

Chapter 1

INTRODUCTION

1.1. Background of the Study

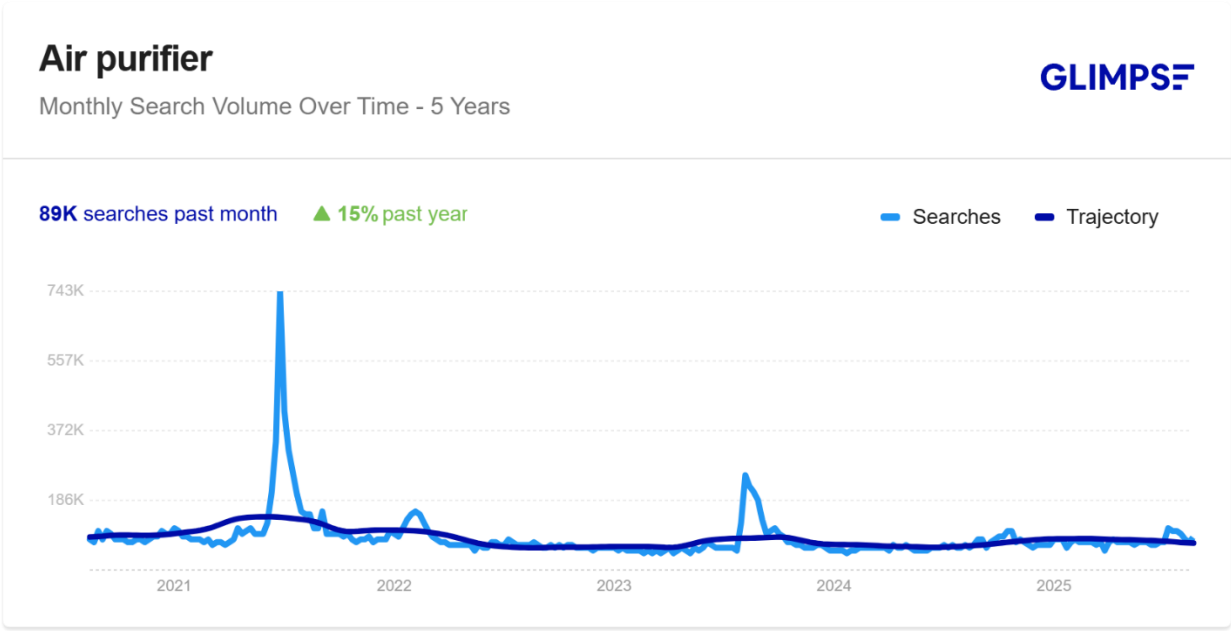
The pursuit of healthier living environments has become a dominant global consumer trend, but it is of critical and immediate importance in developing megacities. A recent landmark study on indoor air quality in Jakarta by the Asian Development Bank Institute found that mean daily indoor PM2.5 levels are dangerously high, which is eight times the health-based guidelines set by the World Health Organization (WHO) (Sun et al., 2025). This severe level of pollution establishes indoor air quality not as a lifestyle concern, but as a significant public health issue for the city's residents.

This health crisis has not gone unnoticed by the Indonesian public, as evidenced by a quantifiable surge in consumer interest. Analysis of this data on search trends as in Figure 1.1 for "air purifier" in Indonesia reveals several key insights. First, it confirms a large and active market, with a substantial baseline of approximately 89,000 monthly searches. Second, it shows this is a growing concern, as the market is not stagnant but is actively growing with a 15% increase in search volume over the past year. Finally, the data shows a high sensitivity to health events, marked by a dramatic spike in late 2021 where search volume surged to over 740,000 monthly searches, correlating with heightened public health concerns during that period (Glimpse, 2025).

Recently, the Indonesian market for smart home devices is experiencing its own significant expansion. The smart speaker segment, in particular, is a notable emerging market, with projected revenues of US\$78.65 million in 2025 and a strong forecast

compound annual growth rate of 8.08% through 2030 (Statista, 2025). This growth is reportedly driven by increasing demand for voice-controlled technology in urban areas, making the Jakarta market particularly relevant.

This study will examine the potential to merge two significant local trends: a growing need for home health solutions and the increasing interest in smart home technology, by assessing consumer acceptance of an innovative hybrid bio-tech device.



