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Military Indoor Air Discourse: A Longitudinal Text-Mining Analysis

Young-Sin BAEK [1] Tai-Youn HAN[2] Woo-Taeg KWON [3] Lee-Seung KWON[4]

1. First Author CEO of Charr CO., LTD, Korea, Email: bys1232@daum.net
2. Second Author Technical Director of Charr CO., LTD, Korea, Email: hantyy7@gmail.com
3. Third Author Professor, Department of Environmental Health & Safety, Eulji University, Korea, Email: awtkw@eulji.ac.kr
4. Corresponding Author Professor, Industry-Academic Cooperation Foundation, Eulji University, Korea, Email: leokwon1@hanmail.net

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Abstract

Purpose: This study examines how indoor air quality and infection-reduction issues have been discussed in military living and operational environments. **Research Design and Data:** The study employed a longitudinal text-mining approach based on a final corpus of 101 coded records collected between 2016 and 2026. The dataset integrated news articles, policy and legal documents, scholarly literature, technical standards, and institutional case materials from Korea and selected overseas military contexts. The corpus was analyzed using frequency analysis, time-series analysis, topic modeling, co-occurrence analysis, keyword prominence mapping, and comparative visual analytics. **Results:** The findings show that military indoor-air discourse is concentrated in barracks, living quarters, training environments, and shipboard spaces. The issue became most visible during the COVID-19 period, particularly through collective infection incidents in recruit training centers, naval vessels, and Air Force training units. Since 2023, however, the discourse has increasingly shifted toward barracks modernization, mold mitigation, HVAC improvement, accommodation renewal, and environmental standards. The Korean corpus was more strongly associated with outbreak-driven and incident-centered themes, whereas the overseas corpus emphasized modernization and systems-oriented environmental management. **Conclusions:** Military indoor-air issues should be understood not as a narrow device problem, but as a multidimensional systems issue involving infection control, troop living conditions, environmental quality, and facility modernization.

Keywords : Military Barracks, Indoor Air Quality, Infection Control, Facility Modernization, Text Mining

JEL Classification Code : I18, J28, Q53, Q58, O33

1. Introduction
[1]

1.1. Background

The In recent years, indoor air quality in military environments has emerged as an important issue in relation to troop health, operational continuity, and military readiness. Military spaces such as barracks, recruit training centers, command and control rooms, medical facilities, and naval vessels are often characterized by closed or semi-closed structures, high occupancy density, and prolonged human stay. Li et al. (2007) argued that ventilation is a critical determinant of airborne infection risk in built environments, suggesting that inadequate airflow can substantially increase the transmission potential of infectious agents indoors.

Since the COVID-19 pandemic, public and institutional awareness of infection control and indoor environmental

management has increased significantly. In military settings, however, the issue extends beyond general health protection. Kasper et al. (2020) showed that a large-scale COVID-19 outbreak on a U.S. aircraft carrier revealed the vulnerability of enclosed and crowded military operational spaces to rapid transmission. Payne et al. (2020) further reported extensive SARS-CoV-2 transmission among U.S. Navy service members aboard the USS Theodore Roosevelt, emphasizing the infection risk associated with close-quarters military living conditions.

At the same time, the military indoor environment should not be understood only through the lens of infectious outbreaks. Barracks quality, accommodation modernization, mold and humidity control, ventilation performance, and system-based monitoring have become important topics in both domestic and overseas military discourse. Lizewski et al. (2022) found that substantial transmission occurred even in an isolated U.S. military recruit training center operating under rigorous prevention measures, indicating that collective military training environments remain highly susceptible to respiratory outbreaks. In the Korean context, Hwang et al. (2013) documented an adenovirus-associated febrile respiratory illness outbreak at a South Korean military training facility, showing that military trainee populations are also highly vulnerable to respiratory transmission in dense living and training conditions.

Therefore, military indoor air management is better understood as a multidimensional issue involving environmental quality, infection reduction, facility performance, and long-term infrastructure improvement. Existing discussions remain fragmented across news reports, policy materials, legal and regulatory documents, technical cases, and academic studies, making it difficult to identify major concerns and research gaps in a systematic manner. Against this background, the present study examines how military indoor air quality and infection-reduction issues have evolved over time in both public discourse and scholarly literature.

1.2. Research Questions

This study addresses the following research questions:
- How have news and scholarly trends related to indoor air quality and infection-reduction technologies in military environments changed during the ten-year period from 2016 to 2026?
- What major issue types, keywords, and thematic structures appear in the integrated corpus of military air-related materials?
- How do domestic Korean cases differ from overseas military cases in terms of outbreak focus, accommodation modernization, air-quality management, and environmental countermeasures?
- What policy and technological implications can be derived from the integrated big data analysis of military indoor air-related issues?

This study does not evaluate the performance of any specific technology or product. Rather, it is a basic policy and environmental health study that analyzes how discourse on indoor air quality, infection reduction, and facility modernization in military barracks has evolved over time.

2. Theoretical Backgrounds and Literature Review

2.1. Military Living and Operational Environments

Military living and operational environments differ from general civilian settings in terms of occupancy structure, functional purpose, and exposure conditions. Barracks, recruit training centers, command and control rooms, medical facilities, and naval vessels are often characterized by high occupancy density, prolonged indoor stay, restricted ventilation, and collective living arrangements. These characteristics make military indoor environments particularly vulnerable to indoor air quality deterioration and airborne infectious disease transmission.

Unlike ordinary residential or office spaces, military indoor environments must support not only comfort and health but also readiness, training continuity, concentration, and resilience. Therefore, indoor air quality in military settings should be understood not merely as an environmental or welfare issue, but as an issue directly related to force health protection and operational sustainability.

2.2. Indoor Air Quality in Military Facilities

Indoor air quality refers to the condition of indoor air as affected by ventilation, airborne pollutants, humidity, temperature, biological contaminants, and chemical substances. In military facilities, indoor air quality problems may arise from insufficient ventilation, overcrowding, persistent humidity, volatile organic compounds, odors, mold, and infectious aerosols.

Previous studies have shown that poor indoor air quality can negatively affect respiratory health, sleep quality, work performance, and cognitive concentration. In military environments, these effects may be amplified because soldiers often live and work in dense collective environments under physically and psychologically

demanding conditions. Accordingly, air quality management in military spaces must address not only pollutant control but also infection-risk reduction and the maintenance of stable and healthy living and working conditions.

2.3. Collective Living Conditions and Infection Risk

Collective living arrangements are a defining feature of many military spaces. Barracks, dormitory-type living quarters, recruit training units, shipboard accommodations, and military medical facilities all involve shared indoor air and repeated close contact among occupants. Such environments create favorable conditions for the rapid spread of airborne infectious diseases, especially when ventilation is insufficient, or outbreak management is delayed.

In military contexts, infection is not only a health issue but also an operational one. Once an outbreak occurs, it may lead to quarantine, movement restrictions, interruption of training programs, reduced manpower availability, and weakened operational effectiveness. Therefore, infection reduction in military settings must be approached through both medical and environmental control strategies, including ventilation, filtration, air sterilization, environmental monitoring, and facility management.

2.4. Air Purification, Air Sterilization, and Environmental Control Technologies

Technologies related to indoor air control can be broadly grouped into ventilation-based methods, filtration-based methods, sterilization-based methods, and integrated environmental management systems. Luo and Zhong (2021) explained that ultraviolet germicidal irradiation (UVGI), particularly in-duct UVGI, is an engineering control approach that can be integrated into HVAC systems when simple ventilation alone is insufficient or when air recirculation cannot be completely avoided. Nguyen et al. (2022) further showed in a systematic review that air disinfection strategies such as UV-C irradiation and filtration repeatedly demonstrated measurable potential for reducing airborne microbial hazards, although the effectiveness of each method depends on the operating environment and technical design.

