accepted: 30 June 2025

ABSTRACT

Purpose – Vehicular air pollution in Bangkok poses a significant threat to public health and environmental quality. This study aims to analyze the acceptance of air pollution control measures among Bangkok residents by considering key demographic factors and public awareness. It also seeks to recommend a comprehensive management strategy to effectively address the issue.

Methodology – A mixed-methods approach was employed, integrating both quantitative and qualitative research methods. The quantitative phase involved a survey of 402 individuals who use either private vehicles or public transportation in Bangkok. The qualitative phase consisted of in-depth interviews with 17 experts specializing in air pollution management. Data analysis included descriptive statistics, one-way ANOVA, and multiple regression analysis.

Results – The findings indicate that educational attainment, occupation, and income significantly influence acceptance of air pollution control measures, while gender and age do not. Additionally, a strong correlation was found between public awareness of air pollution and acceptance levels, with punitive measures such as fines receiving the highest level of support.

Implications – The study proposes an integrated management framework comprising eight strategic components: 1) promoting electric vehicles and clean energy, 2) using AI and Big Data for air quality monitoring, 3) enforcing strict emission regulations, 4) developing clean-energy public transportation, 5) providing economic incentives for sustainable energy adoption, 6) enhancing public environmental awareness, 7) establishing a centralized environmental management agency, and 8) reinforcing legal enforcement. These strategies offer practical guidance for both governmental and private stakeholders.

Originality/Value – This research contributes to the understanding of public acceptance of air pollution control policies in a major Southeast Asian metropolis. By linking demographic and awareness factors with policy acceptance, it offers actionable insights, and a comprehensive strategic framework tailored to Bangkok's urban and environmental context.

Keywords: Atmospheric contamination, Automobiles, Pollution mitigation, Bangkok

Research Type: Research Article

INTRODUCTION

Vehicular air pollution in big urban centers, like Bangkok, poses a substantial threat to human health and environmental quality. The World Health Organization (2020) indicates that fine particulate matter (PM2.5 and PM10) and toxic gases, such as carbon monoxide (CO) and nitrogen dioxide (NO_2), predominantly derived from fossil fuel combustion, are the primary contributors to respiratory diseases, cardiovascular disorders, and cancer. This predicament is intensified by traffic congestion and ineffective public transportation networks, resulting in heightened reliance

Citation:
Phanchandee, W., Tanaborworpanid, N., & Jarujittipant, P. (2025). Integrated Management Guidelines for Reducing Air Pollution from Vehicles in Bangkok. RMUTT Global Business Accounting and Finance Review, 9(1), 55-66.
https://doi.org/10.60101/gbafr.2025.280279

on private vehicles and, in turn, exacerbating air pollution (Thongkum et al., 2020). Resolving this issue requires systematic management strategies that integrate comprehensive methods, including law enforcement, economic tools, and infrastructure development to advance clean energy cars. Nonetheless, a considerable barrier exists in the effective integration of these policies while garnering public support.

This study examines the factors affecting the adoption of vehicle air pollution management measures, analyzing key variables such as personal characteristics (e.g., age, education level, occupation, and income) that influence environmental behavior and policy acceptance. Yamineva and Romppanen (2017) emphasize that air pollution control law in various nations is deficient in rigor and effective implementation, leading to inadequate pollution control measures.

Notwithstanding prior study on air pollution management techniques, there exists a paucity of studies that amalgamate legal, economic, and infrastructural variables to formulate viable strategies for Bangkok. Numerous studies examine individual elements, such as law enforcement (Yamineva & Romppanen, 2017). Nevertheless, they fail to consider the interconnections among these aspects to propose applicable recommendations for Thailand. This research is crucial in filling the academic void by offering a thorough vehicular air pollution management strategy that can function as a policy framework for sustainable air pollution mitigation in Bangkok.

Objectives of the Research

To assess the acceptance of vehicular air pollution reduction measures in Bangkok, categorized by individual demographic characteristics.

To examine public awareness of vehicular air pollution and its impact on the acceptance of control measures in Bangkok.

