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Analysis of Technological Trends in Aviation Industry Using Topic Modeling: The case of Korea

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Abstract This study analyzes technological trends in Korea's aviation industry using patent data. Latent Dirichlet Allocation (LDA) topic modeling is applied to domestic aviation technology patents to identify major technology areas and emerging themes, yielding ten topics. Yearly changes in each topic are examined through linear regression to quantify trend directions. The results show that "unmanned aerial vehicle (UAV) operation" is a promising and expanding field, while "rotor" and "manufacturing process" technologies exhibit declining trends, indicating that Korea's aviation technology focus is shifting toward UAV-related domains. In addition, the technological competitiveness of patent applicants is assessed, revealing that established technology areas are largely dominated by global corporations, whereas competition among leading Korean firms is intensifying in emerging market fields. These findings provide evidence-based guidance for understanding Korea's aviation technology landscape and for setting future R&D strategy priorities.

Keywords Aviation Industry, Technology Trend, Topic Modeling, Patent Analysis

I. Introduction

With the official launch of the Korea Aerospace Administration in May 2024, the Republic of Korea laid the groundwork for advancing toward becoming a leading aerospace nation. With the goal of joining the G7 in the aviation industry by the 2030s, the government has demonstrated a strong commitment to fostering the aviation industry as a national strategic sector by promoting various

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policies, including the Basic Plan for Aviation Industry Development, the Aviation Core Technology Roadmap, and the K-UAM Roadmap (Shin, 2021). However, despite possessing infrastructure ranked seventh globally in defense expenditure and sixth in air transportation, Korea's aircraft manufacturing capability remains at 14th worldwide, and as of 2019, the share of Korea's aviation industry in the global market accounted for only 0.8% (Inter-ministerial Joint Task Force, 2021).

With the diffusion of the Fourth Industrial Revolution, process optimization and automation technologies have been introduced across the aviation industry, and the emergence of new transportation concepts such as Advanced Air Mobility (AAM) and Urban Air Mobility (UAM) has highlighted the need for structural innovation to respond to changes in the future industrial environment (Inter-ministerial Joint Task Force, 2021). In addition, as the recovery of major global manufacturers and airlines accelerates, interest in aviation technology innovation has increased. Amid shifts in the core values of the global aviation industry, Korea faces an urgent need to establish innovative technologies and industrial revitalization strategies to respond to intensifying global competition (Korea Aerospace Administration, 2025). Therefore, identifying the current technological level of the domestic aviation industry and analyzing trends in technological change are necessary to provide empirical evidence for the formulation of strategic national R&D policies.

Numerous studies have been conducted to identify trends in aviation industry technologies. Yoo (2019) quantitatively analyzed technological trends in the aviation industry using U.S. aviation-related patent data and attempted to derive implications for the domestic aviation industry. However, because the analysis focused on U.S. patents, domestic aviation industry trends were not sufficiently considered. Kim et al. (2017) analyzed trends and interrelationships in aerospace research using domestic academic publications; however, unlike patent data, academic papers have limitations in capturing corporate technological trends. Jung and Lee (2010) examined the level of international competitiveness of Korea's aviation industry and identified key technologies for concentrated development. Nevertheless, recent paradigm shifts—such as the adoption of Fourth Industrial Revolution technologies and the growing interest in Urban Air Mobility (UAM) and unmanned aerial vehicles (UAVs)—necessitate studies that reflect more recent developments. Furthermore, existing studies have largely been limited to specific subfields, such as UAM, space technology, or UAVs. Given the rapid changes driven by the Fourth Industrial Revolution, comprehensive analyses of aviation industry technologies from a macro-level perspective remain scarce.

Accordingly, this study aims to comprehensively analyze technological trends across the entire domestic aviation industry using patent data that reflect actual technological developments. This study applies Latent Dirichlet Allocation

(LDA) topic modeling to the “abstract” sections of patent documents to identify latent technological topics and to examine the overall technological structure of the aviation industry. Based on year-by-year changes in the proportions of the identified topics, temporal trends for each topic are analyzed. Linear regression analysis is then conducted, with year as the independent variable and annual topic proportions as the dependent variable, to identify emerging technologies (hot topics) and declining technologies (cold topics). Finally, based on the number of patents held by applicants in each topic, this study analyzes applicants’ market shares by technological field and their focal technologies, thereby assessing the technological competitiveness of major applicants.

The structure of this study is as follows. Chapter 2 reviews the theoretical background and prior studies related to the aviation industry and topic modeling. Chapter 3 describes the research procedure. Chapter 4 presents an analysis of domestic aviation industry technology patents, examines technological trends, and identifies emerging and declining technologies. In addition, it analyzes applicants’ technological competitiveness based on topic-specific patent counts. Finally, Chapter 5 discusses the conclusions, contributions, and limitations of the study.

II. Theoretical Backgrounds

1. Aviation Industry Technologies

1.1 Overview of Aviation Industry Technologies

According to Article 2 of the Act on the Promotion of the Aerospace Industry, the aerospace industry refers to businesses that produce aircraft, space vehicles, related components, or related materials—including manufacturing, processing, assembly, regeneration, modification, or repair—excluding maintenance, repair, and modification activities carried out by aircraft operators for operational purposes as defined in Article 2(1) of the Aviation Safety Act. It also includes application businesses that utilize aircraft or space vehicles in accordance with ordinances prescribed by the Ministry of Science and ICT, excluding air transportation services and aircraft use services under the Aviation Business Act. In this study, based on the definition of the aerospace industry stipulated in Article 2 of the Act on the Promotion of the Aerospace Industry, aviation industry technologies are redefined in accordance with the objectives of the research. As this study focuses on the analysis of aviation industry technologies, the space sector is excluded from the scope of analysis. Accordingly, aviation industry technologies are defined as scientific and technological fields related to the production of aircraft-related components and materials. This definition encompasses not only hardware technologies—such as aircraft structures and propulsion systems—but also related software technologies, including operation and control systems.

Furthermore, pursuant to the aforementioned Act, the government establishes the Basic Plan for Aerospace Industry Development every five years, and the development and support of specific technologies are carried out based on the Aviation Core Technology Roadmap (2020–2030). Accordingly, this study adopts the Aviation Core Technology Roadmap (2020–2030) as the classification framework for aviation technologies.

The Aviation Core Technology Roadmap (2020–2030) classifies aviation industry technologies into six major technology groups, as illustrated in Figure 1. These groups include airframe structures, propulsion systems, mechanical systems, electrical and electronic systems, IT and software (IT·S/W), and ground facility systems. Each group is further subdivided into a total of 25 detailed technology categories.

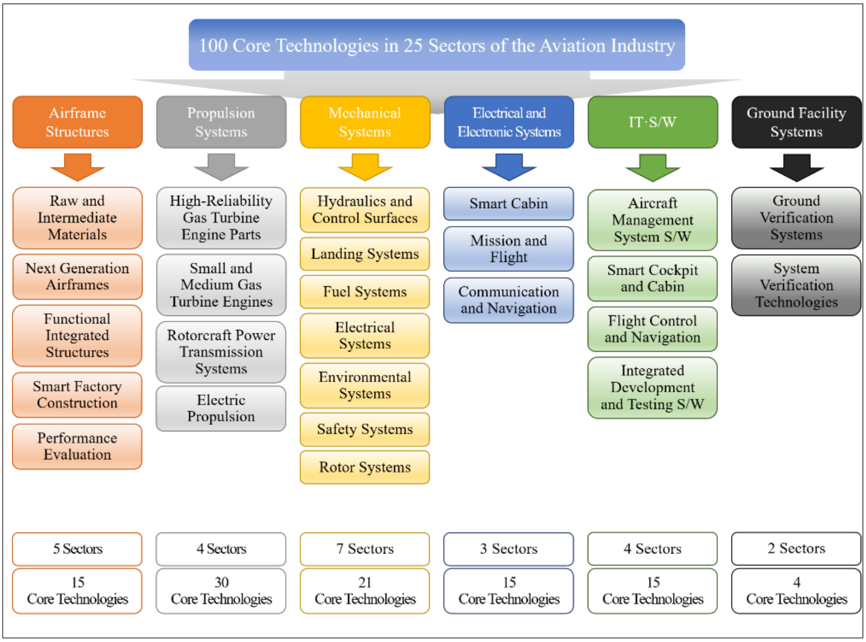

Figure 1. Classification Framework of Aviation Technologies (Inter-ministerial Joint Task Force, 2021)