Air sterilization technologies attempt to inactivate microorganisms such as viruses, bacteria, and fungi through ultraviolet irradiation, catalytic reactions, oxidation-based processes, or hybrid mechanisms. In this respect, they are often discussed as active interventions because they aim not only to capture airborne contaminants but also to reduce biological hazards directly. Kunkel et al. (2017) argued that bioaerosol control should be understood in relation to transport dynamics, removal processes, and control effectiveness across particle sizes, which makes integrated systems especially relevant in complex indoor settings. Accordingly, integrated environmental systems that combine ventilation, filtration, sterilization, sensing, and automatic control are particularly suitable for military environments, where indoor air problems are multidimensional and often require continuous management rather than one-time intervention.

2.5. Ventilation, HVAC, and System-Based Management

Heating, ventilation, and air conditioning systems play a central role in the environmental management of medium- and large-scale buildings. Bhagat et al. (2020) emphasized that ventilation strongly affects the indoor spread of respiratory aerosols, while Azimi and Stephens (2013) showed that HVAC filtration can reduce infectious airborne disease transmission risk at the facility level. These studies support the view that HVAC-linked approaches are particularly important in military settings, because many barracks, training buildings, medical facilities, and operational spaces already depend on centralized airflow systems.

An HVAC-linked approach has several advantages. It supports facility-level treatment rather than room-by-room fragmentation, allows broader coverage across multiple zones, and can be integrated with sensors, monitoring systems, and centralized management platforms. Peng and Jimenez (2021) demonstrated that exhaled CO2 can function as a practical proxy for infection risk in indoor environments, suggesting that monitoring-based management can be combined with ventilation control as part of a wider systems strategy. In military contexts, this supports standardization, scalability, and long-term maintenance, while also connecting indoor air management with broader accommodation and infrastructure issues such as mold mitigation, humidity control, maintenance quality, and living-environment modernization.

2.6. Policy, Standards, and Institutional Responses

Military indoor air issues are also shaped by institutional policy and regulatory responses. Morawska et al. (2021) argued that indoor respiratory infection control requires a paradigm shift in building design, environmental standards, and public-health practice, which implies that air-related countermeasures should not remain limited to temporary emergency measures. Similarly, Alqarni et al. (2024)

showed in their systematic review that indoor air quality control strategies for viral transmission increasingly involve trade-offs among ventilation, environmental parameters, sustainability, and operational management. These findings are directly relevant to military environments, where air-related problems are tied not only to infection risk but also to force health protection, infrastructure performance, and accommodation quality.

In domestic contexts, military indoor air quality management has increasingly been formalized through policy documents, legal frameworks, and operational guidance. In overseas contexts, similar concerns have been linked to barracks modernization, accommodation standards, mold mitigation campaigns, ultraviolet disinfection guidance, and broader quality-of-life initiatives. The broader significance of this institutional dimension is that military indoor air problems are gradually becoming part of military governance related to troop welfare, readiness support, and long-term infrastructure improvement, rather than remaining isolated technical trials.

2.7. Big Data Analysis of News and Scholarly Literature

This study adopts a big data perspective because military indoor air issues are reflected not only in engineering studies but also in news discourse, policy reporting, and institutional communication. News articles and scholarly literature represent two different but complementary layers of knowledge. News discourse helps identify issue attention, major incidents, public framing, and policy reactions, while scholarly literature provides more structured discussions of environmental mechanisms, technical interventions, and research gaps. When the two are analyzed together, it becomes possible to examine how social attention, institutional concern, and academic accumulation intersect or diverge.

Donthu et al. (2021) described bibliometric analysis as a rigorous method for exploring large volumes of scientific data and identifying the evolutionary structure of a field. Zupic and Čater (2015) further explained that bibliometric methods provide a systematic framework for mapping research specialties through citation, co-citation, and co-word analysis, while Aria and Cuccurullo (2017) showed that science mapping workflows can be combined with visualization tools to support structured interpretation of large document collections. For a topic such as military indoor air management, which spans public health, environmental control, facility modernization, and operational readiness, this type of integrated big data approach is especially useful because it allows the researcher to identify long-term trends, high-frequency terms, thematic clusters, and relational structures across heterogeneous materials.

3. Research Methodology

3.1. Research Design

This study employed an integrated big data and text-as-data research design to examine how indoor air quality and infection-reduction issues have been represented in military living and operational environments. Grimmer and Stewart (2013) argued that automated text analysis is especially valuable when researchers seek to identify recurring patterns, issue structures, and conceptual distinctions across large document collections, while Hopkins and King (2010) showed that large-scale content analysis can be used to estimate broader category patterns from unstructured text. On this basis, the present study combined descriptive coding and computational text analysis in order to capture both structured attributes of the corpus and latent thematic patterns embedded in the texts.

3.2. Data Sources

As shown in Table 1, the study used an integrated corpus composed of multiple source types, including news articles, policy documents, legal and regulatory materials, scholarly literature, institutional reports, and selected overseas military cases.

This mixed-source strategy was adopted because military indoor air issues are not adequately represented by one source type alone. Hsieh and Shannon (2005) noted that content analysis can be applied to multiple forms of textual evidence when the purpose is to interpret meanings, categories, and patterns across documents, while Mayring (2000) emphasized that systematic text analysis benefits from clearly defined units, categories, and selection rules. In this sense, the use of heterogeneous but relevant document types was methodologically appropriate for examining a multidimensional issue such as military indoor air management.

Table 1: Composition of the Final Dataset

Variable	Content
Corpus size	101 records
Period of analysis	2016–2026

Domestic records	Korea
Overseas records	United States, Australia, United Kingdom, Singapore, and Canada
Source types	News, policy/legal documents, scholarly literature, technical standards, institutional reports, and case materials
Unit of analysis	Coded text records
Core themes	Indoor air quality, infection reduction, barracks conditions, ventilation, accommodation modernization, and environmental management

3.3. Period of Analysis

The temporal scope of this study covered the ten-year period from 2016 to 2026. This period was selected in order to capture the pre-pandemic phase, the COVID-19 crisis period, and the post-pandemic phase in which military indoor air discourse increasingly expanded toward modernization, standards, and environmental control. The adoption of a longitudinal corpus is consistent with the logic of big data text analysis, which seeks to identify changes in issue intensity, thematic emphasis, and structural transitions over time rather than relying only on cross-sectional observations. Grimmer and Stewart (2013) highlighted that large textual corpora are particularly useful when the research objective includes identifying shifts in discourse over time.

3.4. Corpus Construction

The corpus was constructed through an iterative collection and refinement process. Initial materials were identified through keyword-based searches, after which the dataset was cleaned, screened, and expanded through repeated relevance checks. Mayring (2000) described text analysis as a rule-guided process that requires clear category logic and transparent selection procedures, while Hsieh and Shannon (2005) emphasized that coding decisions should remain closely tied to the analytical purpose of the study. Following this logic, the present study retained only those records that were substantively related to military living conditions, indoor air management, infection reduction, environmental control, or accommodation modernization.

3.5. Keyword Strategy

Keyword selection was a critical step because the subject combined broad environmental terminology with highly specific military contexts. To balance recall and precision, keywords were developed in three semantic groups: military-related terms, air-management-related terms, and health/outbreak-related terms. Hopkins and King (2010) argued that automated content analysis depends heavily on the quality of category construction and term selection, while Grimmer and Stewart (2013) stressed that text-based research requires problem-specific validation rather than mechanical reliance on broad search terms. Accordingly, the keyword strategy in this study was refined iteratively so that overly narrow search expressions would not undercapture relevant cases and overly broad expressions would not introduce excessive noise.

