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# Value Analysis In Airframe Manufacturing Industry: A Value Network Approach

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**Informasi Artikel**

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***Abstract***

***Research aim:*** *To map the value network in the aircraft manufacturing industry ecosystem and to identify the fundamental values in the industry*
***Design/Methode/Approach :*** *A literature review was conducted on 26 research papers selected from 132 articles from Scopus and Google Scholar databases. In-depth interviews were conducted with several actors in the industry to validate the study result*
***Research Finding:*** *Quality, safety, and cost are the essential values in business competition, based on the industry's long-term strategy and business objectives.*
***Theoretical contribution/Originality:*** *The using of network value analysis in the aircraft manufacturing industry*
***Practitioner/Policy implication:*** *The managerial implications of this study are in the form of strategic input for decision-makers in the industry, by understanding their roles and responsibilities in the industry value network.*
***Research limitation:*** *Since this study was conducted using a qualitative approach, the quantitative survey would be recommended for future study.*
***Keywords: airframe, value, value analysis, value network***

**Abstrak**

**Tujuan Penelitian:** Untuk memetakan aliran nilai pada ekosistem industri manufaktur pesawat udara dan mengidentifikasi nilai-nilai inti yang esensial dalam industri.
**Desain/ Metode/ Pendekatan:** Kajian pustaka dilakukan pada 26 makalah penelitian yang diseleksi dari 132 artikel dari database Scopus dan Google Scholar. Wawancara mendalam dilakukan pada beberapa pelaku industri dalam proses validasi hasil kajian.
**Temuan Penelitian :** Kualitas, keamanan, dan biaya adalah nilai yang diperlukan dalam persaingan bisnis, yang diturunkan menjadi strategi dan sasaran jangka panjang industri.
**Kontribusi Teoritis/ Originalitas:** Penggunaan metode Jaringan Nilai pada industri manfaktur pesawat udara.

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**Implikasi Praktis :** Implikasi manajerial studi ini sebagai input strategis bagi pelaku bisnis, dengan memahami peran dan tanggung jawabnya dalam jaringan nilai industri.
**Keterbatasan Penelitian:** Karena studi ini menggunakan pendekatan kualitatif, maka pendekatan kuantitatif disarankan untuk penelitian lebih lanjut.
**Kata kunci : penerbangan, nilai, analisis nilai, jaringan nilai.**

## 1. Introduction

Since the beginning of 2020, many countries have reduced international flight frequencies to suppress the spread of the COVID-19 virus, which affected many airline companies and airport operators. The uncertain duration of the suspension of air transportation services resulted in financial losses to the aviation industry. The uncertainty affected the markets and many industries, including the aviation sector, which had a significant contraction. According to [1], the percentage of passenger decrease had reached about 44%-80%, as shown in Figure 1.

At the global level, [1] noted that most airlines had reduced more than 35% of their passenger seats. Furthermore, there was a reduction of more than 800 million passengers from international passenger traffic, and it was estimated that the potential loss of the airline industry was more than USD 150 billion. The growth in the air transport sector in Indonesia in the first quarter of 2020 (YoY), has been noted by [2], contracted by up to 13%. The number of foreign tourist visitors in the first quarter of 2020 decreased by 31% compared to 2019. Most profits earned on a long-haul flight are generated by a small group of high-yielding passengers, often traveling for business. Nevertheless, this pool of profit-generating passengers has shrunk because of the pandemic [3].

The air transport sector made many significant contributions to the economy and the activities of human civilization. Aviation industry has provided jobs, tax revenues, and investment. Meanwhile, the aviation industry indirectly provides services for goods and labor mobility, especially the manufacturing and service industries, and facilitates various other sectors such as education, religion, sports, and culture. With such a role, the aviation industry is vital both as a source and a driver of economic growth and civilization.