The definitions of each technology sector according to the roadmap are as follows (Inter-ministerial Joint Task Force, 2021). Airframe structure technologies refer to structural technologies that safely support and enable aircraft operation by withstanding aerodynamic forces, gravity, and thrust acting on the aircraft. These technologies include those related to wings, fuselage, empennage, engine mounts, and landing gear. Propulsion system technologies refer to technologies related to propulsion units—such as reciprocating engines and gas turbines—that generate lift or thrust for aircraft. Mechanical system technologies encompass various mechanical systems required for aircraft operation and flight, including control surfaces, flight control mechanisms, landing gear, braking systems, and steering systems. Electrical and electronic system technologies refer to technologies related to avionics systems—such as communication, navigation, flight control, and instrumentation systems required for aircraft mission execution, as well as electrical power generation and distribution systems. IT and software (IT·S/W) technologies refer to aircraft software technologies necessary for the operation of systems such as communication, navigation, flight control, and instrumentation in support of aircraft mission execution. Ground facility system technologies refer to technologies related to testing and verification facilities and equipment, including simulators and other test equipment required for the development, operational testing, and evaluation of manned and unmanned aircraft.

1.2 Research Trends in Aviation Industry Technologies

Previous studies on aviation industry technologies are summarized in Table 1.

Table 1. Previous Studies on Aviation Industry Technologies

Author	Research Method	Key Findings / Implications
Bae et al. (2015)	Citation Analysis; Co-classification Analysis	Aviation industry technologies have been developed through convergence with various industries. While the level of convergence in F24B technologies has declined, active convergence with the aviation industry has been observed in F01D and B23P technologies.
Yoo (2019)	Keyword Analysis; Network Analysis; Topic Modeling	The path dependency of technological innovation in the Korean aviation industry on the U.S. aviation industry was reaffirmed. Unmanned aerial vehicle (UAV) technology was identified as the most critical area for future aviation R&D.
Kim et al. (2015)	TF-IDF; Topic Modeling	Future promising fields of the aviation industry were identified as aviation safety policy, air fares (low-cost carriers), and environmentally friendly, high fuel-efficiency fuels.
Kim et al. (2021)	Network Analysis	Provided a guide for determining aerospace technology research topics and offered information necessary for aviation management.

Seol (2023)	Topic Modeling	Aerospace research in Korea is primarily concentrated on space technologies, while research on launch vehicle bodies and space observation and exploration technologies remains insufficient.
Kim et al. (2017)	Topic Modeling; Network Analysis	Identified hot research areas as [T3] aviation operation safety, [T4] avionics, and [T8] air transportation and logistics, and cold research areas as [T2] aviation policy and [T7] aviation materials. Relationships among aerospace industry research fields were also derived.
Choi and Kwon (2023)	Patent Analysis; Topic Modeling	China holds a dominant position in the consumer drone market, while the United States leads in the military and commercial sectors. Korea is focusing on the development of manned–unmanned integrated systems in the defense industry.
Kim and Park (2022)	Case Analysis	Current core technologies remain at the basic research level. To enhance technological maturity, system-level development is required, encompassing both core technology development and system integration.
Jung and Lee (2010)	Technology Competitiveness Index (TCI); Growth Curve Model (GCM)	The communications equipment, semiconductor/electronic components, and precision equipment sectors were identified as having long-term competitiveness, and a transition toward a civilian-centered industry was suggested.
Baek et al. (2023)	Dynamic Topic Modeling	Continuous research is required to address noise issues for UAM commercialization. In addition, active research on traffic scenario development is underway to revitalize the UAM market, indicating the need for interdisciplinary convergence research.

Studies analyzing trends in aviation industry technologies have primarily been conducted using patent or academic publication data. Among studies utilizing patent data, Yoo (2019) analyzed aviation industry patents filed with the United States Patent and Trademark Office using network analysis and topic modeling, confirming that the Korean aviation industry exhibits path dependency on the technological innovation trajectory of the U.S. aviation industry. The study also suggested that unmanned aerial vehicle (UAV) technologies would be the most critical area for future aviation R&D. Choi and Kwon (2023) analyzed UAV-related patents to examine technological trends in unmanned aircraft, finding that China dominates the consumer drone market, the United States leads in military and commercial drone sectors, and Korea is focusing on the development of manned–unmanned integrated systems within the defense industry. Jung and Lee (2010) employed the Technology Competitiveness Index and a growth curve model to analyze which core technologies Korea should prioritize in order to secure long-term competitiveness in the global aviation market, suggesting that communications equipment, semiconductor and electronic components, and precision instruments exhibit relatively high competitiveness. However, these studies are limited in that they either relied on foreign data without sufficiently considering domestic technological trends or focused on specific subfields of the aviation industry.

In recent years, the aviation industry has undergone paradigm shifts driven by the Fourth Industrial Revolution, including the expansion of Urban Air Mobility (UAM) and unmanned aerial vehicles (UAVs), as well as rapid technological innovation, highlighting the need for studies that reflect the latest trends. Among studies utilizing academic publication data, Kim et al. (2017) analyzed research trends in the domestic aerospace field, identifying active (hot) research topics and relatively underexplored (cold) areas, and examining relationships among research domains. Baek et al. (2023) identified temporal changes in research topics related to Urban Air Mobility (UAM), suggesting that continuous research is required to address persistent noise issues for UAM commercialization. The study also indicated that active research on traffic scenario development is underway to promote UAM market expansion, underscoring the need for interdisciplinary convergence research. Nevertheless, while academic publication data are useful for identifying scholarly trends, they have limitations in directly capturing firms' actual technological development activities compared to patent data.

Although previous studies have examined aviation industry technologies from diverse perspectives and across various subfields, comprehensive analyses that adopt a macro-level perspective using domestic patent data remain scarce. Accordingly, this study seeks to address these limitations by utilizing domestic patent data to comprehensively analyze technological trends in the aviation industry and the technological capabilities of major competitive actors, thereby providing empirical evidence to support the formulation of practical strategies for strengthening industrial competitiveness.

2. Topic Modeling

2.1 Overview of Topic Modeling

Topic modeling is a statistical methodology used to extract latent themes from a large volume of collected text documents (Blei et al., 2003). Algorithms for topic modeling include Latent Dirichlet Allocation (LDA), Latent Semantic Analysis (LSA), and probabilistic Latent Semantic Analysis (pLSA), among which LDA is the most widely used (Seol, 2023). LDA topic modeling assumes that documents are composed of multiple latent topics, each characterized by a probability distribution over words, and that words in a document are generated according to these topic distributions (Baek et al., 2023). The document generation process of LDA is illustrated in Figure 2. Here, D denotes the total number of documents, N denotes the number of words within a document, and K represents the number of topics. $W_{d,i}$ is the i-th word in the d-th document, and $Z_{d,i}$ indicates the topic assigned to $W_{d,i}$, θ_d represents the topic proportion of the d-th document, while $\o_k$ represents the word distribution for the k-th topic. In the document generation process, θ_d and $\o_k$ are drawn from Dirichlet distributions, after which a topic assignment ($Z_{d,i}$) is selected for each word and the corresponding word ($W_{d,i}$) is generated. In this process, α and β denote the Dirichlet hyperparameters for θ_d and $\o_k$, respectively, and the Dirichlet distributions are determined by the values of α and β (Blei et al., 2003; Lee and Lee, 2019).