3.6. Inclusion and Exclusion Criteria

To ensure relevance and consistency, this study applied explicit inclusion and exclusion criteria before coding and analysis. Materials were included when they explicitly referred to military living or operational environments, addressed indoor air quality or infection-reduction measures in military contexts, described military outbreaks in dense or enclosed spaces, or dealt with standards, modernization, and institutional responses relevant to military indoor environments. Hsieh and Shannon (2005) pointed out that rigorous qualitative content analysis depends on clearly defined coding boundaries, and Mayring (2000) similarly emphasized the need for transparent category rules in systematic text interpretation. The present study therefore excluded materials that were unrelated to military settings, focused only on general consumer products, lacked environmental relevance, or duplicated existing records.

3.7. Coding Framework

After collection and refinement, the corpus was coded according to a structured framework including country, military branch, space type, issue type, technology type, and problem type. This framework enabled the study to move beyond simple document accumulation and toward comparative interpretation of the corpus structure. Mayring (2000) described category-guided coding as a key strength of systematic text analysis, and Hsieh and Shannon (2005) distinguished between coding approaches that derive categories inductively from the data and those that apply theoretically informed categories deductively. The coding framework in this study combined both logics by using pre-defined analytical dimensions while allowing contextual interpretation of individual records during the coding process.

3.8. Analytical Methods1

This study applied a combination of descriptive and text-mining methods. Frequency analysis and time-series analysis were used to examine the distribution of the corpus by year, country, military branch, and issue structure. Topic modeling was employed to identify latent thematic clusters within the textual corpus. Blei, Ng, and Jordan (2003) introduced Latent Dirichlet Allocation as a probabilistic model for discovering thematic structure in document collections, and Blei (2012) later explained that topic models are especially useful for large text archives in which hidden thematic organization cannot be captured by manual reading alone. Co-occurrence analysis was used to examine associations among core terms, while comparative profiling and bibliometric-style visualization were supported by methods similar to those discussed by van Eck and Waltman (2010, 2017), who showed that mapping and clustering tools can help reveal the structural organization of large document sets.

3.9. Data Processing Procedure

The analytical workflow proceeded in several stages: data integration, duplicate removal, corpus refinement, coding, text normalization, descriptive analysis, topic modeling, co-occurrence analysis, and comparative interpretation. Grimmer and Stewart (2013) warned that automated text analysis is not a substitute for careful research design and validation, and Hopkins and King (2010) similarly emphasized that quantitative text methods must be closely aligned with the substantive research goal. Consistent with these methodological principles, the present study used a staged procedure in which computational methods were applied only after the corpus had been manually screened and categorically structured.

3.10. Reliability and Validity

To enhance reliability, the study applied explicit inclusion and exclusion rules, a consistent coding framework, and repeated manual review of ambiguous records. To enhance validity, it triangulated multiple source types rather than relying on a single document class. Hsieh and Shannon (2005) emphasized that trustworthiness in content analysis depends on transparency of coding logic and interpretive consistency, while Mayring (2000) argued that validity is strengthened when category formation and text selection follow explicit methodological rules. In addition, Grimmer and Stewart (2013) stressed that computational text analysis requires problem-specific validation. For this reason, the present study treated the corpus as an exploratory, but systematically constructed evidence base and interpreted the results through both computational output and substantive contextual review.

4. Research Results and Discussion

4.1. Overview of the Corpus

The final corpus used in this study consisted of 101 coded records, integrating policy documents, legal and regulatory materials, academic papers, news articles, technical standards, case reports, and institutional publications related to military indoor air environments, infection control, ventilation, air quality management, and accommodation conditions. As summarized in Table 1, the dataset covered both domestic Korean materials and selected overseas cases, thereby enabling cross-national as well as cross-category comparison. The breadth of the corpus made it possible to analyze patterns not only by issue type, but also by country, military branch, spatial setting, problem type, and technology type.

Although the primary analytical focus of this study was the 2016–2026 period, several earlier records were retained as contextual references because they provided important background on military barracks modernization and indoor air management. Accordingly, the corpus included both time-sensitive outbreak materials and structural background materials, allowing the study to identify both short-term issue peaks and longer-term institutional developments.

4.2. Temporal Distribution of the Corpus

As shown in Figure 1, the temporal distribution of the corpus was highly uneven. The largest share belonged to the COVID period (2020–2022, n = 51), followed by the post-COVID period (2023–2026, n = 30), the background period before 2016 (n = 13), and the pre-COVID period of 2016–2019 (n = 7). This pattern indicates that military indoor-air-related discourse intensified sharply during the pandemic period.

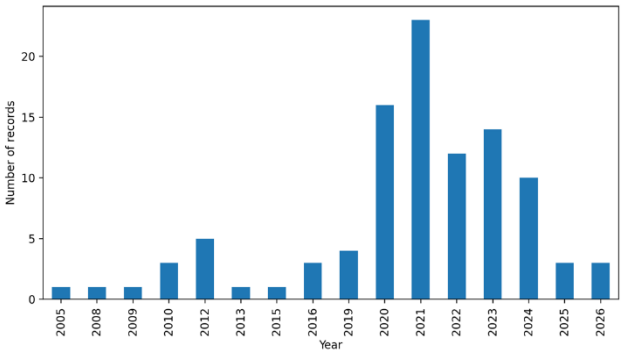

Figure 1: Temporal Distribution of the Corpus by Year

However, the presence of a substantial post-2023 segment suggests that the issue did not disappear after the peak of the pandemic. Rather, the discourse appears to have shifted from outbreak-centered reporting toward accommodation modernization, mold mitigation, ventilation improvement, and institutional air-quality management. In other words, the time-series pattern indicates a transition from incident-driven emergency visibility to broader environmental and facility-management concerns.

4.3. Country Distribution

The corpus was dominated by Korean records (n = 59), followed by the United States (n = 25). Additional records were identified from Australia (n = 6), the United Kingdom (n = 4), Singapore (n = 3), and Canada (n = 3), with one item categorized as other or unclear. This pattern, illustrated in Figure 4-2, indicates that the study remained grounded in domestic Korean military discourse while also incorporating a meaningful comparative overseas layer.

The Korean materials were more heavily associated with outbreak incidents, policy adaptation, and force-wide living-environment issues, whereas the overseas materials were more strongly associated with barracks modernization, mold mitigation, HVAC improvement, ultraviolet disinfection, and infrastructure standards. Thus, the country distribution is analytically important because the domestic and overseas datasets contribute different but complementary emphases, rather than reproducing the same patterns.

4.4. Distribution by Military Branch

By military branch, the largest category was Joint/Common (n = 34), followed by the Army (n = 31), Air Force (n = 18), and Navy (n = 18). As shown in Figure 4-11, this distribution is not random but reflects systematic variation in the institutional and spatial structure of the corpus. The high proportion of joint/common records reflects the large number of policy documents, standards, accommodation materials, and institutional texts that were not limited to a single branch.

Among the branch-specific materials, the Army showed the strongest presence, largely because many domestic records focused on recruit training centers, barracks, and troop living spaces. Navy-related materials were concentrated around shipboard collective exposure and closed-space outbreak cases, while Air Force materials were more closely tied to training units, educational facilities, and base environments. This result suggests that military indoor-air issues are distributed across all branches, although the operational context differs by service.

4.5. Distribution by Space Type

The most frequent spatial category was Barracks/Living Quarters (n = 39). This was followed by General/Policy (n = 30), Training/Education (n = 15), Naval Vessel/Shipboard (n = 10), and Medical Facility (n = 5). This spatial structure is one of the clearest findings of the study because it shows that military indoor-air discourse is centered primarily on the daily living environment, especially barracks and living quarters, rather than on specialized technical facilities alone.