Source: Glimpse, 2025

Figure 1.1 Monthly Search Volume for "Air Purifier" in Indonesia (5-Year Trend)

1.2. Problem Statement

The primary driver of Jakarta's poor indoor air quality is unique; unlike in many developed countries, an estimated 63% of indoor PM2.5 originates from the infiltration of polluted outdoor air (Sun et al., 2025). This context makes in-home air purification an essential, rather than supplemental, health intervention. The current market solution, the

conventional HEPA air purifier, has been proven to be effective at reducing PM_{2.5} in a Jakarta residential setting (Bhakti et al., 2023). However, these devices present a secondary set of critical problems.

First, they fail to address key pollutants. They are fundamentally incapable of addressing the build-up of indoor carbon dioxide (CO₂), and critically, some models can even emit harmful ozone as a byproduct (California Air Resources Board, n.d.). Second, they create significant environmental and maintenance burdens. The reliance on disposable, plastic-based filters contribute to environmental waste, a problem highlighted by a co-founder of the natural purifier brand Briiv, who noted that a key goal should be to "help remove thousands of tons of non-biodegradable HEPA filters from landfill every year" (Gilbert, 2022). Furthermore, the effectiveness of these devices is often compromised by user neglect, as surveys reveal 20% of owners fail to change filters regularly (Business Wire, 2023).

This combination of unresolved pollutants (CO₂, ozone), environmental concerns, and user-dependent performance highlights the need for a more sustainable and autonomous air purification solution.

1.3. Existing Research and Related Products

The fundamental challenge of creating self-sustaining, breathable air has been a subject of scientific research for over half a century. At 1964, a *TIME Magazine* article detailed research into breathable environments for submarines and spacecraft, showcasing a "breathable tank" made from a gas-permeable silicone membrane (TIME, 1964). This established the scientific principle of passive gas exchange.

The application of living microalgae, as seen in the public Liquid3 "liquid tree" project in Belgrade, represents a significant evolution in this approach. This urban photo-bioreactor, developed by the University of Belgrade, serves as a crucial proof-of-concept. According to the United Nations Development Programme (UNDP), a key partner in the project, the microalgae in the system are 10 to 50 times more efficient than trees, with a single unit providing the air purification equivalent of two 10-year-old trees or 200 square meters of lawn (UNDP, 2021).

A single Liquid3 unit captures approximately 50.46 kg of CO₂ annually, an amount 2.5 times greater than the 20 kg of CO₂ fixed by a conventional mature tree (Cervera et al., 2024). Furthermore, the two systems offer complementary benefits. A conventional tree excels as a passive physical filter for airborne Particulate Matter (PM2.5) which is the primary pollutant of concern in Jakarta (Sun et al., 2025). The bio-purifier, in contrast, acts as an active biological filter for other pollutants, with studies noting its ability to filter heavy metals from the air (UNDP, 2021). This establishes that bio-purifiers are not a replacement for trees, but a highly efficient, space-saving, and complementary solution for dense urban areas.

This innovative approach is being implemented within Indonesia's own industrial sector. A prime example is the decarbonization initiative by PT Semen Indonesia, which cultivates microalgae at its factory in West Java. In collaboration with Gadjah Mada University, this project successfully absorbs 1.8 tons of CO₂ per year from industrial emissions, providing a powerful, local proof-of-concept for the technology's effectiveness (Kencana, 2023).

This biological principle has now been commercialized for home use. The Aerium by Algenair (USA) successfully markets a living algae purifier, proving the viability of this technology for consumers (Algenair, Inc., 2022). Briiv (UK) has achieved significant market success with a purifier using natural materials, validating the robust consumer demand for sustainable and aesthetic wellness devices (Gilbert, 2022).

As a summary of this analysis, the distinct market positions of these leading products, which define the specific gap for innovation, are presented in Table 1.1

Table 1.1 Comparison between Briiv, Algenair, and Proposed Innovation

Feature	Briiv (Natural Filter)	Algenair's Aerium (Bio-Purifier)	Proposed Product (Bio-Integrated)
Core Technology	Physical Adsorption	Biological Conversion (Photosynthesis)	Biological Conversion (Photosynthesis)
Key Functionality	Filters Particulates & VOCs	Reduces CO ₂ & Produces Oxygen	Reduces CO ₂ & Produces Oxygen
Smart Features	Basic App Control	None	Fully Integrated Smart Speaker
Maintenance Model	Biodegradable Filter Replacement	Nutrient/Culture Refill	Sealed, Recyclable Cartridge
Target Market	Broad "Eco-Conscious" Consumer	Niche "Early Adopter" / Wellness Enthusiast	Mainstream "Smart Home" & Wellness Consumer
Market Stage	Mature / Commercially Validated	Emerging / Pioneering	Proposed / Untapped Convergence

Source: (Algenair, Inc., 2022; Gilbert, 2022)

1.4. Proposed Innovation and Research Gap

This thesis proposes the analysis of a product concept that serves as a specific case study to investigate the factors influencing consumer acceptance of bio-integrated

technology. The product is envisioned as a fully portable, all-in-one smart boombox with an integrated algae tank for air bio-purification.