This contraction of the airline industry affected the aircraft manufacturing industry, which provides aircraft used by airline companies. The reduction in passenger numbers and flight trips disrupted the aircraft manufacturing business as the demand for aircraft had drastically reduced. As a result, aircraft manufacturing companies must redefine the values that support the sustainability of actors in the aircraft industry. Thus, mapping the flow of values between actors in the aircraft manufacturing industry ecosystem is necessary.

The previous studies mostly used the 5 Forces Analysis method [4], while very few used the Value Network Analysis method to analyze the airframe manufacturing industry. Some of the shortcomings of Porter's 5 Forces concept were explained in the previous studies, including this Porter's framework using the assumptions on the traditional perfect market, which has a simple market structure [5]. The framework is unsuitable for a complex and dynamic market structure in industries that involve various collaboration strategies [6], while the value network system describes a business model of 21st-century organizations [7]. Within the value network, the flow is not limited to the product flow in monetary goods but also the

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knowledge and benefits. The airframe manufacturing industry is dynamic and involves many collaboration strategies with companies from the same or different industries. Hence, it is more suitable if the analysis uses the value network method.

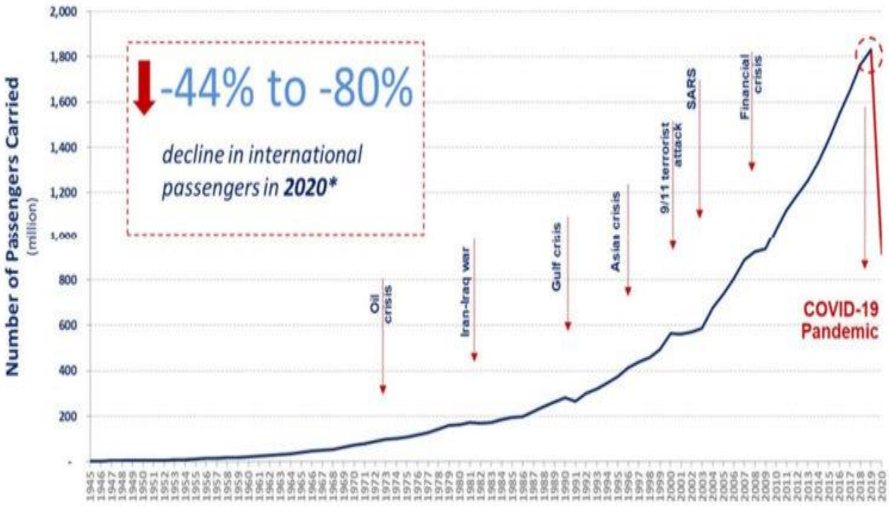


**Figure 1. The International Traffic Collapse: An Unprecedented Decline in History**
*Source: ICAO (2020)*

Focusing on key areas where value creation can be maximized will encourage players in the industry to achieve excellence through the right strategy and good business processes. This study was conducted to fill the gap in previous studies that employ value network analysis in the airframe manufacturing industry. Thus, this research aims to answer the research questions: (i) How is the value flow between actors in the airframe manufacturing industry? and (ii) What are the values in the industry that can be a value proposition component to its customers and stakeholders?

This study consists of 5 sections, beginning with section 2, which contains a literature review. Section 3 describes the research methods used in this study. Section 4 discusses the results of the study, data analysis, and discussion. Finally, section 5 closes the analysis with a conclusion outlining the answers to the research questions and limitations of this study.

## 2. Literature Review

"Value network", described by [8], differs from firms' prevalent view of value configuration. They challenged the limitations of the commonly used model, Porter's value chain, and presented two alternative models: the value shop and the value network. They suggested that the value chain model suits the companies that produce tangible goods, such as car manufacturers. However, it does not effectively represent the value creation process for firms that provide customer services.

Value analysis in the airframe manufacturing industry was studied through a value network approach. This approach views value creation as a network of activities and interactions among various stakeholders rather than a linear process. The concept of a value network was introduced by [8] who argued that the traditional value chain model proposed by [9] needed to be revised in its ability to capture the complexity of value creation in service-oriented firms. The value network in the airframe manufacturing industry consists of various actors, including suppliers, manufacturers, customers, and regulatory bodies, who work together to create and deliver value to end-users. Each actor's unique role contributes to the overall value network differently.