Training and education spaces formed the second major operational cluster, suggesting that military indoor-air issues are also closely connected to recruit training continuity and high-density group environments. Shipboard cases further highlight the importance of enclosed naval spaces, particularly under outbreak conditions, while medical facilities remain conceptually important because they connect environmental management with infection-control practice. In other words, the spatial distribution supports the view that military indoor air quality is fundamentally linked to troop accommodation, quality of life, and collective exposure.

4.6. Distribution by Issue Type

The most common issue type was Outbreak/Incident (n = 37), followed by News/General (n = 21), Technology/Application (n = 16), Policy/Standard (n = 13), Facility Modernization (n = 8), and Research (n = 6). As visualized in Figure 4-3, this result indicates that military indoor-air discourse became most visible during crisis events, especially outbreaks and collective infections. In practical terms, this means that the issue often entered public attention through emergency conditions rather than through long-term infrastructure planning alone.
At the same time, the presence of technology application, policy/standard, and modernization records shows that the

discourse is not purely reactive. A substantial part of the corpus addresses structural and preventive themes, such as air-quality regulation, accommodation improvement, ultraviolet disinfection, HVAC upgrades, and environmental monitoring. Therefore, the corpus reflects both reactive outbreak discourse and proactive modernization discourse.

4.7. Distribution by Technology Type

The largest technology category was General/Multiple (n = 70), indicating that many records were not limited to one isolated technical solution but instead addressed broader environmental or institutional issues. More specific categories included Ventilation/HVAC/Filtration (n = 10), Monitoring/Policy/System (n = 8), Air Sterilization/UV (n = 4), and Air Purification (n = 3). This distribution suggests that current discourse on military indoor air is not narrowly equipment-centered.

Rather than focusing only on portable air purifiers or a single technical device, the dataset reflects a broader concern with ventilation, environmental control, institutional standards, system-based monitoring, and accommodation conditions. This finding supports the interpretation that military indoor-air management should be understood as a systems issue, not merely as a product issue.

4.8. Distribution by Problem Branch

The most common problem category was General Environment/Facilities (n = 45), followed by Cluster Infection + Infection/Respiratory (n = 29), Mold/Humidity (n = 8), Infection/Respiratory only (n = 6), and Indoor Air Quality (n = 6). Smaller categories included VOC/Formaldehyde, Odor, and mixed categories. This distribution indicates that the military indoor-air problem is framed in two dominant ways. One is as a public health and outbreak problem, especially when infections spread rapidly in collective environments. The other is as a living-environment and facility problem, including barracks quality, mold, humidity, and infrastructure defects.

In other words, the corpus does not treat indoor air as a purely technical air-cleaning matter. Rather, it is closely connected to troop accommodation, health protection, environmental performance, and military facility quality. This result is especially important because it provides the empirical basis for the later discussion that military indoor-air management should be approached through a combined health–environment–infrastructure framework.

4.9. Big Data Analysis of Keywords and Themes

The 101-item corpus was re-analyzed using a mixed text-mining workflow combining time-series counting, frequency analysis, topic modeling, co-occurrence analysis, keyword prominence visualization, radar-based comparison, and comparative visual analytics. Taken together, these analytical procedures show that the corpus is not organized around stand-alone air-cleaning devices alone, but around a broader issue structure linking outbreak incidents, collective living environments, accommodation quality, facility modernization, and environmental management. The analytical significance of this section lies not simply in identifying which words appeared most often, but in demonstrating how the corpus is organized temporally, structurally, relationally, and comparatively.

4.9.1. Frequency Analysis

Frequency analysis as shown in Figure 2 was conducted to identify the structural distribution of the 101-item corpus across countries, military branches, spatial categories, issue types, and major lexical items. This analysis provides the descriptive foundation of the big data corpus by showing which institutional contexts, operational environments, and recurring issue frames appeared most frequently.

At the country level, the corpus was dominated by Korean materials (n = 59), followed by the United States (n = 25), with smaller contributions from Australia (n = 6), the United Kingdom (n = 4), Singapore (n = 3), and Canada (n = 3). As shown in Figure 2, the corpus is therefore anchored in domestic Korean military discourse while also incorporating a meaningful overseas comparative layer.

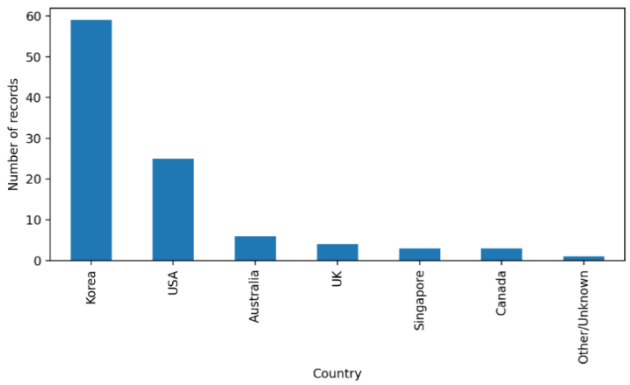

Figure 2: Country Distribution of the Corpus

This distribution indicates that the Korean side of the corpus primarily provides the empirical basis for outbreak- and policy-related analysis, whereas the overseas side contributes more strongly to themes such as accommodation modernization, mold mitigation, HVAC improvement,

ultraviolet-based disinfection, and institutional standards.

Issue-type frequency analysis shows a similarly clear structure. The largest category was Outbreak/Incident (n = 37), followed by News/General (n = 21), Technology/Application (n = 16), Policy/Standard (n = 13), Facility Modernization (n = 8), and Research (n = 6). As presented in Figure 3, this suggests that military indoor-air-related discourse has been most visible during crisis events, especially outbreaks and collective infections, although a substantial part of the corpus also reflects structural and preventive concerns such as modernization, standards, and technical application.

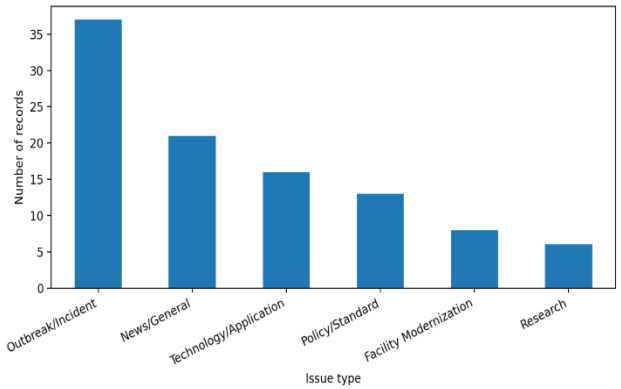

Figure 3: Distribution by Issue Type

In lexical terms, the most frequent keywords in the corpus included cluster infection, confirmed cases, Air Force, cumulative, Nonsan Army Training Center, barracks/living quarters, Army, Navy, Cheonghae Unit, improvement, ship, mold, installation, indoor air quality, and modernization.

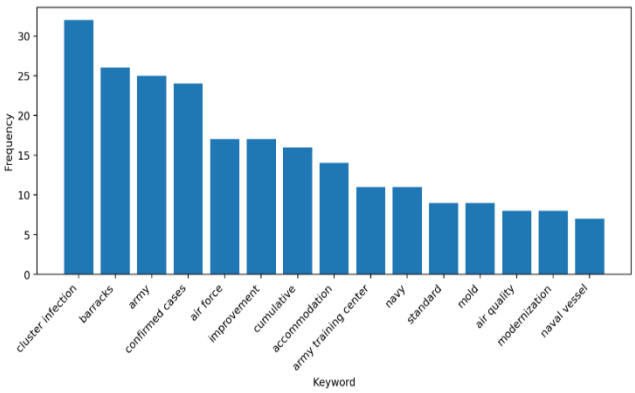

Figure 4: Top Keywords in the Coded Corpus

As shown in Figure 4, the most salient terms are not narrowly product-oriented but instead combine outbreak language, collective living environments, and environmental or facility-management language. Taken together, the frequency structure of the corpus suggests that military indoor-air management should be interpreted as a broader systems issue rather than as a narrow issue of stand-alone air-cleaning devices.