To propose integrated management strategies for reducing vehicular air pollution in Bangkok.

LITERATURE REVIEW

Awareness of Vehicular Air Pollution

Integrated Management Approaches (IMA) is a concept used by organizations to integrate various management systems, such as quality (ISO 9001), environment (ISO 14001), and occupational safety (ISO 45001) under a single framework effectively, with the aim of increasing effectiveness, reducing redundancy, and promoting sustainable development. Several studies have found that good integration of Integrated Management Systems (IMS) will result in cost reduction, increased efficiency, and increased stakeholder satisfaction (Dahlin & Isaksson, 2017). This integration not only reduces redundancy, but also improves efficiency in resource utilization, information management, and strategic decision-making. However, the success of integrated management systems depends on the design that is consistent with the organization's goals and culture, not just the integration of documents (Wilkinson & Dale, 2000). This means that the implementation of the integrated management approach must start with a deep understanding of the organizational context, including the analysis of work structures, operating processes, and the readiness of personnel to accept change. Planning and implementation must be systematic. By using the principles of organizational needs analysis and comprehensive risk management (Simion et al., 2021), risk management in an integrated system must consider the risks arising from the interconnection of different systems and their potential impact on overall operations. In addition, the depth of integration has been proposed, ranging from technical coordination to embedding the concept of integrating management systems into the organization's learning culture (Jørgensen et al., 2006). Creating this learning culture is the key to the sustainable success of the integrated management approach, as it helps personnel understand and accept changes, and participate in the continuous development and improvement of the system. Therefore, the integrated management approach is a strategic tool with potential to support the organization's competitiveness and sustainability in the long term.

Awareness of Vehicular Air Pollution

Awareness refers to the process by which individuals perceive, understand and value certain information or issues, reflecting their knowledge, understanding and responding to them in a rational and responsible manner. Awareness of vehicle air pollution is a multidimensional issue, involving knowledge, attitudes and perceptions about air pollution and control measures. Understanding these factors is essential for developing effective approaches to reduce the impacts on public health and the environment. Research in several countries suggests that the public has a general level of awareness of air pollution and its health effects. For example, in Ireland and Accra, Ghana, more than 66% of respondents were aware of the impact of air pollution on their health (Quintyne & Kelly, 2023; Odonkor & Mahami, 2020). However, there are gaps in knowledge about sources of pollution, for example, doctors in Lebanon have a limited understanding of obscure sources of pollution, such as e-cigarettes or air fresheners (Assi et al., 2022). In terms of attitudes, the public generally sees air pollution reduction as a shared responsibility, and health professionals see their role, but few ask patients about their exposure to air pollution (Assi et al., 2022). For pollution control measures Technological advances such as clean engines and stricter policies have helped reduce vehicle emissions in the United States and Europe (Wallington et al., 2022) and regulating a small number of high-emission vehicles has been found to be more effective than limiting the use of conventional vehicles (Böhm et al., 2022). Public attitudes toward these measures have been relatively positive, with support for clean energy vehicles and public transport (Liang et al., 2023). Meanwhile, emotionally engaging and empathetic communication can be effective in changing behavior (Riley et al., 2021), and there have been calls for global standards for air quality measurement and coordinated policymaking across the world (Locke et al., 2022).