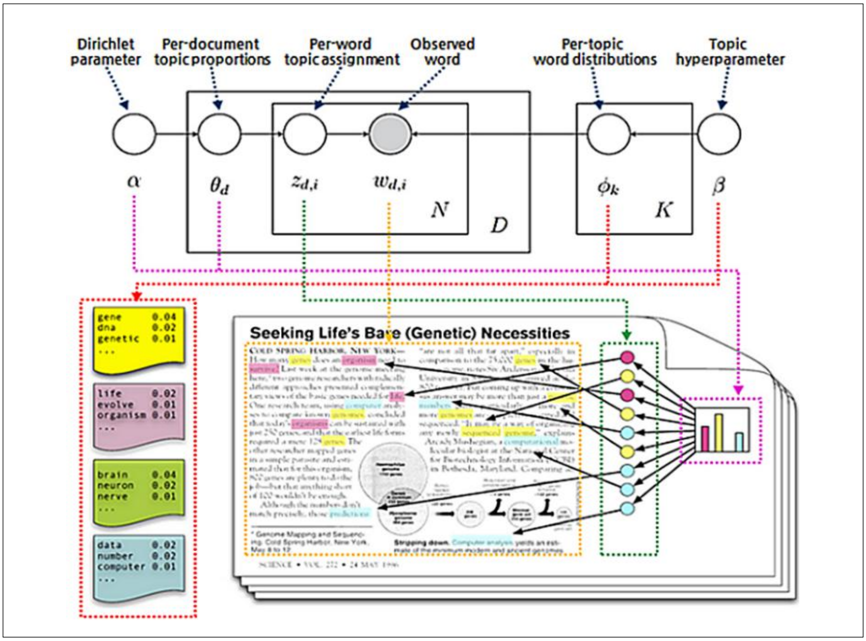

Figure 2. Document Generation Process of LDA Topic Modeling (Blei et al., 2003; Blei, 2012)

2.2 Research Trends in Topic Modeling

Previous studies related to topic modeling are summarized in Table 2. Jeon et al. (2020) applied topic modeling to news article data to analyze trends in combat armored vehicle technology development, extracting frequently mentioned keywords and topics and conducting time-series analysis. Kim et al. (2024) utilized patent data and topic modeling to examine technological trends and future trajectories of unmanned ground vehicles (UGVs) in order to identify key technologies that should be secured in the future. Go (2024) analyzed research trends in artificial intelligence education by applying word cloud and topic modeling techniques to academic publication data related to AI education, and derived relevant implications.

Table 2. Previous Studies Related to Topic Modeling

Field	Author	Research Method	Key Findings / Implications
Defense	Jeon et al. (2020)	LDA Topic Modeling	Analyzed defense industry news articles to identify timely technological trends and derived hot and cold topics through time-series analysis.
Mobility	Jung and Lee (2025)	LDA Topic Modeling; Integrated Innovation Model	Suggested that the diffusion of autonomous vehicle technologies requires not only technological factors but also consideration of social acceptance, public safety, and individuals' innovation orientation.
Artificial Intelligence	Lee et al. (2022)	LDA Topic Modeling	Conducted a cross-country competitiveness analysis of artificial intelligence technologies and suggested that improving qualitative technological capabilities is necessary to enhance Korea's AI competitiveness.
Education	Go (2024)	LDA Topic Modeling; Word Cloud	Identified major research areas in domestic AI education and provided directions for future R&D planning and strategic formulation in the AI education field.
Policy	Won and Lee (2023)	LDA Topic Modeling	Suggested that R&D special zone policies should reflect academic discussions and practitioners' interests and shift toward flexible, testbed-oriented policies that can adapt to environmental changes.
Sports	Lee and Lee (2023)	LDA Topic Modeling	Analyzed trends in the application of Fourth Industrial Revolution technologies to sports and suggested the need for follow-up studies on virtual reality and wearable devices.
Urban Studies	Jang and Jung (2021)	LDA Topic Modeling	Indicated that research on urban regeneration is increasing, the importance of smart city technologies is growing, and urban studies are expanding into the social sciences.

Topic modeling has the advantage of identifying latent topics that are not explicitly observable in textual data (Oh & Moon, 2022). Topic modeling has been widely applied across various domains of scientific research and technology analysis; among these, trend analysis has been the most extensively studied area (Seol, 2021; Kim et al., 2017). Latent Dirichlet Allocation (LDA) is the most representative technique among topic modeling methods, and as shown in Table 2, studies employing LDA topic modeling have been widely conducted across diverse fields for purposes such as patent analysis, trend analysis, and trajectory identification.

In recent years, various topic modeling techniques based on neural networks, such as BERTopic, have emerged. Nevertheless, LDA topic modeling continues to be widely used as a powerful tool for identifying hidden topics due to its intuitive structure and ease of result interpretation (Ma & Park, 2025). Accordingly, this study adopts LDA topic modeling—whose interpretability and intuitiveness have been well established—to identify latent topics in domestic aviation industry technologies and to analyze their technological trends.

III. Research Methodology

The research procedure of this study is illustrated in Figure 3. Patent data registered with the Korean Intellectual Property Office (KIPO) were collected using the patent information retrieval service KIPRIS. The collected patent data were then preprocessed through morphological analysis and stop-word removal. Subsequently, Latent Dirichlet Allocation (LDA) topic modeling was applied to classify the detailed technological fields of the aviation industry.

Based on the year-by-year proportions of the derived topics, year was set as the independent variable and the annual topic proportion as the dependent variable, and linear regression analysis was conducted to identify emerging technologies (hot topics) and declining technologies (cold topics). In addition, to analyze applicants' technological competitiveness, the number of patents held by each applicant for each topic was examined based on the topic modeling results. Finally, the analytical results were comprehensively interpreted to derive implications for technological trends in the domestic aviation industry.

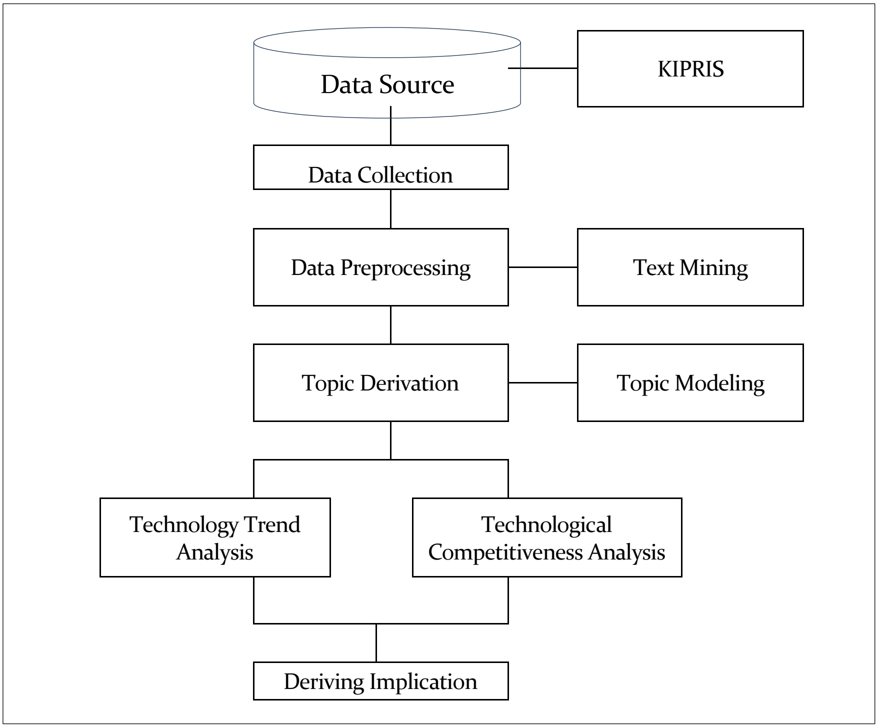

Figure 3. Research Procedure

1. Data Collection

The data used in this study were collected through KIPRIS (Korea Intellectual Property Rights Information Service), a patent information retrieval service. There are two primary approaches to searching patent data: using patent classification systems and using relevant keywords (Xie & Miyazaki, 2013). Keyword-based searches may result in the omission of relevant patents or the inclusion of irrelevant ones (Xie & Miyazaki, 2013). In contrast, utilizing patent classification systems requires less effort in handling synonyms and offers the advantage of overcoming the limitations of keyword-based searches, such as the omission of valid data (WIPO, 2021). Accordingly, this study collected patent data using International Patent Classification (IPC) codes related to the aviation industry.