4.9.2. Topic Modeling Analysis

Topic modeling analysis was conducted to identify latent thematic structures within the 101-item corpus. Whereas the preceding frequency analysis showed which categories and keywords appeared most often, topic modeling was used to reveal how those words clustered into broader issue frames. For this purpose, a Non-negative Matrix Factorization (NMF) model was applied to the processed text fields of the coded corpus, and four dominant topics were extracted.

As shown in Figure 5 and summarized in Table 2, the corpus was not organized around a single homogeneous theme. Instead, it was distributed across four recurring thematic clusters. The first cluster corresponded primarily to domestic outbreak expansion, especially cumulative confirmed-case reporting in recruit training centers, general Army units, and Air Force training environments.

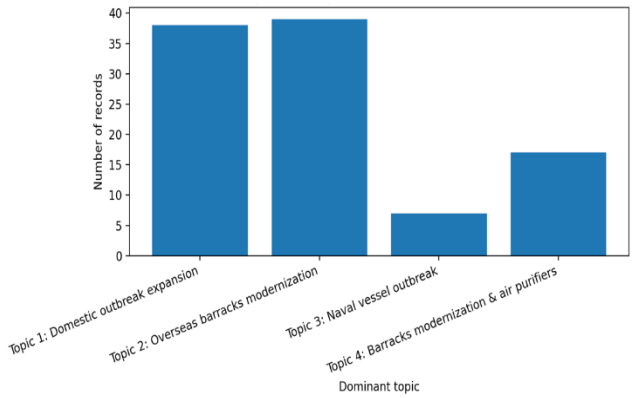

Figure 5: Top Keywords in the Coded Corpus

Table 2: Topic Modeling Summary

Topic	Top terms	Records
Topic 1: Domestic outbreak expansion	cumulative, cluster infection, army training center, confirmed cases, air force, nonsan, military unit, nonsan training center	38
Topic 2: Overseas barracks modernization	barracks, accommodation, mold, living-in, Australia, army, new, HVAC	39
Topic 3: Naval vessel outbreak	Cheonghae Unit, confirmed cases, infection, scale, spread, closed space,	7

	largest, cluster infection	
Topic 4: Barracks modernization and air purifiers	barracks/living quarters, modernization, residential facilities, floor-sleeping type, bed type, new construction, air purifier, deployment	17

These results are important because they confirm that the corpus is not dominated by a narrow equipment-centered discourse. The largest thematic clusters are associated with outbreak reporting, barracks quality, accommodation improvement, and environmental control, rather than with any one technical device. The topic structure also reveals that domestic and overseas materials contribute differently to the corpus: domestic materials are more strongly concentrated in outbreak-driven themes, whereas overseas materials contribute more heavily to modernization, mold mitigation, ventilation, and accommodation standards.

4.9.3. Co-occurrence / Association Analysis

Co-occurrence analysis was conducted to identify how core terms were associated with one another across the corpus. Unlike simple keyword frequency analysis, which measures how often terms appear individually, co-occurrence analysis examines which terms repeatedly appear together within the same records. This makes it possible to reveal the relational structure of the discourse and to identify the conceptual clusters that organize the corpus.

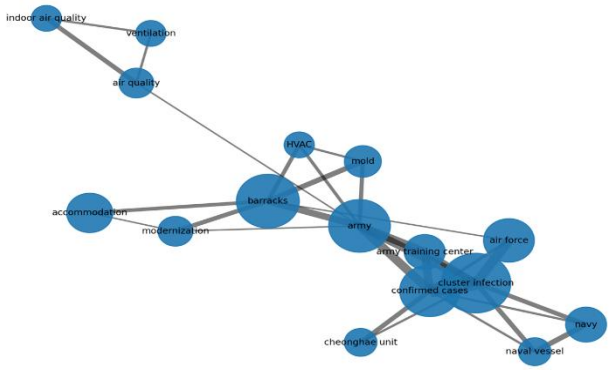

Figure 6: Co-occurrence Network of Core Terms

As shown in Figure 6 and Table 3, the strongest associations in the corpus were not centered on a single device-related term. Instead, the network was organized around several interconnected clusters. The first and most prominent cluster linked cluster infection, confirmed cases, army training center, air force, and navy, indicating that a substantial portion of the corpus is structured around collective infection events, cumulative case reporting, and service- or space-specific outbreak narratives. The second major cluster connected barracks, accommodation, modernization, mold, ventilation, and indoor air quality, corresponding more strongly to long-term environmental management, barracks quality, and infrastructure improvement.

Table 3: Major Co-occurrence Pairs (weight ≥ 2)

Term 1	Term 2	Weight
cluster infection	confirmed cases	19
air force	cluster infection	12
army	army training center	11
army	cluster infection	11
army	confirmed cases	11
army training center	confirmed cases	10
army	barracks	9
army training center	cluster infection	9
barracks	mold	7
naval vessel	navy	7
air quality	indoor air quality	6
barracks	modernization	6

The network structure demonstrates that the corpus is conceptually divided between an outbreak-response frame and an accommodation/environmental-management frame, but that the two are not completely isolated. Terms such as barracks, indoor air quality, ventilation, and modernization function as bridging nodes between incident-centered discourse and systems-oriented discourse. This relational structure provides additional evidence that military indoor-air issues should be interpreted as a systems-oriented field of concern.

4.9.4. Keyword Prominence Visualization

To further compare the lexical emphasis of the domestic and overseas corpora, keyword prominence maps were generated based on term frequency. In these visualizations, larger words indicate higher relative frequency within each sub-corpus.

As shown in Figure 7, the Korean corpus is dominated by terms such as cluster infection, confirmed cases, air force, cumulative, barracks, army, army training center, and Cheonghae Unit. This indicates that the domestic materials are strongly structured around outbreak incidents, cumulative case reporting, and military unit-specific infection events. By contrast, Figure 8 shows that the overseas corpus is dominated by terms such as accommodation, barracks, mold, air quality, standard, policy, renovation, and improvement. This suggests that overseas

materials are more strongly oriented toward accommodation quality, environmental standards, facility renewal, and infrastructure-based responses.

Figure 7: Korea Keyword Prominence Map

Figure 8: Overseas Keyword Prominence Map

Taken together, the keyword prominence maps provide a highly intuitive comparison between the two corpora. The Korean corpus is more strongly associated with incident-driven and outbreak-centered discourse, whereas the overseas corpus is more strongly associated with facility-centered and modernization-oriented discourse.

4.9.5. Radar-Based Comparative Analysis

Radar-based comparative analysis was conducted to visualize the relative thematic balance of the domestic Korean corpus and the overseas corpus. Whereas frequency analysis and topic modeling showed the dominant categories and latent clusters within the full dataset, the radar chart was used to compare the proportional intensity of five core analytical dimensions: infection/outbreak, living quarters, modernization, air quality/policy, and mold/HVAC/technology.

As shown in Figure 9, the Korean corpus displays its strongest relative emphasis in the dimensions of infection/outbreak and living quarters. This reflects the fact that the domestic materials were heavily shaped by collective infection incidents in recruit training centers, Army barracks, naval vessels, and Air Force training environments. By contrast, the overseas corpus shows a broader and more balanced thematic profile, with relatively stronger emphasis on modernization, mold/HVAC/technology, and air quality/policy. This pattern corresponds to the large number of overseas materials dealing with barracks refurbishment, mold mitigation, HVAC improvement, ultraviolet-based disinfection, accommodation standards, and institutional environmental guidance.