For example, suppliers play a crucial role in ensuring the timely delivery of high-quality raw materials, while manufacturers are responsible for designing and producing the airframes. On the other hand, customers provide input on their needs and requirements, while regulatory bodies set standards and ensure compliance with safety and quality regulations.

In the airframe manufacturing industry, each actor must be aligned with the goals and objectives of the overall network in order to maximize value for all stakeholders. This approach also provides a holistic and comprehensive framework for analyzing value creation in the airframe manufacturing industry. By understanding the relationships and interactions among the various actors, manufacturers can identify opportunities to improve the value they deliver to customers and enhance the competitiveness of their products in the market.

According to [10], the value network supported the complex exchanges of knowledge, support, benefits, products, and money between people in intra- and inter-firm relationships. This model recognizes that value creation is not a simple and linear process but rather a complex network of relationships that involve the exchange of multiple forms of value. In contrast to the value chain model, which focuses on the flow of materials and products through a firm, the value network approach highlights the importance of intangible assets, such as knowledge and expertise, in creating value. It also acknowledges the role of relationships and networks in shaping the value created and delivered by organizations.

In summary, the interpretation of the value network expands upon the original concept by incorporating the complexity of relationships and networks into the value creation model. Concerning the multiple forms of value exchanged between individuals and organizations, the value network approach provides a more comprehensive view of the value creation process.

## 3. Research Methods

A review of previous studies was conducted in this study to build on the existing knowledge in a particular field. We collected and analyzed published research on the airframe manufacturing industry values from reputable journals to understand the current state of knowledge comprehensively. The review involved searching reputable academic journal databases such as Scopus and Google Scholar to collect articles that had been published. The keywords used in the data collection were ***value*** AND ***airframe***. The search was limited to the publication period of the last five years (2018-2022) and the specific fields of business, management, and economics. A total of 114 articles were obtained from Scopus databases, and 18 were from Google Scholar sources, published exclusively in English. We then screened them twice to ensure that they were relevant to the research objectives of this study. The first screening was reading the abstracts of the articles thoroughly, and the second screening included reading the entire contents of the articles to confirm their relevance. Furthermore, 106 journal papers were excluded, and 26 papers were obtained and analyzed in this study.

Once the relevant articles were identified, the data were organized and analyzed based on themes relevant to the research questions, specifically the factors that influence value creation in the aircraft manufacturing industry. The characteristics of values discussed in previous studies were also identified in every factor. Finally, to gain a deeper understanding of the real-world implications of the findings, the data were validated through interviews and discussions with the actors in the industry ecosystem, including the technical director of an airline company and the manager of an aircraft manufacturing company. The validation process ensures the accuracy and credibility of the research and allows us to make any necessary adjustments.

The next step was mapping the flows of products and information in an industry's value network. We first identified the main actors involved in the aircraft manufacturing industry, including primary and supporting actors, and investigated their roles and relationship. Next, the values and their flow directions were determined within the network to gain a complete picture of the framework. The discussions with the actors were taking place to validate that the results accurately reflect the industry and its ecosystem characteristics. Content analysis methods were conducted to obtain the themes clustered further into categories: values, strategies, and objectives. The analysis results can be used to improve the company's performance in the airframe manufacturing industry or as inputs for the industry competitiveness factors. Clustering the characteristics of values would be the ultimate stage to identifying actual critical values in the industry.

## 4. Results and Discussion

Several factors influencing the industry's values were obtained from the analysis processes of 26 peer-reviewed articles relevant to the topic. Table 1 shows the factors which make contributions to the industry's values. Most previous studies focus on using of technology to improve industry's efficiency, safety, innovation, and cost. For example, the aircraft design technology, namely the computer-aided design (CAD) and other simulation tools for designing the aircraft, may help reduce the time and cost of the design process [11], while the technology applied in production, such as the automation machines and robotics may improve efficiency and accuracy, and also reducing the risk of errors and accidents [12].