Acceptance of Vehicular Air Pollution Control Measures in Bangkok

Acceptance refers to the process by which an individual or group of individuals are open to, agree with, and are ready to comply with or support an approach, measure, or policy, which may stem from their understanding, perceived benefits, or motivations that are consistent with their own values and context. Acceptance of vehicle air pollution control measures depends on a combination of sanctions, incentives, and corporate social responsibility (CSR) measures, each of which faces different challenges in the context of dense cities with severe pollution levels. Sanctions, such as fines, aim to reduce non-compliance, but their effectiveness is limited by inconsistent enforcement and low public awareness (Kuilim et al., 2023). Meanwhile, pollution taxes, such as high-emission vehicle taxes, can provide financial incentives to avoid using polluting vehicles, but their success depends on public acceptance and the state's ability to effectively collect taxes (Wongwatcharapaiboon, 2020). In terms of incentives, tax cuts for low-emission vehicles have been proven to be an effective strategy to stimulate the adoption of clean technologies in China. This can be applied in the context of Bangkok (Lo et al., 2021). In addition, soft loans can help reduce financial barriers to purchasing or upgrading vehicles to lower emissions (Qin & Gao, 2022), and subsidies for public transport fares, such as electric trains, can significantly reduce private car use in the suburbs of Bangkok (Thaithatkul et al., 2023). Meanwhile, CSR initiatives, such as campaigns to raise awareness about sustainable transport or support community pollution reduction activities, can effectively promote private sector and public participation (Thongpracum & Silpjaru, 2020). Overall, a combination of measures appropriate to the Bangkok context, coupled with comprehensive policy design and public participation, is the key to sustainable vehicle pollution management (Edelman, 2022).

Research Hypotheses

The acceptance of vehicular air pollution control measures in Bangkok varies based on individual characteristic characteristics.

Awareness of vehicular air pollution influences the acceptance of control measures for it in Bangkok.