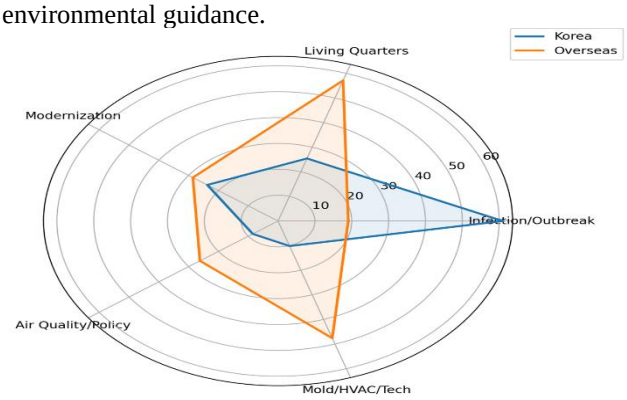

Figure 9: Radar Comparison of Korea and Overseas Thematic Profiles

The radar profile is analytically important because it makes visible the difference in thematic orientation between the two corpora. The Korean materials are more sharply concentrated in incident-driven and living-environment-centered themes, while the overseas materials are more strongly distributed across structural and systems-oriented themes. In other words, the Korean corpus is more reactive in profile, whereas the overseas corpus is more preventive and infrastructural in orientation.

4.9.6. Comparative Visual Analytics

To supplement the preceding frequency, time-series, topic, and co-occurrence analyses, additional comparative visual analytics were introduced. These visualizations were designed to make the structural differences within the corpus more immediately visible, especially in relation to country composition, branch–space concentration, annual issue movement, and thematic contrast between domestic and overseas materials.

Figure 10 presents a heatmap of country by issue type. The figure shows that Korean materials are strongly concentrated in outbreak and general-news categories, while the United States and other overseas cases contribute more prominently to policy, modernization, and technology-oriented records.

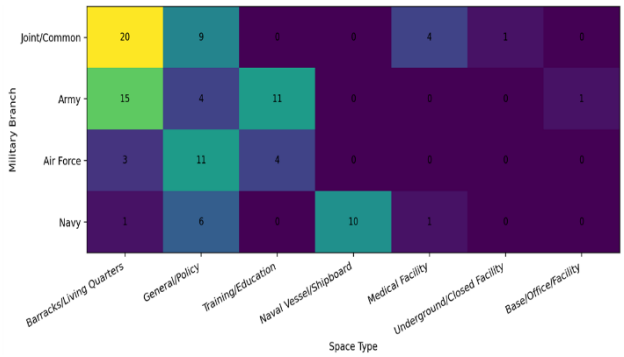

Figure 10: Country × Issue Type Heatmap

Figure 11 maps military branch against space type and shows that the Army is concentrated most strongly in barracks and training-related spaces, the Navy is strongly associated with shipboard and naval-vessel records, and the Air Force is linked more closely to training and base-related spaces.

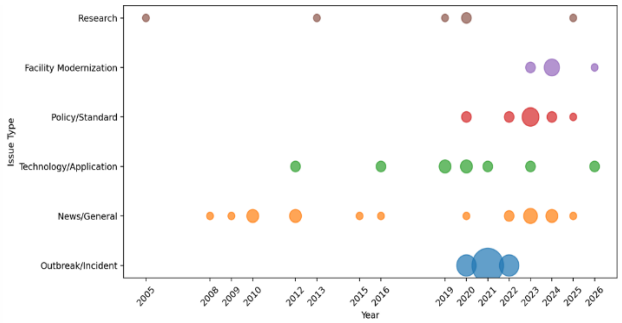

Figure 11: Military Branch × Space Type Heatmap

Figure 12 uses a bubble-chart format to show how issue categories changed over time, with large bubbles during 2020–2022 concentrated mainly in outbreak and incident categories.

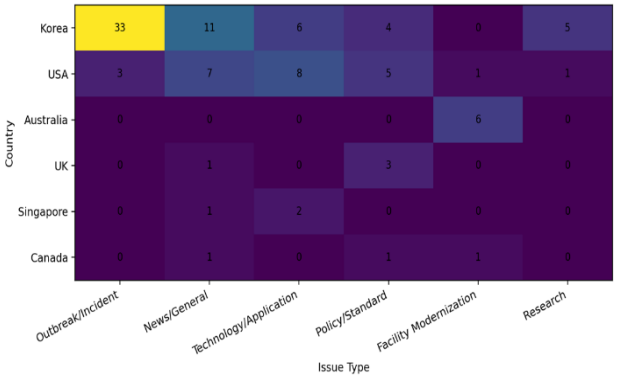

Figure 12: Timeline Bubble Chart of Issue Types

Finally, Figure 13 compares the relative thematic share of five analytical dimensions between the Korean and overseas corpora, clearly showing that the Korean side is strongest in infection/outbreak and living-quarter themes, whereas the overseas side is relatively stronger in modernization, air quality/policy, and mold/HVAC/technology.

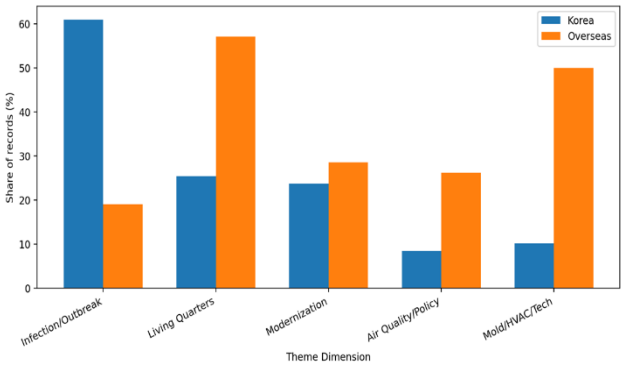

Figure 13: Domestic vs Overseas Theme Comparison

Taken together, these comparative visualizations provide a more intuitive bridge into the discussion section. They show that the corpus is differentiated not only by topic frequency, but also by structural position, temporal concentration, service-specific spatial focus, and thematic balance.

4.10. Domestic–Overseas Comparison

A clearer contrast between the domestic and overseas corpora emerges when the preceding results are examined together. The frequency analysis, topic modeling, co-occurrence analysis, keyword prominence maps, and comparative visual analytics all indicate that the two corpora share a common concern with military indoor environments, but differ substantially in their dominant thematic orientation.

The domestic Korean corpus is more strongly structured around collective infection incidents, cumulative confirmed-case reporting, recruit training center outbreaks, military unit-level disruption, and troop living conditions. By contrast, the overseas corpus is more strongly oriented toward accommodation quality, barracks modernization, mold mitigation, ventilation and HVAC improvement, air-quality standards, and infrastructure renewal. The Korean materials therefore explain why military indoor-air issues become urgent and operationally visible, whereas the overseas materials illustrate how the same issue is increasingly addressed through institutional, infrastructural, and preventive strategies.

This contrast can be interpreted as a difference between an incident-driven frame and a systems-oriented frame. In the Korean materials, military indoor-air issues appear mainly when they become operationally urgent through outbreak events, quarantine, or disruption of training and unit activity. In the overseas materials, the same issue is more often discussed as part of broader efforts to improve barracks quality, reduce mold and humidity, upgrade HVAC systems, strengthen environmental standards, and modernize military accommodation infrastructure. Importantly, these two corpora are not contradictory but complementary. Together, they support a combined framework linking infection-risk reduction, troop living conditions, environmental quality, barracks modernization, and long-term facility management.

4.11. Discussion

The findings of this study suggest that military indoor-air-related issues should not be interpreted as a narrow problem of installing stand-alone air-cleaning devices. Rather, the present corpus indicates that the issue is embedded in the interaction among collective living conditions, troop accommodation quality, infection-risk management, ventilation performance, mold and humidity control, institutional standards, and facility modernization. This interpretation is broadly consistent with the international literature. Li et al. (2007) identified ventilation as a key determinant of airborne infection risk in buildings, while Nazaroff (2016) emphasized that indoor bioaerosol behavior is shaped by source strength, particle size, air exchange, deposition, and filtration.