Airframe and engine advanced technologies that develop frame materials and structures also reduce $CO_2$ emission levels, even though they may have a 43% higher production cost [13]. This technology positively affects on the environment since air transportation may increase the emissions. Meanwhile, the study by [14] confirmed that emission charges would increase aircraft load factors and reduce flight frequency. Besides affecting high emission costs, the noise factor in air transportation is increasingly becoming a research topic that affects the environment [15].

As one of the industries heavily influenced by regulations and government policies or standards issued by authorized associations, aircraft manufacturing companies face several business risks, especially the high level of safety means which affects the high value of the investment and their operational costs.

The high safety level encourages technological developments in production and maintenance, including technology for monitoring aircraft reliability carried out regularly and predicting the remaining useful life of its parts [16]. The study conducted by [17] revealed that

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a cost-benefit financial analysis is needed to be carried out in the industry to make decisions about the operation of an aircraft. Apart from operating normally, another alternative for the aircraft is to change its flight route or not use it anymore.

**Table 1. Factors affecting airframe manufacturing industry values**

| Factors | # of articles | Value discussed | Reference |
|---|---|---|---|
| Intensive use of technology | 16 | Efficiency<br>Safety<br>Innovation<br>Cost | [13] [16][11] [15] [12] [17] [18] [19] [20] [21] [22] [23] [24][25] [26][27] |
| Collaborations and contracts | 2 | Alliances | [28] [29] |
| Reliability and serviceability | 2 | Optimization<br>Reliability | [30] [31] |
| Life cycle cost | 2 | Sustainability | [32] [33] |
| Total quality management | 1 | Quality | [34] |
| Related regulation | 3 | Sustainability | [35] [36] [14] |

*Source: Processed Data*

In their study, [27] revealed that any research on the use of technology for aircraft requires functional and efficiency considerations, and the possibility of promoting the commercial application. The use of technology was estimated to be an essential value for the companies in the aircraft manufacturing industry and encourage them to innovate to produce highly competitive aircraft. Competition with aircraft leasing companies is a factor that must be considered in the aviation industry, considering that many airlines choose not to own their aircraft. One of the rationales for choosing aircraft leasing for airline companies is the relatively high maintenance costs to achieve the required level of reliability. Long-term contracts with Maintenance, Repair, and Operation (MRO) companies are the alternative solutions to optimize maintenance costs.

Collaboration with universities also gives some benefits to the aircraft manufacturing companies by utilizing their expertise in technology development through partnerships, research, and development projects. Some companies are hiring graduates who have studied relevant fields. Collaborations between suppliers and buyers are also joint in the industry, for example, by conducting joint cost management with suppliers. Results of research conducted by [28] in their study, developed a cost calculation system by determining the most significant cost drivers and predicting the total cost of the parts required, thus supporting a mutually beneficial and sustainable cooperative relationship. Such collaborations are critical to developing a robust aircraft manufacturing sector and keeping the companies competitive.

Another challenge in this industry is the availability of a workforce that can learn and innovate and produce optimal human resource productivity, in addition to using automation technology and robotic machines. Another research by [37] revealed that labor productivity depends on the market segments and the market relations development. The study indicated that labor productivity is lower than productivity in developing countries due to insufficient skills and poor management. According [34], the most influence factors to implement the Total Quality Management concept are culture and people. Their high-quality products are easier to produce with talented human resources in airframe manufacturers.

Collaboration is also carried out by aircraft manufacturing companies with suppliers, especially jet engines and parts suppliers. Even though MRO companies often carry out the maintenance process, manufacturers also keep the parts inventory for backup at any time if there is an emergency condition. The flow of value in the form of output and input for each actor in the aircraft manufacturing industry ecosystem is described in Figure 2. Some actors identified are the airframe manufacturing company as a focal company, some core suppliers, MRO companies, leasing companies, airline companies, and the government.