For patent retrieval, a concordance table between the Korean Standard Industrial Classification (KSIC) and the International Patent Classification (IPC) was used, and patents containing IPC codes corresponding to aircraft manufacturing (C3130) were selected as the objects of analysis. The IPC codes associated with aircraft manufacturing include B64B, B64C, B64D, B64F, B64G, F02K, and F03H. In addition, because patents typically require approximately two to three years after application for examination, registration, and publication (Song, 2023), this study limited its analysis to patents that had been fully registered by 2022, based on the research year of 2025.

The search query applied in KIPRIS was as follows:

IPC = [B64B + B64C + B64D + B64F + B64G + F02K + F03H] * AD = [20050101–20221231]

As a result of the search, a total of 6,678 patents were collected. To exclude patents with low relevance to aviation industry technologies, qualitative screening was conducted. After filtering patents based on their main IPC codes, IPC codes unrelated to the aviation industry were individually reviewed, and patents that did not align with the objectives of the study were removed. Examples of excluded patents include application-oriented inventions that merely utilize aircraft as operational or monitoring tools, such as drone-based fire alarm systems or water quality measurement methods. Through this qualitative screening process, 1,884 patents were excluded, resulting in a final dataset of 4,794 patents used for analysis.

Table 3. IPC Codes for Aircraft Manufacturing

Industry	Industrial Classification (KSIC)	IPC Code	Description
Aircraft Manufacturing	C31 (C3130)	B64B	Lighter-than-air aircraft
		B64C	Aeroplanes; Helicopters
		B64D	Aircraft equipment or fittings; Equipment for aircraft; Arrangement or mounting of power plants or propulsion units in aircraft
		B64F	Ground or aircraft carrier facilities specially adapted for use in connection with aircraft; Design, manufacture, assembly, cleaning, maintenance, repair, handling, transport, testing, or inspection of aircraft not otherwise classified
		B64G	Spacecraft; Vehicles or equipment therefor
		F02K	Jet propulsion plants

		F03H	Producing a reactive propulsive thrust, not otherwise provided for

Figure 4 illustrates the annual trend in the number of aviation industry technology patent registrations after qualitative screening. Overall, patent registrations related to aviation industry technologies exhibit an upward trend, with a compound annual growth rate (CAGR) of approximately 23.83%, indicating active technological development activities. In particular, the number of patent registrations has increased substantially to more than 400 cases per year since 2015. This increase appears to be associated with the initiation of the KF-X program for the development of an indigenous fighter aircraft in the same year (Jung, 2019), as well as the implementation of various government policies aimed at fostering the aviation industry, including the Second Basic Aviation Policy Plan (2015–2019).

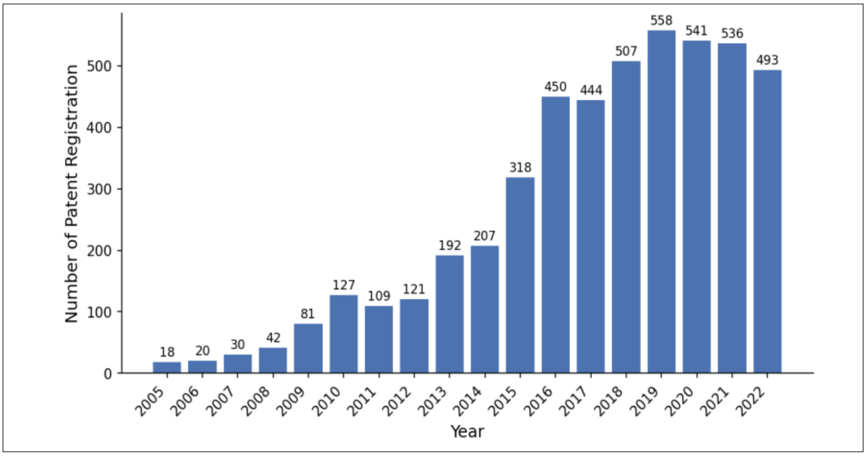

Figure 4. Annual Number of Patent Registration

2. Data Preprocessing

Prior to applying topic modeling, text data require a preprocessing procedure to improve analytical efficiency and accuracy, as textual data are unstructured in nature (Park et al., 2019). In this study, preprocessing was conducted on the abstract sections of patent documents. First, noise elements such as unnecessary special characters, particles, and extra spaces were removed. Next, during the tokenization stage, the preprocessed text was segmented into morpheme units using the morphological analyzer Mecab, and nouns were extracted for analysis.

Subsequently, a stopword dictionary was constructed to remove irrelevant terms that appeared during the analysis process, and iterative reviews were conducted to refine the stopword list. Examples of stopwords include “aviation,” “invention,” “method,” “device,” “system,” “formation,” “multiple,” “embodiment,” “unit,” and “operation.” These terms were selected as stopwords because they commonly appeared across all documents or had low technical significance, making it difficult to identify meaningful topics.

3. Topic Extraction

LDA topic modeling was applied to the preprocessed patent abstract data to extract topics related to aviation industry technologies. The LDA topic modeling was implemented using the gensim library in Python. To determine an appropriate number of topics, metrics such as the coherence score and perplexity can be used. However, these measures serve only as model-fit indicators from a modeling perspective and do not necessarily guarantee interpretable or generalized topics. In studies where interpretability of results is critical, qualitative judgment by domain experts is often more appropriate than relying solely on quantitative indicators (Schofield et al., 2025).

Accordingly, the number of topics was determined through repeated comparisons of modeling results with different topic numbers in consultation with experts in the aviation field. The model was trained with 20 passes and 200 iterations. As a result of this review process, it was determined that a topic number of 10 provided the most reasonable and interpretable topic distinctions. Based on the key keywords associated with each topic, topic labels were subsequently defined.

4. Technology Trend Analysis

After extracting topics through topic modeling, the year-by-year proportion of each topic was calculated to examine temporal trends for individual topics. In this study, linear regression analysis was conducted to identify topics with consistently increasing or decreasing popularity, with year set as the independent variable and the annual proportion of each topic as the dependent variable (Griffiths & Steyvers, 2004).

In this process, prior to 2010, the annual number of patent applications was fewer than 100, meaning that even small differences in application counts could result in disproportionately large fluctuations in topic proportions and lead to potential misinterpretation. From 2005 to 2009, a total of 191 patents were filed, accounting for approximately 4% of the entire dataset. Accordingly, the linear regression analysis was performed using data from 2010 to 2022, during which more than 100 patents were filed annually.

As a result, topics with positive regression coefficients and statistically significant p-values ($p \leq 0.05$) were classified as emerging technologies (hot topics), whereas topics with negative regression coefficients and p-values of 0.05 or lower were classified as declining technologies (cold topics) (Kim et al., 2017). In addition, topics with a coefficient of determination (R-square) of 0.5 or lower—indicating insufficient explanatory power of the independent variable for the dependent variable—were deemed statistically insignificant and excluded from further analysis (Kim et al., 2024).