Conceptual Framework

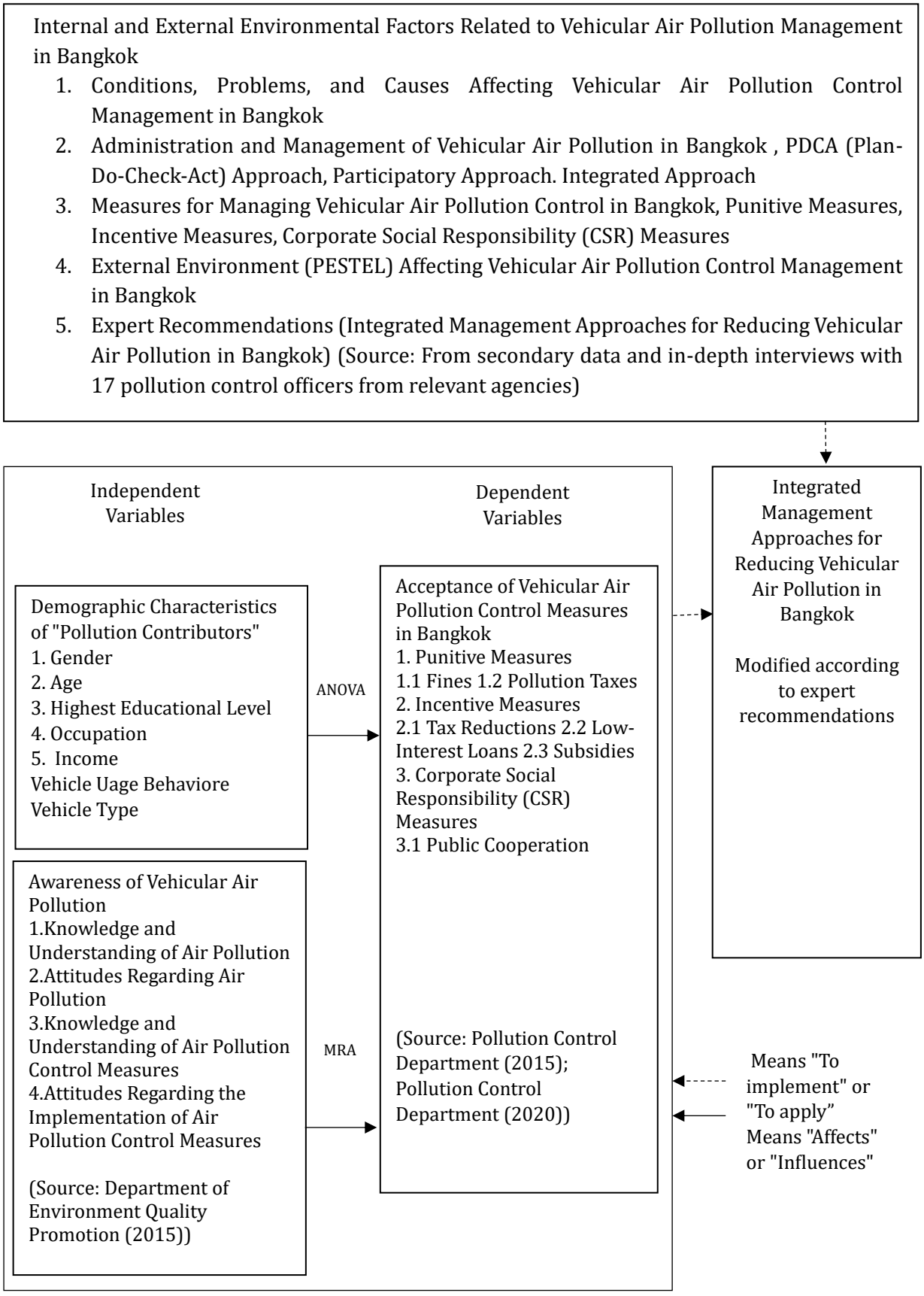

Figure 1: Conceptual Framework of the Research

METHODOLOGY

In this study, a mixed-method research method was used, which combines quantitative and qualitative research methods, to obtain more comprehensive and in-depth data. The research process divided the sample and population into 2 main groups: quantitative research group and qualitative research group. For the quantitative research, the target group consisted of private car drivers, bus drivers, and public transport passengers in Bangkok. The sample size calculation used the formula of Krejcie and Morgan (1970) under a 95% confidence level and a 5% error margin. The appropriate sample size was 354 people. However, to prevent the problem of incomplete data, the sample size was increased by another 29%, or approximately 500 people, using probability sampling to select the sample. The data were collected from September to November 2024. For the qualitative research, 17 key informants were selected, who were executives and experts from 8 government agencies involved in air pollution control and management in Bangkok. The minimum qualification is to have at least 5 years of experience in this field.

The research instruments are divided into 2 main types according to the nature of the data: quantitative and qualitative data collection instruments. For quantitative data collection, a questionnaire developed online via the Google Forms platform was used, with a total of 402 respondents providing complete information. For qualitative data collection, semi-structured interviews were conducted with experts with experience in air pollution control and management in Bangkok to extract in-depth information, opinions, and direct experiences related to the research issues in detail. The interviews were planned in advance and conducted systematically with the selected informants based on strict criteria.

For the data analysis process, quantitative research used descriptive statistics to show frequencies and percentages, as well as hypothesis testing using a one-way analysis of variance (One-Way ANOVA) via the F test, testing the difference between means with a t-test, and multiple regression analysis (MRA) to examine the relationship between variables. For qualitative data, the interview data was analyzed using content analysis, which is the interpretation of text and categorization according to key points. To obtain in-depth findings and policy recommendations that are sensible and applicable in the context of Bangkok.

RESULTS

The personal attributes of private vehicle drivers, bus drivers, and public transportation users in Bangkok who completed the questionnaire indicated that the majority were female, aged 30 to 40 years, possessed a bachelor's degree, were employed in the private sector, and had a family monthly income exceeding 30,000 baht.

A comparative analysis of means and standard deviations concerning awareness of vehicular air pollution among private vehicle drivers, bus drivers, and public transportation users in Bangkok, involving a total sample of 402 respondents, indicated that overall awareness was high (M=3.84, S.D.=.669). Upon analyzing individual components, the highest mean was observed in knowledge and understanding of air pollution, with a high level of awareness (=4.02, S.D.=.694), whereas the lowest mean pertained to knowledge and understanding of air pollution control measures, which also exhibited a high level of awareness (=3.67, S.D.=.782).

A study including 402 individuals in Bangkok examined the means and standard deviations regarding their acceptance of measures aimed at reducing vehicular air pollution. The findings indicated that the overall acceptance was elevated (=3.76, S.D.=.692). Upon analysis of individual components, the greatest mean was observed in fines, with a high level of acceptance (=3.82, S.D.=.755), whereas the lowest mean was recorded for low-interest loans, which also maintained a high level of acceptability (=3.73, S.D.=.805). It is significant that low-interest loans and subsidies exhibited same means, while low-interest loans have shown a lower standard deviation compared to subsidies.