More recently, Morawska et al. (2021), Nair et al. (2022), and Alqarni et al. (2024) all argued that indoor respiratory-infection control should be approached as an integrated environmental-management problem rather than as a single-device intervention.

First, the present study confirms that military living environments—especially barracks and living quarters—form the central spatial domain of military indoor-air discourse. This result aligns with prior foreign studies showing that congregate military settings are unusually vulnerable to respiratory transmission. German et al. (2008) reported that respiratory tract infections were common in a military recruit setting, while Kasper et al. (2020) and Payne et al. (2020) documented extensive SARS-CoV-2 transmission in the enclosed, high-density environment of the USS Theodore Roosevelt. Lizewski et al. (2022) further showed that substantial transmission could still occur in an isolated U.S. military recruit training center despite rigorous prevention measures. Taken together, these studies support the present corpus finding that the daily living and training environment—not only medical or specialized technical spaces—should be treated as the principal operational target of intervention.

Second, the time-series and issue-type analyses in this study indicate that military indoor-air discourse has historically become most visible during outbreaks and other acute incidents. This pattern is also supported by the foreign literature. The aircraft-carrier and recruit-training-center studies by Kasper et al. (2020), Payne et al. (2020), and Lizewski et al. (2022) all show that once transmission occurs in dense military settings, the consequences are not limited to individual illness but extend to quarantine, disruption of unit function, and operational strain. At the same time, the broader engineering literature suggests that such outbreak visibility is closely connected to indoor-environmental conditions. Bhagat et al. (2020) demonstrated the importance of ventilation in limiting indoor aerosol spread, and Morawska et al. (2021) argued that building-level controls should be regarded as fundamental components of respiratory infection prevention. In this sense, the present study's finding that military indoor-air issues first became highly visible through crisis events is not inconsistent with foreign evidence; rather, it reflects a pattern already documented internationally.

Third, the post-2023 segment of the corpus suggests a shift from incident-centered attention toward accommodation modernization, mold mitigation, HVAC improvement, environmental standards, and infrastructure renewal. This transition also resonates with the foreign literature, although the overseas literature often frames these issues in more technical and systems-oriented terms. Azimi and Stephens (2013) showed that HVAC filtration can materially reduce infectious airborne disease risk in indoor environments, while Peng and Jimenez (2021) suggested that exhaled CO2 can be used as a practical proxy for indoor infection risk and thus as a basis for real-time environmental management. Luo and Zhong (2021) reviewed in-duct UVGI as an engineering control for airborne bioaerosols in HVAC systems, and Nguyen et al. (2022) found that indoor air disinfection techniques such as UV-based systems and filtration have meaningful but context-dependent potential. Nair et al. (2022) likewise concluded that effective risk reduction depends on combining multiple strategies rather than relying on a single measure. These foreign studies help explain why the later phase of the present corpus is dominated not by crisis reporting alone, but by ventilation, HVAC, modernization, and environmental-control themes.
Fourth, the domestic–overseas comparison in this study revealed a difference between an incident-driven frame and a systems-oriented frame. The Korean corpus was more strongly associated with outbreak visibility, cumulative

confirmed cases, and unit-level disruption, whereas the overseas corpus was more strongly associated with accommodation quality, barracks modernization, mold control, environmental standards, and long-term facility management. This contrast can be interpreted more clearly in light of the foreign literature. The military outbreak papers by Kasper et al. (2020), Payne et al. (2020), Lizewski et al. (2022), and German et al. (2008) explain why congregate military environments generate urgent public-health and operational concerns. By contrast, the environmental-control literature represented by Li et al. (2007), Nazaroff (2016), Azimi and Stephens (2013), Luo and Zhong (2021), and Alqarni et al. (2024) points toward structural responses centered on ventilation, filtration, air disinfection, environmental monitoring, and IAQ management. Accordingly, the present domestic–overseas contrast should not be read as a contradiction. Rather, it reflects two complementary layers of the same problem: one showing why military indoor-air issues become urgent, and the other showing how they can be addressed over the longer term.

Fifth, the co-occurrence analysis in this study showed that the corpus is not conceptually fragmented but organized around two interconnected systems: one centered on cluster infection, confirmed cases, training centers, and military-unit outbreak reporting, and the other centered on barracks, accommodation, mold, ventilation, modernization, and environmental standards. This dual structure is strongly consistent with foreign work on indoor bioaerosol transport and control. Kunkel et al. (2017) demonstrated that higher-efficiency HVAC filtration reduced the amount of recovered bioaerosol material at a distance from the source, while Nazaroff (2016) emphasized that indoor bioaerosol concentrations are governed by material-balance relationships involving source emission, air exchange, deposition, and active filtration. These studies reinforce the implication of the present co-occurrence network: military indoor-air management should be addressed where health risk, environmental exposure, and facility conditions converge, rather than being split artificially into “medical” and “engineering” problems.

Sixth, the technological findings of the corpus indicate that specific technologies such as UV, air purification, or filtration do appear, but they do not dominate the discourse in isolation. Instead, technology is typically embedded in a wider system involving ventilation, standards, monitoring, environmental maintenance, and accommodation management. This interpretation again matches the foreign literature. Morawska et al. (2021) explicitly called for a paradigm shift in indoor respiratory infection control, and Alqarni et al. (2024) showed that viral-transmission control in indoor settings is inseparable from broader IAQ considerations and operational trade-offs. Similarly, Nair et al. (2022) and Nguyen et al. (2022) both indicated that the effectiveness of air-cleaning and disinfection technologies is highly context dependent. Therefore, the present study’s conclusion—that a stand-alone equipment approach is insufficient—is well supported by foreign evidence.

From a strategic perspective, the present study therefore points toward a systems-based model of military indoor-air management. Such a model should integrate at least four dimensions: (1) outbreak and infection-risk reduction, (2) troop living-environment improvement, (3) ventilation/HVAC and environmental control, and (4) facility modernization supported by institutional standards.

This proposed direction is not merely inferred from the present corpus; it is also broadly consistent with the foreign evidence base spanning military outbreak studies, building-ventilation research, filtration studies, UVGI reviews, IAQ systematic reviews, and bioaerosol dynamics research. At the same time, the findings of this study should be interpreted with appropriate caution because the present corpus remains a constructed dataset based on heterogeneous publicly accessible sources.

Nevertheless, the overall comparison is clear: military indoor-air issues are neither peripheral nor reducible to a single technology. They are multidimensional concerns involving collective living, force health protection, environmental quality, and facility modernization, and they should therefore be treated as a strategic field of military environmental management.

5. Conclusions

This study examined military indoor-air-related discourse through an integrated big data analysis of news materials, policy and legal documents, scholarly literature, technical standards, and institutional case materials. Focusing on indoor air quality, infection-reduction technologies, accommodation conditions, ventilation, mold mitigation, and environmental management in military living and operational environments, the study constructed a final corpus of 101 coded records covering the period from 2016 to 2026. Rather than evaluating a single product or engineering system directly, the study aimed to identify how military indoor-air issues have been framed, discussed, and structured across public discourse, institutional materials, and scholarly sources over time.

The results indicate that military indoor-air discourse is

concentrated primarily in barracks, living quarters, training environments, and shipboard spaces. The corpus also shows that military indoor-air issues became most visible during the COVID-19 period through collective infection incidents in recruit training centers, general military units, naval vessels, and Air Force training facilities. However, the issue did not disappear after the pandemic peak. In the post-2023 period, the discourse increasingly expanded toward barracks modernization, mold mitigation, accommodation renewal, HVAC improvement, indoor air standards, and environmental policy. This transition suggests that military indoor-air discourse has shifted from a short-term outbreak-response frame toward a broader environmental-management and facility-modernization frame.