5. Technological Competitiveness Analysis

By analyzing the patents held by applicants, it is possible to identify their technological capabilities and strategic orientations (Lee & Lee, 2019). In this study, a technological competitiveness analysis was conducted for the top 10 applicants with the largest number of patent applications in the overall dataset. The analysis of technological competitiveness was carried out from two perspectives.

First, the proportion of patents held by each applicant across different topics was calculated to identify the technological areas on which each applicant focuses. Second, the proportion of patents held by applicants within each topic was calculated to identify leading applicants in specific technological fields (Baek et al., 2023). Through this technological competitiveness analysis, the technological development ecosystem and competitive structure within the aviation industry can be quantitatively examined, and the results can serve as foundational data for formulating future technology development strategies.

Table 4. Formulas for Technological Competitiveness Analysis

Analysis Perspective	Formula	Description
Applicant-based Focus Technology Analysis	$Q_{ij} = \frac{N_{ij}}{\sum_{j=1}^{n} N_{ij}} \times 100$	Calculates the proportion of patents in technology field j held by applicant i relative to the total number of patents owned by applicant i, thereby identifying the applicant's core technological focus areas.
Technology Field-based Leading Applicant Analysis	$P_{ij} = \frac{N_{ij}}{\sum_{i=1}^{n} N_{ij}} \times 100$	Calculates the proportion of patents held by applicant i within a specific technology field j, thereby identifying leading applicants in each technological field.

IV. Findings

1. Classification of Technology Fields

The topic names, top 20 keywords, and proportions of the ten topics derived through topic modeling are presented in Table 5. Topic names were defined through discussions with domain experts based on the top 20 keywords for each topic, detailed patent information (titles, applicants, and IPC codes), aviation industry technology classifications, and relevant prior studies. The derived topics encompass a wide range of aviation-related fields, from aircraft structures to flight operation technologies.

Topic 1 consists of keywords such as “imaging,” “image,” “information,” “camera,” and “location,” and was therefore labeled Image Recognition.

Topic 2 includes keywords such as “rotation,” “axis,” “blade,” “rotor,” and “shaft,” and was labeled Rotor.

Topic 3 is composed of keywords including “landing,” “control,” “takeoff and landing,” “unmanned,” and “position,” and was labeled Takeoff and Landing.

Topic 4 includes keywords such as “composite,” “manufacturing,” “processing,” “shape,” and “fabrication,” and was labeled Manufacturing Process.

Topic 5 consists of keywords such as “coupling,” “fixation,” “direction,” “support,” and “frame,” and was labeled Airframe Structure.

Topic 6 includes keywords such as “flight,” “rotation,” “driving,” “thrust,” “lift,” and “power,” and was labeled Power System.

Topic 7 consists of keywords such as “flight,” “data,” “information,” “control,” “unmanned aerial vehicle,” and “communication,” and was labeled Unmanned Aircraft Operation.

Topic 8 includes keywords such as “fuel,” “supply,” “engine,” “tank,” and “gas,” and was labeled Propulsion System.

Topic 9 is composed of keywords such as “test,” “inspection,” “component,” “simulation,” “environment,” and “examination,” and was labeled Performance Testing.

Topic 10 consists of keywords such as “battery,” “driving,” “charging,” “power source,” “electric power,” and “electricity,” and was labeled Battery.

Among the derived topics, those with relatively high proportions include Airframe Structure (19.02%), Unmanned Aircraft Operation (18.38%), Propulsion System (10.66%), and Power System (10.64%), indicating that these fields are characterized by active technological development. In contrast, topics with relatively low proportions—such as Performance Testing (3.11%), Rotor (6.72%), and Manufacturing Process (6.99%)—appear to exhibit lower levels of technological development activity and are therefore assessed as relatively less competitive fields.

Table 5. Topics Identified through Topic Modeling and Their Proportions

No	Topic	Frequent words	Proportion
T5	Airframe Structure	coupling, fixation, direction, support, connection, frame, installation, body, upper, lower, movement, rotation, arrangement, fuselage, plate, position, assembly, hole, guide, adjustment	19.02%
T7	Unmanned Aircraft Operation	flight, data, signal, information, control, generation, reception, unmanned, communication, sensor, UAV, path, input, decision, value, basis, setting, execution, transmission, command	18.38%
T8	Propulsion System	fuel, supply, engine, tank, gas, injection, pressure, heat, inflow, connection, cooling, valve, propellant, exhaust, rocket, chamber, nozzle, flow, temperature, liquid	10.66%
T6	Power System	flight, rotation, thrust, rotor, control, drive, lift, power, auxiliary, engine, direction, vertical, propeller, body, propulsion, airframe, connection, rotary wing, hybrid, electric	10.64%
T1	Image Recognition	imaging, image, information, camera, location, flight, ground, control, acquisition, coordinates, operation, object, area, terminal, precision, identification, display, server, processing	8.66%
T10	Battery	battery, drive, charging, motor, power source, electric power, supply, control, electricity, connection, operation, signal, output, wireless, voltage, circuit, station, conversion, behavior, switch	8.01%
T3	Takeoff and Landing	landing, control, takeoff and landing, unmanned, location, fuselage, measurement, attitude, flight, sensor, value, speed, point, altitude, distance, aircraft, setting, automation, reference	7.82%
T4	Manufacturing Process	composite, manufacturing, processing, structure, shape, arrangement, propulsion, nozzle, fabrication, machinery, surface, direction, section, fiber, rear, structural component, hydraulic, material, fuselage, area	6.99%
T2	Rotor	rotation, axis, blade, rotor, vibration, structure, shaft, assembly, connection, helicopter, direction, coupling, fuselage, center, hub, assembly, motion, position, actuator, adjustment	6.72%
T9	Performance Testing	test, inspection, component, multi, ground, simulation, environment, examination, performance, structure, testing, satellite, surface, execution, detachment, coating, support, implementation, helicopter, application	3.11%

2. Technology Trend Analysis

The year-by-year trends of topic changes are illustrated in Figure 5.

Patents related to Topic 1 (Image Recognition) were rarely filed until the mid-2000s but began to increase gradually after 2009. From the mid-2010s, the proportion stabilized at approximately 7–12%, and in recent years, it has consistently exceeded 10%, indicating a high level of technological interest. As image-based unmanned aerial vehicle technologies have rapidly advanced in recent years, related technological development activities have intensified (Heo & Lee, 2024), which appears to have contributed to the increase in patent applications in the image recognition field.

Topic 2 (Rotor) exhibited a relatively high proportion of 10–20% until the early 2010s, reflecting active technological development. However, since the mid-2010s, its proportion has continuously declined, reaching a low level of approximately 3–4% in recent years. Although the need for next-generation rotary-wing aircraft technologies suitable for Korea's mountainous terrain has been emphasized (Kim & Park, 2022), growing interest has shifted toward emerging fields such as advanced air mobility and unmanned aircraft. As a result, the relative share of rotor-related patents appears to have decreased.

Topic 3 (Takeoff and Landing) initially showed a relatively high proportion of 16.67%. However, during the early period, the annual number of patent applications was small, and even minor differences in application counts likely caused disproportionately large fluctuations in proportions. Since the 2010s, as the number of patent applications increased, the proportion of this topic has shown a gradual upward trend, accounting for approximately 10% in the 2020s. This increase is likely attributable to the active development of Urban Air Mobility (UAM) and vertical takeoff and landing (VTOL) technologies in recent years (Min, 2023). In Korea, while the Korea Aerospace Research Institute initially led eVTOL development, private-sector leadership has expanded more recently, with companies such as Hyundai Motor Group and Hanwha Systems entering the UAM field (Park, 2022).

Topic 4 (Manufacturing Process) maintained a relatively stable proportion of around 10% from the early period and reached a peak of 13.53% in 2014. Thereafter, its share steadily declined, reaching a low level of 2.84% in 2022. This trend suggests a relative decrease in research and patenting activities related to manufacturing processes.