The comprehensive research indicated that gender and age were not key determinants influencing the acceptance of air pollution control measures. Nonetheless, educational attainment, profession, and income were substantial determinants. The research indicated that

variations in educational attainment, profession, and income may lead to markedly varied levels of acceptance of measurements at the statistical significance thresholds of .01 and .05.

Multiple regression analysis revealed that the four awareness criteria collectively accounted for 61.2% (adjusted R^2 = .612) of the variance in the overall adoption of vehicle air pollution control measures in Bangkok. Knowledge and understanding of air pollution, attitudes towards air pollution, knowledge and understanding of air pollution control measures, and attitudes regarding the implementation of such measures significantly influenced the acceptance of vehicular air pollution control measures in Bangkok at statistical significance levels of .01 and .05. In assessing the influence of independent variables on the acceptance of vehicular air pollution control measures in Bangkok, attitudes towards the implementation of such measures held the greatest weight (beta = .335), followed by knowledge and understanding of air pollution control measures (beta = .304), whereas knowledge and understanding of air pollution had the least weight (beta = .124).

Comprehensive Management Strategies for Mitigating Vehicular Air Pollution in Bangkok

The comprehensive management strategy for mitigating vehicular air pollution in Bangkok should include eight methodologies as outlined below:

Approach 1 Advocating for electric vehicles and clean energy technologies to achieve sustainable air pollution mitigation. This strategy emphasizes expediting the shift from fossil fuel vehicles to electric vehicles (EVs) and clean energy technologies via economic incentives, including tax reductions, subsidies, and financial assistance, to enhance public accessibility to EVs, alongside the establishment of adequate infrastructure, such as charging stations.

Approach 2 Utilizing artificial intelligence (AI) and big data for efficient air quality monitoring and management Artificial intelligence and big data technology can assess pollution trends, predict air quality, and develop more effective pollution management strategies. Intelligent air quality sensor networks enable the government to monitor pollution levels in real-time and utilize this information to formulate suitable policies or regulatory measures.

Approach 3 Implementing rigorous emission rules in accordance with international benchmarks, such as Euro 6, to regulate air quality. Emission regulations such as Euro 6 set limits on car emissions, effectively mitigating pollution from combustion engines. This strategy necessitates stringent regulation and legal enforcement, coupled with assistance for residents migrating to electric vehicles.

Approach 4 Creating high-quality, efficient, and cost-effective sustainable energy mass transit systems via the PDCA management methodology Enhancing mass transport networks, including electric trains and clean energy buses, diminishes the prevalence of polluting private vehicles. This methodology necessitates development planning utilizing the PDCA (Plan-Do-Check-Act) framework to perpetually enhance the efficiency and accessibility of public transportation systems, including the establishment of equitable fares to encourage more public utilization of mass transit.

Approach 5 Advocating for and facilitating the shift to clean energy vehicles to enhance environmental and energy sustainability Mitigating air pollution necessitates the implementation of measures that facilitate the transition of drivers to eco-friendly vehicles, such as electric vehicles or other alternative energy vehicles, through incentives including tax reductions, subsidies, and the expansion of charging station infrastructure.

Approach 6 Augmenting public understanding and awareness of air pollution prevention and mitigation This strategy prioritizes public education regarding the effects of air pollution, while fostering awareness and promoting eco-friendly habits through campaigns, educational initiatives, and efficient communication channels.

Approach 7 Forming a unified environmental agency to enhance collaboration across pertinent entities Mitigating pollution necessitates collaboration among pertinent public and private entities. Creating an organization that functions as a hub for information integration, policy planning, and environmental oversight can facilitate more efficient operations.

Approach 8 Formulating law enforcement strategies to enhance efficacy in managing and mitigating air pollution. Legal measures, like heightened fines, stringent punishments, and the

utilization of digital technologies for monitoring vehicle emissions, are essential strategies for effective law enforcement that must be executed in conjunction with additional supportive measures to attain sustainable change.