The main characteristics of the value indicated in previous studies comprise nine factors: innovation, quality, safety, cost, efficiency, sustainability, alliances, optimization, and reliability. Airframe manufacturing companies must constantly innovate to stay competitive and meet the changing needs of the market. In addition, the highest quality is required due to safety issues and aircraft reliability since safety is of the utmost importance in the industry.

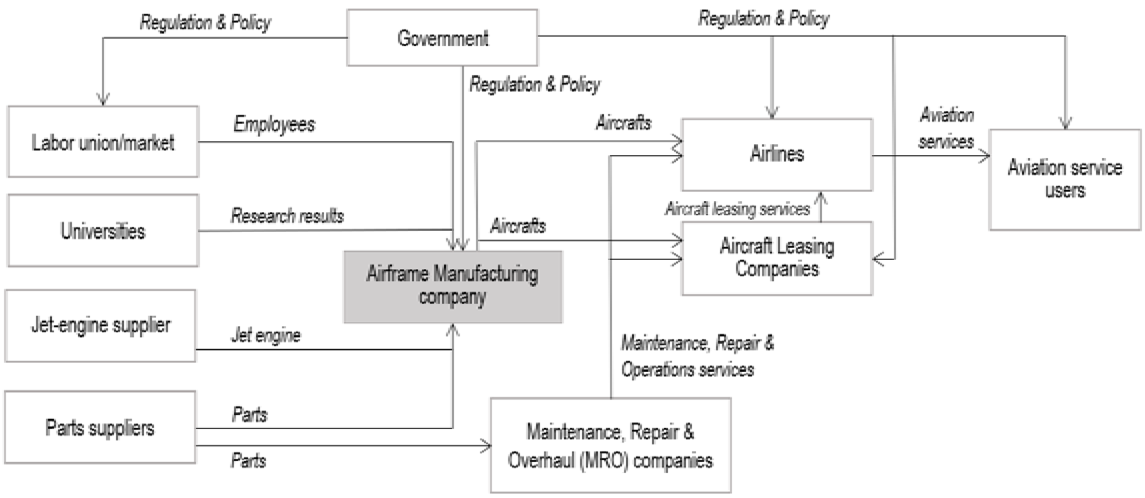


**Figure 2. Value network in the airframe manufacturing industry ecosystem**

The companies need to be efficient by reducing operating costs and using the latest technology with an investment value calculated in an optimization simulation to obtain the appropriate results. Moreover, concern about the environment and climate change is growing.

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Hence, it is increasingly crucial for airframe manufacturers to consider sustainability in their operations.

Collaborations with various stakeholders are essential to access the resources and expertise they need to succeed. The industry is constantly changing dynamically, and companies are forced to have the adaptability to be sustained. Therefore, in-depth interviews were conducted with several actors in the industrial ecosystem to identify the actual value of the airframe manufacturers industry as input for designing the companies' strategy. From the results of these interviews, content analysis method was conducted to obtain the industry's values. Factors that describe the character of values in the industry were clustered into the most critical values that each airframe manufacturing company must possess, the company's strategy, and the objectives that are the company's short- and long-term goals, as shown in Table 2.

In contrast, the clusters of the three strategy components are shown in Figure 3. According to Porter's theory of generic strategies, also known as Porter's model of competitive advantage, companies can pursue three primary generic strategies to achieve a competitive advantage [9]. The first is differentiation which involves developing unique products or services that offer unique value to customers and set the company apart from its competitor. The second is cost leadership which involves minimizing costs to offer lower prices than competitors, which can attract price-sensitive customers. The last one is a focus, through targeting a specific niche market or segment and tailoring products or services to meet the market needs.

In the airframe manufacturing industry, especially after the pandemic, while the number of travel and aircraft demands decreased, the cost is the most important value among the other two in the industry, to ensure business sustainability.