Topic 5 (Airframe Structure) represents a foundational technology of the aviation industry and has maintained a high proportion of approximately 20% throughout most of the study period. After reaching a peak of 23.85% in 2011, the proportion gradually declined but has continued to remain high at around 19% in recent years. This indicates sustained technological development activities in areas such as aircraft lightweight design, composite material engineering, and structural safety enhancement. Korea has secured technological competitiveness in airframe design, particularly centered on the defense sector (Korea Aerospace Administration, 2025).

Both Topic 6 (Power System) and Topic 8 (Propulsion System) constitute core technologies of aircraft propulsion systems. From the mid-2010s to 2022, both topics consistently maintained proportions of approximately 10%, without exhibiting clear increasing or decreasing trends. Although these technology groups are classified as high-difficulty, high-value-added core technologies within the aviation industry, they remain highly dependent on foreign technologies. Accordingly, they have been designated as strategic core aviation technologies, with efforts underway to promote localization and independent development (Inter-ministerial Joint Task Force, 2021). Government-led R&D initiatives are reflected in sustained patenting activity, as evidenced by Topic 8 (Propulsion System) accounting for 11.36% in 2022, the third-highest proportion among all topics.

Topic 7 (Unmanned Aircraft Operation) has shown a steadily increasing trend since the 2010s. While its proportion remained below 10% prior to 2010, it rose to 21.1% in 2022, the highest among all topics. As interest in unmanned aerial vehicles (UAVs) has increased and their applications have expanded into diverse fields such as environmental monitoring, logistics, and security (Hwang, 2024), technological development related to UAV operation has become increasingly active. This trend indicates that UAV-related technologies have emerged as a core domain within the aviation industry.

Topic 9 (Performance Testing) had very few patent applications prior to 2010 and maintained a low proportion of approximately 3% throughout most of the study period. Although it represents the smallest topic in terms of proportion, patent applications have continued steadily. As new aviation technologies—such as UAVs, electric propulsion systems, and UAM—have emerged, the need for new certification standards to ensure safety has increased (Lim et al., 2016), leading to sustained development of performance testing technologies.

Topic 10 (Battery) generally exhibited a low proportion of around 5%, except for a temporary increase to 12.60% in 2010. However, since the mid-2010s, its share has gradually increased, reaching 10.55% in 2022, the fourth-highest proportion among all topics. Battery technology is a key enabler for improving system performance and enabling long-range flight in the aviation industry, and electrification is being actively pursued across various domains, including drones, UAVs, and UAM (Lee et al., 2024). Accordingly, as the importance of environmentally friendly aviation technologies increases, patenting activity related to battery technologies has also expanded.

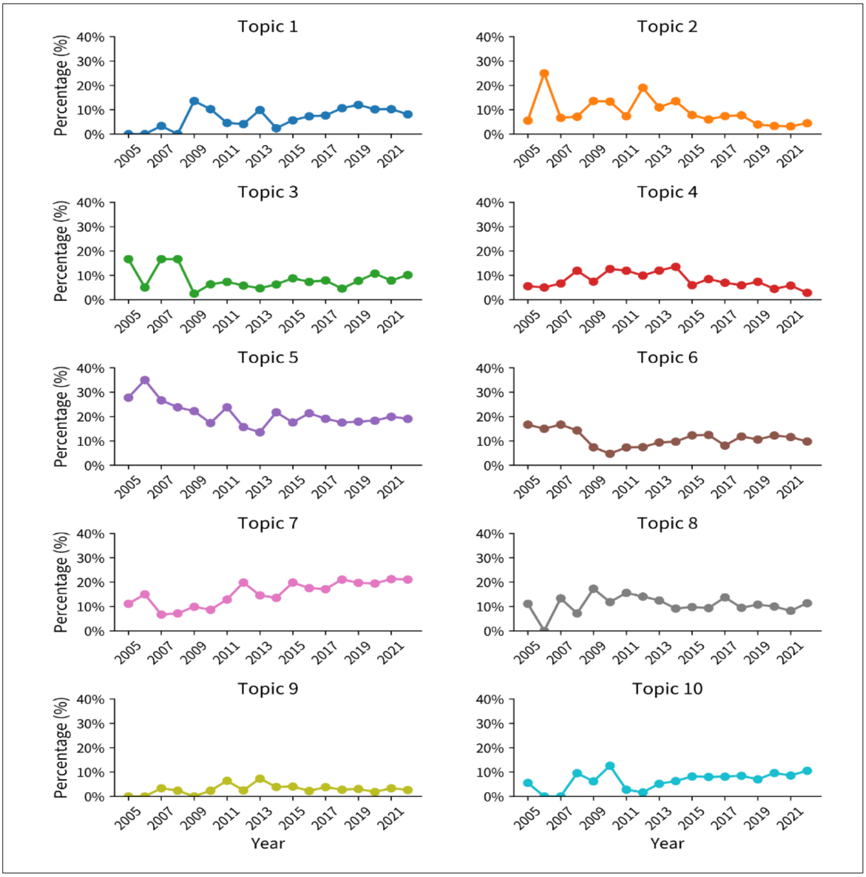

Figure 5. Changes in Topic Proportions over Time

The results of the linear regression analysis conducted to identify emerging and declining technologies are presented in Table 6. The analysis identified one hot topic and two cold topics. Specifically, Topic 7 (Unmanned Aircraft Operation) was classified as a hot topic, indicating that this technology is expected to experience sustained growth and to remain a promising technological field in the future. In contrast, Topic 2 (Rotor) and Topic 4 (Manufacturing Process) were classified as cold topics, as their proportions exhibited statistically significant declining trends. This suggests that the relative importance of these technologies in future technological development is likely to decrease.

The hot topic, Topic 7 (Unmanned Aircraft Operation), is closely associated with next-generation air mobility technologies such as unmanned aerial vehicles (UAVs), Urban Air Mobility (UAM), and Advanced Air Mobility (AAM), for which technological demand has been increasing in recent years. In practice, research in the field of unmanned aircraft operation has actively expanded into emerging domains such as UAM and AAM, and the global and domestic UAV markets have been growing rapidly (Heo & Lee, 2024). Accordingly, interest in technologies related to this field is expected to continue to increase (Kim et al., 2024).

By contrast, the cold topics—Topic 2 (Rotor) and Topic 4 (Manufacturing Process)—appear to have entered a mature stage, where opportunities for new patent filings have diminished. In addition, as the focus of research and development has shifted toward emerging areas such as unmanned aircraft and UAM, the relative shares of these topics are expected to continue declining. Other topics for which the regression model was deemed statistically insignificant—either due to an R-square value of 0.5 or lower or a p-value of 0.05 or higher—include Topic 1 (Image Recognition), Topic 3 (Takeoff and Landing), Topic 5 (Airframe Structure), Topic 6 (Power System), Topic 8 (Propulsion System), Topic 9 (Performance Testing), and Topic 10 (Battery). These technologies either maintain relatively stable levels over time or exhibit short-term fluctuations driven by the expansion of specific application areas, without showing clear long-term trends.

Overall, the results indicate that the technological development trajectory of the domestic aviation industry is shifting from traditional fields centered on large manned aircraft toward emerging technology domains focused on unmanned aircraft.

Table 6. Results of Linear Regression Analysis

No	Topic	R-square	p-value	Coefficient	HOT&COLD
T1	Image Recognition	0.2173	0.1084	0.3545	
T2	Rotor	0.596	0.002**	-0.9355	COLD
T3	Takeoff and Landing	0.3292	0.0403*	0.2742	
T4	Manufacturing Process	0.7619	0.0001***	-0.7655	COLD
T5	Airframe Structure	0.0039	0.8403	0.0425	
T6	Power System	0.4492	0.0122*	0.407	
T7	Unmanned Aircraft Operation	0.6114	0.0016**	0.7854	HOT
T8	Propulsion System	0.2968	0.0542	-0.311	
T9	Performance Testing	0.1703	0.1611	-0.1721	
T10	Battery	0.1753	0.1544	0.3207	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3. Technological Competitiveness Analysis

Figure 6 presents the top 10 major patent applicants. The leading applicants include the Korea Aerospace Research Institute (KARI), the Agency for Defense Development (ADD), and Korea Aerospace Industries (KAI). The top 10 applicants collectively account for 1,825 patent applications, representing approximately 40% of the total 4,794 patents, indicating a highly concentrated patenting structure within the industry.