DISCUSSION AND IMPLICATIONS

The examination of personal attributes of private vehicle operators, bus drivers, and public transit users in Bangkok uncovers distinct characteristics of this demographic. The predominant responders were female, aged 30 to 40 years, with bachelor's degrees, worked in the private sector, and earning household incomes over 30,000 baht monthly. This illustrates the demographic traits of the urban middle-class sample group, which often exhibits elevated levels of environmental awareness and perception. The research conducted by Phadongyang and Boonchunone (2023) revealed that cognitive status and alignment with reference groups influenced individuals' intentions to adopt electric automobiles. This illustrates the impact of higher education and private sector employment on individuals' receptiveness to environmental legislation. Charoenram and Phoochinda (2021) research indicated that communication and public relations about air pollution management measures are inadequate and require enhancement to increase public awareness and compliance with these laws. This aligns with the sample group's elevated propensity to acquire information from online and digital media. Tangpityawet's study (2020) indicates that demographic groups with stable economic conditions and heightened environmental consciousness are more likely to endorse low-carbon city initiatives and air pollution mitigation strategies compared to other demographic groups.

The researcher may assert that the analysis of knowledge regarding vehicular air pollution indicates that individuals in Bangkok are predominantly cognizant of this issue. This illustrates their sentiments toward pollution issues and methods for their mitigation. The mean score for knowledge and understanding of air pollution was the highest, indicating that citizens are aware of its causes and effects. This corresponds with the concept of environmental awareness (Hungerford & Volk, 1990), which underscores that environmental knowledge is essential for fostering conservation practices. Furthermore, perceptions of air pollution and the enforcement of control measures demonstrated elevated awareness, reflecting favorable public inclinations towards the management of these concerns. This aligns with the Theory of Planned Behavior (Ajzen, 1991), which posits that favorable attitudes affect pro-environmental behaviors. Nonetheless, although the knowledge and comprehension of pollution control measures (mean = 3.67) were elevated, they were inferior to other factors. This indicates that more effective campaign communication tactics and explicit information are necessary to enhance public comprehension of air pollution management initiatives.

The investigation indicates that Bangkok people exhibit a strong acceptance of automobile air pollution management methods, with fines garnering the highest level of approval. This indicates that legislation and penalties are effective methods for regulating those who engage in pollution. This aligns with the concept of Command and Control Regulation (Harrington & Morgenstern, 2007), which posits that individuals are more inclined to adhere to regulations when mandated by law. Concurrently, the least favored measure was low-interest loans, albeit at a considerable level, with a lower standard deviation than subsidies, indicating constancy of opinion within the sample group. This tendency corresponds with the notion of market-based instruments (Stavins, 2003), which posits that economic incentives such as loans and subsidies effectively encourage ecologically sustainable practices. The disparity in standard deviations between low-interest loans and subsidies indicates varying perceptions of the accessibility and feasibility of these financial instruments. This indicates that the processes of policy implementation require enhancement for practical use.

The research indicated that gender and age did not significantly affect the adoption of air pollution control measures, although education level, occupation, and income were statistically significant determinants at the .01 and .05 levels. This aligns with the concept of Environmental Concern and Socioeconomic Factors (Dietz et al., 1998), which posits that individuals with greater educational attainment and higher income levels are more likely to endorse environmental policies due to their enhanced comprehension of the impacts of pollution and improved access to

resources that facilitate behavioral change. In addition, the research findings also align with the Value-Belief-Norm Theory (Stern, 2000), which posits that social and economic variables shape environmental attitudes and actions. Consequently, population segments with stable incomes and occupations may perceive the endorsement of environmental initiatives as aligned with their personal values and beliefs, whereas lower-income groups or those with precarious employment may prioritize the economic ramifications of regulatory measures, leading to disparities in their levels of acceptance.