The device's features are designed to directly address the core constructs of established behavioral models. It is conceived as a rugged, high-fidelity boombox for home and travel, featuring a powerful rechargeable battery, a full suite of modern connectivity (Bluetooth, AUX, USB charging ports), an LCD touchscreen, and a built-in phone holder. These features are intended to maximize the product's Perceived Usefulness (PU), a key construct of the Technology Acceptance Model (TAM), by offering a multi-functional entertainment and smart home hub.

Crucially, this integration of an engaging entertainment device with a passive health appliance is a deliberate design choice. It is intended to solve the specific problem of user neglect, such as the failure to change filters regularly (Business Wire, 2023), which was stated in the Problem Statement (Section 1.2). Appliances which has only a single function, such as air purifiers, are often neglected because they are easily forgotten when not actively in use (Business Wire, 2023). Pairing the purifier with a frequently used product like a boombox naturally draws the user's attention, providing regular reminders of the device and its current status. This encourages them to physically interact with the device and visually check its condition, including the health of the "Bio-Core cartridge", thereby transforming a neglected appliance into an engaging part of the user's daily routine.

The core bio-innovation is a removable "Bio-Core Cartridge" containing microalgae in a nutrient-rich hydrogel matrix. This semi-solid design eliminates the risk of liquid sloshing, ensuring stability during travel. The cartridge itself is a sealed "breathable tank"

made from a gas-permeable membrane, inspired by the concept from 1964 (TIME, 1964), allowing for the silent, passive conversion of CO₂ into oxygen, a process sustained by an internal LED system. To maximize Perceived Ease of Use (PEOU) and Perceived Behavioral Control (PBC), the cartridge is secured with a simple mechanical clipping mechanism, making maintenance a straightforward and mess-free process.

The primary research gaps this thesis addresses is the lack of empirical understanding regarding consumer acceptance of this bio-integrated device, particularly within the Jakarta market. Given Jakarta's severe air quality challenges (Sun et al., 2025) and the documented "perception gap" among residents (Nurwidyaningrum et al., 2020), this research will apply the established TAM and TPB frameworks to determine if consumers in Jakarta perceive sufficient value in this all-in-one, portable solution to form a positive purchase intention.

1.5. Research Objectives

1. To analyze the attitudes of consumers in Jakarta towards existing air purifiers and sustainable home products.
2. To determine the key factors influencing consumer acceptance of a bio-integrated smart speaker, based on the Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB).
3. To identify the product's Unique Selling Proposition (USP) and potential market positioning from a consumer perspective.
4. To assess the overall market potential in Jakarta based on the analysis of consumer acceptance.

1.6. Research Questions

1. What are the primary factors (perceived usefulness, ease of use, social norms) that influence a Jakarta consumer's intention to adopt a hybrid algae purifier and smart speaker?
2. How do consumer attitudes towards sustainability and health impact their acceptance of this bio-tech product?
3. What is the perceived value of the product's multifunctionality (air purification and smart speaker) among potential users in Jakarta?

1.7. Significance of Study

This study holds on both a practical and a theoretical level, contributing to the broader challenge of sustainable urban living and the academic understanding of technology adoption. This study is also important because it addresses a critical public health problem in Jakarta. As detailed further in the literature review, residents are exposed to dangerously high levels of indoor air pollution, a situation largely driven by outdoor infiltration (Sun et al., 2025). The aim of this research is to offer actionable insights for a novel category of sustainable, bio-integrated technology, showing how it can be a more effective and user-friendly solution than current options. For industry practitioners, the findings will offer a valuable piece of market intelligence on the specific factors that drive consumer acceptance in the Jakarta market, informing product development and marketing strategies. For society, this research contributes a small but meaningful step towards creating healthier, more sustainable urban environments, a challenge of increasing importance for humankind in an era of rapid urbanization.

The theoretical significance of this work is its role as one of the first studies to empirically apply an integrated Technology Acceptance Model (TAM) (Davis, 1989) and the Theory of Planned Behavior (TPB) (Ajzen, 1991) to a bio-integrated smart home device. This research will contribute valuable empirical data to consumer behavior literature, and by focusing specifically on Jakarta, the findings stand to illuminate the unique factors influencing technology acceptance among Indonesian consumers.