Given the government-led nature of aviation industry development in Korea, R&D activities are largely centered on public research institutes and defense-related firms, such as KARI, ADD, KAI, Hanwha Systems, and LIG Nex1. In addition, foreign companies—including The Boeing Company and Airbus Helicopters—account for approximately 7.7% of total patent applications. Despite being foreign firms, The Boeing Company and Airbus Helicopters hold a substantial number of patents in Korea. Owing to their strong technological competitiveness in the global market, these companies represent key competitors whose R&D trends should be continuously monitored by domestic firms.

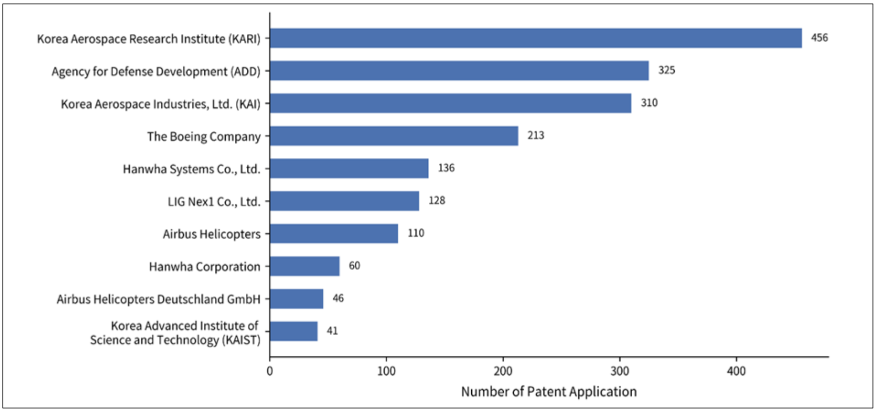

Figure 6. Top 10 Patent Applicants

3.1 Analysis of Applicants' Focus Technologies

The concentration of technological fields by applicant is presented in Table 7, which allows identification of the technology areas in which each applicant concentrates its R&D capabilities. The top three technology fields with the highest proportions for each applicant are indicated in bold, and these fields are regarded as the applicant's focus technologies (Lee & Lee, 2019).

The focus technologies of the research institutions—the Korea Aerospace Research Institute (KARI) and the Agency for Defense Development (ADD)—were found to be identical: Topic 5 (Airframe Structure), Topic 7 (Unmanned Aircraft Operation), and Topic 8 (Propulsion System). KARI has actively engaged in technology development related to airframe manufacturing and core power systems, including the development of the Optionally Piloted Personal Air Vehicle (OPPAV), a key airframe for Korea's Urban Air Mobility (K-UAM), as well as the liquid rocket engine for the Nuri launch vehicle. ADD, in contrast, has focused on defense-oriented weapons system development, such as the KF-21 fighter aircraft and medium-altitude unmanned aerial vehicles (MUAVs).

Among domestic firms—including Korea Aerospace Industries (KAI), Hanwha Systems, LIG Nex1, and Hanwha Corporation—focus technology areas vary depending on each company's business domain. As a system integrator engaged in complete aircraft manufacturing, KAI shows strong concentration in Topic 5 (Airframe Structure) and Topic 7 (Unmanned Aircraft Operation), with shares of 21.9% and 25.5%, respectively. Hanwha Systems exhibits a particularly high concentration in Topic 7 (Unmanned Aircraft Operation) at 37.5%, followed by Topic 5 (Airframe Structure) at 23.5% and Topic 1 (Image Recognition) at 11.8%. LIG Nex1 also demonstrates a high concentration in Topic 7 (Unmanned Aircraft Operation) at 29.7%, along with notable focus on Topic 1 (Image Recognition) and Topic 10 (Battery), each accounting for 12.5%.

Hanwha Systems and LIG Nex1—both representative defense companies—share common focus technologies in Topic 1 (Image Recognition) and Topic 7 (Unmanned Aircraft Operation), reflecting their emphasis on electronic and software-related domains such as surveillance and reconnaissance, avionics, and guided weapon systems. Hanwha Corporation shows its highest concentration in Topic 4 (Manufacturing Process) at 31.7%, along with a substantial share in Topic 8 (Propulsion System) at 16.7%, indicating a strategic focus on technologies related to engine production.

Global firms such as The Boeing Company and Airbus Helicopters exhibit relatively high concentration in traditional core technology fields within the domestic market. The Boeing Company shows a strong focus on Topic 4 (Manufacturing Process), accounting for 34.3% of its patent portfolio. Airbus Helicopters and Airbus Helicopters GmbH demonstrate high concentrations in Topic 2 (Rotor), at 30.9% and 47.8%, respectively, indicating a strategic emphasis on rotary-wing aircraft technologies. These findings suggest that, although The Boeing Company and Airbus Helicopters are both globally recognized as leading aerospace firms, their R&D strategies in the Korean market differ substantially.

Table 7. Analysis of Applicants' Focus Technologies

No	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
KARI	3.1%	5.0%	9.4%	3.1%	**18.0%**	11.8%	**15.8%**	**25.7%**	3.3%	4.8%
ADD	3.4%	5.2%	5.8%	13.8%	**18.2%**	4.3%	**20.9%**	**20.6%**	4.0%	3.7%
KAI	5.5%	6.5%	5.8%	4.5%	**21.9%**	3.9%	**25.5%**	**10.0%**	8.7%	7.7%
The Boeing Company	0.9%	10.3%	2.3%	**34.3%**	10.3%	2.8%	**15.5%**	6.6%	**11.7%**	5.2%
Hanwha Systems	**11.8%**	5.1%	3.7%	0.0%	**23.5%**	3.7%	**37.5%**	4.4%	3.7%	6.6%
LIG Nex1	**12.5%**	1.6%	10.9%	3.1%	11.7%	8.6%	**29.7%**	8.6%	0.8%	**12.5%**
Airbus Helicopters	1.8%	**30.9%**	4.5%	6.4%	**10.0%**	**23.6%**	8.2%	**10.0%**	0.9%	3.6%
Hanwha	6.7%	6.7%	6.7%	**31.7%**	**11.7%**	6.7%	**11.7%**	**16.7%**	1.7%	0.0%
Airbus Helicopters Deutschland GmbH	0.0%	**47.8%**	0.0%	6.5%	**13.0%**	**15.2%**	6.5%	6.5%	0.0%	4.3%
KAIST	12.2%	4.9%	12.2%	0.0%	**19.5%**	9.8%	**19.5%**	**14.6%**	2.4%	4.9%

3.2 Analysis of Leading Applicants by Technology Field

The distribution of patent ownership by applicant across technology fields is presented in Table 8, which allows identification of the applicants leading each specific technology field. The top three applicants with the highest shares in each field are indicated in bold and are regarded as leading applicants in the respective fields (Lee & Lee, 2019).

In the field of Topic 7 (Unmanned Aircraft Operation), which was identified as an emerging technology (hot topic), the Korea Aerospace Research Institute (KARI), the Agency for Defense Development (ADD), and Korea Aerospace Industries (KAI) account for the largest shares. However, compared with other topics, no single applicant holds a share exceeding 10%, indicating that no dominant player has yet emerged and that competition among multiple organizations is ongoing. Hanwha Systems and LIG Nex1 follow with shares of 5.8% and 4.3%, respectively, showing relatively small differences among competitors. Similarly, in other topics related to next-generation air mobility and unmanned aircraft—such as Topic 1 (Image Recognition) and Topic 10 (Battery)—no applicant exhibits a monopolistic position. This suggests that leadership in the future aviation market has not yet been firmly established and that competitive dynamics remain active.