The examination of awareness variables about vehicle air pollution that impact the acceptance of control measures in Bangkok identified four key aspects influencing acceptance. Individuals with greater comprehension of air pollution are more likely to endorse strict penalties, aligning with Ajzen's (1991) Theory of Planned Behavior, which highlights the importance of knowledge in policy compliance. Positive attitudes toward air pollution issues increase support for measures such as pollution taxes, tax abatements, and collaborative initiatives, consistent with Schwartz's (1977) assertion that environmental values shape public policy endorsement. Awareness and understanding of pollution control methods impact acceptance across all strategies, including penalties, economic incentives, and public collaboration, corroborating Stern et al.'s (1999) findings that policy comprehension is critical to public support. Furthermore, perspectives on the implementation of pollution control measures also significantly influence acceptance across strategies, supporting Dietz et al. (2005) hypothesis that favorable views of enforcement practices enhance public backing and adherence to regulations. These findings collectively demonstrate the multifaceted role of awareness and attitudes in shaping public acceptance of pollution mitigation policies in Bangkok.

Policy implications drawn from this research highlight the need for comprehensive, multi-agency collaboration to effectively mitigate vehicular air pollution in Bangkok. Government agencies, particularly the Pollution Control Department, should prioritize updating emission standards to align with international benchmarks, deploy advanced air quality monitoring systems using AI and big data, and strengthen legal enforcement to ensure compliance. Simultaneously, they must support research into new pollution control technologies and alternative clean energy sources. The Department of Land Transport should promote the transition to electric and clean-energy vehicles by tightening vehicle registration standards, offering tax incentives, and subsidizing trade-in programs for older vehicles. Enhanced vehicle inspection protocols and the adjustment of tax policies to discourage high-emission vehicles will also be crucial to encourage cleaner transport options.

Furthermore, the Bangkok Metropolitan Administration must expand clean-energy public transit infrastructure, establish low emission zones, and implement traffic management measures to reduce congestion and emissions in urban centers. Public awareness campaigns, leveraging digital platforms and community initiatives like "Dust Detective," can help build citizen engagement and foster collective responsibility toward reducing pollution. These policy implications underscore the importance of integrated approaches that combine regulatory enforcement, economic incentives, technological innovation, and public participation to create sustainable change. By fostering cooperation among government, industry, and civil society, Bangkok can build a robust, resilient framework for tackling vehicular air pollution that also serves as a model for other rapidly urbanizing cities facing similar environmental challenges.

Managerial implications from this study emphasize the vital role of industry leaders and transit authorities in driving air pollution mitigation efforts. Automotive manufacturers should accelerate the development of clean energy and hybrid vehicles, improve exhaust filtration technologies, and adapt production processes to minimize fossil fuel use and greenhouse gas emissions. Collaborations with government agencies to offer customer incentives, such as tax rebates for low-emission vehicles, will be crucial to stimulate market adoption. Concurrently, the energy sector must expand sustainable infrastructure, including the proliferation of electric vehicle charging stations, advancements in battery technologies, and increased production of biofuels and low-sulfur fuels, while investing in research on alternative energy sources such as hydrogen and solar power. Public transit enterprises also play a significant role by transitioning fleets to electric buses, rigorously enforcing emission inspections, optimizing route planning to

reduce congestion, and incentivizing public transit usage through fare adjustments and enhanced service quality. Together, these strategic managerial initiatives highlight the necessity of cross-sectoral collaboration, technological innovation, and customer-focused incentives to effectively address vehicle-related air pollution and build a sustainable urban transport ecosystem.

The academic implications of this research are multifaceted, offering valuable contributions to the fields of environmental management, urban policy, and behavioral studies. This study bridges the gap between theory and practice by linking public awareness and demographic factors with policy acceptance, supporting theories such as the Theory of Planned Behavior and the Value-Belief-Norm Theory in environmental contexts. It highlights the role of knowledge, attitudes, and perceptions in shaping public acceptance of air pollution control measures, demonstrating how these constructs interact with demographic variables like education, income, and occupation. Furthermore, the integrated management framework proposed here offers a conceptual foundation for future scholarly work on urban environmental governance, showing how technological, legal, economic, and social measures can be combined into coherent strategies. Academically, this research underscores the need for interdisciplinary approaches that merge public policy, environmental psychology, behavioral economics, and technological studies. It also suggests pathways for future inquiry, such as longitudinal studies to examine causal relationships, and experimental designs to assess the impact of specific policy interventions or communication campaigns on public attitudes and behaviors. By providing empirical evidence in the context of a major Southeast Asian metropolis, this study enriches the global literature on air pollution management and serves as a reference point for comparative research in other urban settings facing similar environmental challenges.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