A central finding of this study is that domestic and overseas materials play different but complementary roles. The Korean corpus is more strongly associated with incident-driven, outbreak-centered, and operationally urgent themes, whereas the overseas corpus is more strongly associated with accommodation modernization, mold and humidity control, HVAC improvement, environmental standards, and long-term infrastructure renewal. In this sense, the domestic materials help explain why military indoor-air issues become urgent and operationally visible, while the overseas materials illustrate how they can be addressed structurally and preventively over the longer term.

Another important conclusion is that military indoor-air issues are not organized around a single stand-alone air-cleaning device. Instead, they are structured around the interaction among collective living conditions, infection risk, barracks quality, modernization, ventilation, mold mitigation, and institutional environmental management. This means that military indoor-air management should be understood not as a narrow equipment issue, but as a multidimensional systems issue involving environmental quality, force health protection, operational continuity, and infrastructure modernization.

From a practical and policy perspective, the findings suggest that future military indoor-air strategies should integrate at least four dimensions: infection-risk reduction and outbreak preparedness, improvement of troop living conditions, ventilation and HVAC-based environmental control, and facility modernization supported by institutional standards. The most meaningful intervention points are therefore likely to be the spaces where collective living and environmental exposure converge, especially barracks, training facilities, and enclosed operational environments. In addition, domestic military policy may benefit from learning from overseas cases in which indoor-air issues are increasingly addressed through accommodation renewal, mold mitigation, environmental standards, and systems-based facility improvement.

At the same time, this study has limitations. The corpus was constructed from publicly accessible materials and does not represent an exhaustive archive of all military indoor-air-related records. It also includes heterogeneous sources such as news reports, policy documents, legal texts, scholarly papers, technical standards, and institutional case materials, which means that the dataset reflects multiple discourse logics rather than one uniform evidence base. Furthermore, the study focused on discourse structure and thematic patterns rather than direct engineering performance evaluation of specific technologies. Accordingly, the findings should be understood as evidence of issue structure, comparative orientation, and policy direction rather than as proof of the technical superiority of any single intervention.

Nevertheless, the overall conclusion of the study is clear. Military indoor-air issues are not peripheral, and they are not reducible to one technical device or one outbreak event. Rather, they are multidimensional concerns involving collective living, force health protection, environmental quality, accommodation standards, and military facility modernization.

The evidence presented in this study supports the argument that military indoor-air management should be treated as a strategic and institutional field of concern. Ultimately, healthier, safer, and more resilient military environments will depend not only on emergency outbreak response, but also on sustained attention to barracks quality, environmental control, ventilation systems, institutional standards, and long-term facility modernization.

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Appendix : Data Collection, Coding, and Text-Mining Procedure

Item	Application in This Study
Data sources	Domestic data were collected from Korean news databases, government press releases, Ministry of National Defense and service-level public materials, the National Law Information Center, RISS, KCI, and DBpia. Overseas data were collected from Google Scholar, PubMed, Scopus-indexed search results, U.S. Department of Defense and military public materials, defense-related institutional sources, academic articles, and technical standards.
Search terms	Korean search terms included “military barracks,” “barracks living quarters,” “military indoor air quality,” “military air quality,” “military infectious disease,” “military cluster infection,” “recruit training center infection,” “shipboard infection,” “military ventilation,” “military air purifier,” “barracks modernization,” “mold in military facilities,” and “barracks improvement.” English search terms included “military barracks,” “military indoor air quality,” “barracks ventilation,” “military infection control,” “military outbreak,” “shipboard infection,” “military housing modernization,” “mold in barracks,” “HVAC military facilities,” and “air disinfection military.”
Collection period	Data collection was conducted from March to April 2026. The analytical period was set from 2016 to 2026. A limited number of earlier records were retained only as background materials when they were necessary to explain the institutional or technical context of military indoor air management.
Inclusion criteria	Materials were included when they were directly related to military living or operational spaces, such as barracks, recruit training facilities, medical facilities, command-and-control rooms, naval vessels, or other enclosed military environments. Materials were also included when they addressed indoor air quality, ventilation, HVAC, infection reduction, cluster infection, mold, humidity, odor, barracks modernization, facility improvement, or environmental management standards.
Exclusion criteria	Materials were excluded when they were unrelated to military settings, focused only on general residential or commercial spaces, consisted mainly of product advertisements, duplicated previously collected records, lacked direct relevance to indoor air quality or infection reduction, had unclear sources, or did not provide sufficient textual content for coding. When multiple records described the same incident, the record with the clearest source and most complete information was retained.
Final corpus	After duplicate removal, relevance screening, full-text checking, and coding-feasibility review, 101 records were retained as the final corpus. The final dataset consisted of news articles, policy and legal documents, scholarly literature, technical standards, institutional reports, and overseas military case materials.
Coders	The materials were coded according to a predefined coding framework developed by the research team. After initial coding, ambiguous cases were reviewed and adjusted through joint discussion. The main coding categories were country, military branch, space type, issue type, technology type, problem type, year, source type, and core keywords.
Coding categories	The coding categories included country, military branch, space type, issue type, technology type, problem type, year, source type, and core keywords. Space type was classified into barracks/living quarters, training/education facilities, naval vessels, medical facilities, and general/policy-related materials. Issue type was classified into outbreak/incident, policy/standard, technology/application, facility modernization, and general news or institutional reporting.
Reliability measures	To improve coding consistency, a preliminary coding guide was prepared before the main coding process. A pilot coding exercise was conducted on a subset of records, and the coding rules were refined accordingly.

	When multiple researchers were involved, coding disagreements were reviewed and resolved through discussion. If required, intercoder reliability statistics such as Cohen's kappa can be calculated and reported.
Text preprocessing	Duplicate sentences, advertising phrases, URLs, special characters, and irrelevant symbols were removed from the collected texts. Korean and English materials were processed with attention to core nouns and compound terms. General stop words unrelated to the research purpose were excluded. Terms with equivalent meanings were normalized where appropriate; for example, "barracks," "living quarters," and related Korean expressions were grouped under a common military living-space category when analytically necessary.
Analytical tools	Microsoft Excel was used for data organization and coding. Frequency analysis, time-series analysis, topic modeling, co-occurrence analysis, and visualization were conducted using a Python-based analytical environment. VOSviewer, KH Coder, or the R bibliometrix package may be used as supplementary tools where appropriate.
Analytical methods	Frequency analysis was used to examine the distribution of records by year, country, military branch, space type, and issue type. Time-series analysis was used to identify changes in discourse between 2016 and 2026. Topic modeling was used to extract latent thematic structures, and co-occurrence analysis was used to examine relationships among major keywords. Domestic and overseas records were compared to identify differences in discourse structure.
Topic number selection	Models with three, four, and five topics were compared. The final number of topics was selected based on interpretability, thematic distinctiveness, redundancy, and distributional balance. The four-topic model was selected because it most clearly distinguished domestic outbreak expansion, overseas barracks modernization, naval vessel outbreaks, and barracks modernization with air-purifier deployment.
Visualization	The results were visualized using annual distribution charts, country distribution charts, issue-type distribution charts, keyword frequency graphs, topic-term graphs, co-occurrence networks, and domestic–overseas comparison charts. Each figure was generated to support interpretation of the analytical results. Figures that repeated substantially similar information were excluded from the main text or moved to an appendix.
Reproducibility	To enhance reproducibility, the study explicitly documented data sources, search terms, inclusion and exclusion criteria, coding categories, analytical tools, and preprocessing rules. The list of final records should be provided in an appendix where possible to improve transparency and allow future researchers to reconstruct a comparable corpus.