In contrast, traditional technology fields classified as declining technologies (cold topics), such as Topic 2 (Rotor) and Topic 4 (Manufacturing Process), are dominated by global foreign firms. In Topic 2 (Rotor), The Boeing Company and Airbus Helicopters, along with Airbus Helicopters GmbH, account for shares of 6.8% and 10.6%, respectively. In Topic 4 (Manufacturing Process), The Boeing Company holds a dominant position with a share of 21.8%.

In other fields—namely Topic 3 (Takeoff and Landing), Topic 6 (Power System), and Topic 8 (Propulsion System)—KARI ranks first with shares of 11.5%, 10.6%, and 22.9%, respectively, demonstrating a clear leadership position. These results indicate that core technologies such as aircraft engines are being developed primarily through state-led R&D initiatives rather than through market-driven competition.

In the field of Topic 5 (Airframe Structure), KARI, ADD, and KAI account for shares of 9.0%, 6.5%, and 7.5%, respectively. The substantial gap between these organizations and other applicants suggests that these three entities collectively lead technological development in airframe structure technologies. In Topic 9 (Performance Testing), KAI holds the largest share at 18.1%, while The Boeing Company follows closely with a share of 16.8%, indicating active competition between the two firms in this field.

Overall, the results indicate that while traditional aviation technology markets are led by global firms, domestic companies and research institutions are actively competing and forming an innovation ecosystem in emerging fields such as unmanned aircraft and Urban Air Mobility (UAM).

Table 8. Analysis of Leading Applicants by Technology Field

No	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
KARI	3.4%	**7.1%**	**11.5%**	4.2%	**9.0%**	**10.6%**	**8.2%**	**22.9%**	**10.1%**	**5.7%**
ADD	2.7%	5.3%	**5.1%**	**13.4%**	**6.5%**	**2.7%**	**7.7%**	**13.1%**	8.7%	3.1%
KAI	**4.1%**	6.2%	**4.8%**	4.2%	**7.5%**	2.4%	**9.0%**	**6.1%**	**18.1%**	**6.3%**
The Boeing Company	0.5%	**6.8%**	1.3%	**21.8%**	2.4%	1.2%	3.7%	2.7%	**16.8%**	2.9%
Hanwha Systems	**3.9%**	2.2%	1.3%	0.0%	3.5%	1.0%	5.8%	1.2%	3.4%	2.3%
LIG Nex1	**3.9%**	0.6%	3.7%	1.2%	1.6%	2.2%	4.3%	2.2%	0.7%	**4.2%**
Airbus Helicopters	0.5%	**10.6%**	1.3%	2.1%	1.2%	**5.1%**	1.0%	2.2%	0.7%	1.0%
Hanwha	1.0%	1.2%	1.1%	**5.7%**	0.8%	0.8%	0.8%	2.0%	0.7%	0.0%
Airbus Helicopters Deutschland GmbH	0.0%	**6.8%**	0.0%	0.9%	0.7%	1.4%	0.3%	0.6%	0.0%	0.5%
KAIST	1.2%	0.6%	1.3%	0.0%	0.9%	0.8%	0.9%	1.2%	0.7%	0.5%

V. Conclusion

This study conducted a patent analysis using Latent Dirichlet Allocation (LDA) topic modeling to identify technological trends in the domestic aviation industry. Through this analysis, ten detailed technology fields within the aviation industry were identified, their temporal trends were examined, and emerging technologies (hot topics) and declining technologies (cold topics) were predicted. In addition, the technological competitiveness of patent applicants was analyzed from two perspectives: applicants' focus technologies and leading applicants by technology field, based on the number of patents held by applicants in each field.

The results indicate that aviation industry technologies can be classified into ten distinct fields. Among these, Topic 5 (Airframe Structure), Topic 7 (Unmanned Aircraft Operation), and Topic 8 (Propulsion System) accounted for relatively high proportions, whereas Topic 9 (Performance Testing), Topic 2 (Rotor), and Topic 4 (Manufacturing Process) exhibited relatively low proportions. By examining year-by-year changes in topic proportions and conducting linear regression analysis with year as the independent variable and topic proportions as the dependent variable, emerging and declining technologies were identified. Topic 7 (Unmanned Aircraft Operation) was classified as an emerging technology, while Topic 2 (Rotor) and Topic 4 (Manufacturing Process) were identified as declining technologies. The trend analysis confirms that the technological development trajectory of the domestic aviation industry is shifting from traditional fields centered on large manned aircraft toward emerging technology domains focused on unmanned aircraft. Furthermore, the analysis of applicants' technological competitiveness enabled identification of applicants' focus technologies and leading applicants by technology field, thereby providing insights into applicants' R&D strategies. The results indicate that traditional aviation technology markets are primarily driven either by national research institutes or by global firms, whereas in emerging fields such as unmanned aircraft and Urban Air Mobility (UAM), no single applicant dominates the market and competitive dynamics are actively unfolding. As Korea is a latecomer to the aviation industry and currently faces a substantial technological gap with advanced countries, concentrating resources on a limited number of fields where comparative advantages can be secured is considered an efficient strategy (Yoo, 2018). Meanwhile, the global aviation industry is rapidly restructuring around unmanned aerial vehicles (UAVs) and urban air mobility (UAM). According to industry forecasts, the global UAV market is projected to grow from approximately USD 42.3 billion in 2025 to USD 191.8 billion by 2035, exhibiting a compound annual growth rate (CAGR) of over 16% (Research Nester, 2025). In this context, the emergence of Topic 7 (Unmanned Aircraft Operation) identified in this study suggests that Korea's technological development trajectory is aligned with the ongoing global transition toward unmanned and autonomous aviation systems. This indicates that the Korean aviation industry is strategically responding to structural changes in next-generation aviation technologies. Therefore, narrowing the technological gap with advanced countries will require a focused strategy on future aviation technology fields, particularly Topic 7, which has been identified as a promising and emerging area.

This study offers several contributions. First, unlike previous studies that relied primarily on foreign aviation data, this study utilized domestic patent data to derive detailed technology fields of the Korean aviation industry and to examine their temporal evolution. Second, by applying linear regression analysis, this study quantitatively analyzed technological changes over time, enabling the identification of emerging technologies and contributing to the formulation of future aviation industry development strategies. Third, by analyzing the technological competitiveness of patent applicants, this study identified the technological strategies of research institutes and firms, as well as leading applicants by technology field, providing useful insights for future technology planning and strategic decision-making.

Despite these contributions, this study has several limitations. First, although patent data were collected using IPC codes corresponding to aircraft manufacturing based on a concordance between the Korean Standard Industrial Classification (KSIC) and the International Patent Classification (IPC), the two classification systems do not perfectly correspond. As a result, some aviation-related patents may have been omitted or irrelevant patents included. Although qualitative screening was conducted to remove patents with low relevance to the research objectives, future studies should explore improved patent search strategies to address these limitations. Second, subjectivity may have been partially introduced during the data preprocessing stage, particularly in the selection of stopwords and the determination of the optimal number of topics. Future research may enhance objectivity and reliability by applying advanced neural network–based topic modeling techniques such as BERTopic. Third, as technological competitiveness was assessed primarily based on the number of patent applications, qualitative aspects of patents were not considered. However, raw patent counts do not necessarily reflect the quality or impact of a technology. Therefore, future studies could incorporate qualitative indicators such as forward citations, patent family size, or the technology strength index. This approach would provide a more nuanced assessment of whether leading applicants possess highly influential patents in addition to maintaining substantial patent portfolios, allowing for a more comprehensive evaluation of technological competitiveness.

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