This study acknowledges several limitations that must be considered in interpreting its findings and forming future research directions. Firstly, the quantitative component relied on self-reported data gathered via online questionnaires, which may lead to biases in responses due to social desirability or the respondents' subjective interpretation of questions. Additionally, while the study sampled a diverse group of Bangkok residents, the sample predominantly represented middle-class individuals with higher education and stable incomes, potentially limiting the generalizability of the findings to lower-income or informal sector populations. The qualitative component, based on interviews with 17 experts, though rich in insights, may not encompass the full spectrum of perspectives from other stakeholders, such as small business owners, marginalized communities, or policymakers from additional government agencies. Another limitation is the cross-sectional nature of the study, which prevents the establishment of causal relationships between awareness, demographic factors, and the acceptance of pollution control measures. These factors collectively highlight the necessity of cautious interpretation and the importance of extending future research to fill existing gaps.

Future studies should consider conducting longitudinal research that can trace shifts in public acceptance and awareness over time, particularly in response to policy changes or air quality fluctuations. This approach would enable researchers to examine the causal impacts of government policies, technological advancements, or economic incentives on the adoption of pollution mitigation measures. In addition, incorporating experimental or quasi-experimental designs, such as randomized controlled trials of communication campaigns or policy interventions, could help identify the effectiveness of various strategies aimed at promoting clean energy vehicle adoption and sustainable behaviors. Further research should also broaden the sample to include more diverse socioeconomic groups, residents from peripheral urban areas, and individuals working in informal or gig economies, as their attitudes and constraints may differ significantly from those of the middle-class population studied here. Such research would yield a more nuanced understanding of the social and economic factors influencing pollution control measure acceptance.

Moreover, future studies should investigate the role of digital technologies and artificial intelligence in monitoring air quality and shaping public perceptions and behaviors toward

pollution control measures. Specifically, researchers can examine how real-time data sharing platforms, predictive modeling, and targeted communication through digital channels influence public awareness, trust in institutions, and compliance with regulations. Additionally, interdisciplinary research combining environmental psychology, behavioral economics, and public policy should explore the social and psychological drivers that determine public support and participation in pollution reduction initiatives. This includes studying the impact of message framing, emotional appeals, and community-based campaigns on long-term behavioral change. By addressing these research gaps, scholars and policymakers can develop more effective, equitable, and sustainable strategies to mitigate vehicular air pollution in Bangkok and comparable urban settings.

CONCLUSION

This study shows that people in Bangkok have a high level of awareness of air pollution from vehicles and a high level of acceptance of pollution control measures. It was found that education, occupation, and income are important factors affecting the acceptance of pollution control measures, while gender and age have no significant effects. The research also reveals that knowledge about air pollution, attitudes toward pollution problems, knowledge about control measures, and attitudes toward pollution control operations all affect the acceptance of control measures. This research proposes eight integrated management strategies to reduce air pollution from vehicles, covering the promotion of clean energy vehicles, the use of AI technology for monitoring, the establishment of strict emission standards, and the development of sustainable mass transit systems. This study makes an important contribution to public policy formulation in dealing with air pollution problems by providing empirical data that can be applied in the context of large cities in developing countries and providing guidelines for the development of effective measures to sustainably reduce air pollution.

ACKNOWLEDGMENTS

The authors would like to thank the Pollution Control Department, the Department of Land Transport, and the Environment Office of Bangkok for their cooperation and valuable data for qualitative data collection, as well as the experts and practitioners who took the time to be interviewed and shared their experiences willingly. We would like to thank North Bangkok University, for their academic support and various resources. The authors would like to thank all the respondents who played an important role in the success of this research.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest found in this research.

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