**Table 2. Themes and value clustering**

| Excerpts from interview results | Themes | Clusters |
|---|---|---|
| *".. the most important thing for our buyers is the reliability of the aircraft we produce because of the high maintenance cost."* | Quality | Values |
| *".. safety is the number one issue in the aviation industry."* | Safety | Values |
| *".. the challenge is to produce aircraft with high quality and reasonable price."* | Cost | Values |
| *".. budget airlines are currently preferred by tourists therefore aircraft production costs must be calculated properly to obtain the optimal condition."* | Efficiency | Strategy |
| *".. employees are required to be innovative, find new ideas that can increase revenue without increasing costs." ".. we are in an industry using the sophisticated technology."* | Innovation | Strategy |
| *".. a balanced between determinants of business performance must be considered."* | Optimization | Strategy |
| *".. cooperation with other companies is a one way to survive and grow together."* | Alliances | Strategy |
| *".. reliability causes maintenance cost to be reduced, as well as daily operating costs, this is what our buyers like."* | Reliability | Objectives |

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| | | |
|---|---|---|
| *".. there are not many players in the airframe manufacturing industry. What is important is to know the market needs, then the sustainability is not impossible."* | Sustainability | Objectives |

This condition was suffered by all actors in the airframe manufacturing industry and its ecosystem, including the big players in the industry for medium to large scale passengers-aircraft, namely Airbus and Boeing, with a duopoly market structure. Moreover, to survive and achieve business sustainability, utilization of the value creation model through collaboration or alliances with other companies is essential. Efficiency is the primary strategy, even though it is sometimes perceived as the opposite of the innovation strategy, which requires much of funds. For this reason, optimization is needed for all strategies, programs, and activities carried out by the company to balance the cost incurred and the benefits obtained. For example, Airbus' decided to reduce approximately 15,000 positions across its global workforce to safeguard its future [38]. Furthermore, when airlines return today with product innovations, Airbus is starting to recover from the downturn due to the crisis caused by the COVID-19 pandemic.

Airbus has played the four strategies at the right time when appropriately needed so that it has the opportunity to achieve its business objectives. However, unfortunately, the exact condition experienced by Boeing, Airbus' biggest competitor, which declared a large number of losses during the pandemic. Especially with several accidents that occurred on one type of aircraft, which damaged the safety value, one of the industry's critical values.

Reliability is one of the absolute goals that every airframe manufacturing company has, namely the condition of a low probability of damage or failure of aircraft during operation and long service life [39]. Therefore, the serviceability factor in aircraft maintenance is critical in ensuring the safety value required in the industry.  Furthermore, the role of MRO companies as industry partners creates a balanced bargaining power between the two, even though they have the same customers, namely the airline companies that buy aircraft from the manufacturers and require maintenance, operational, and overhaul services provided by MRO companies. They can use this condition as a strong point in the industry by collaborating in providing reliable and high-quality products and services to airline companies while building bonds between actors in the industry.

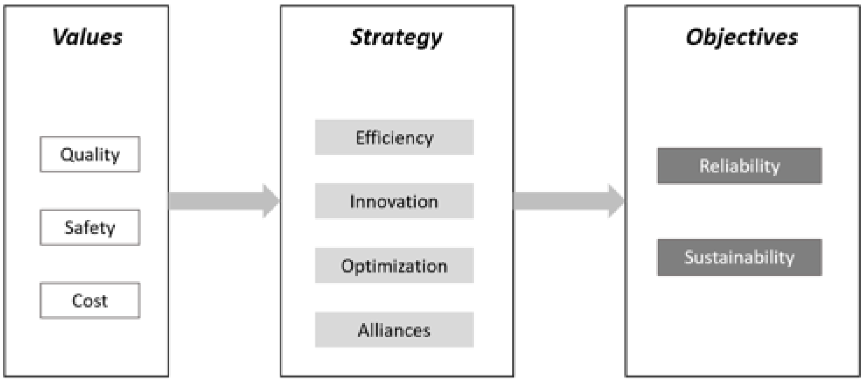


**Figure 3. Values, strategy, and objective clusters**

All critical values in the industry are used in carrying out the combination of strategies, as applied in Airbus company, which will increase product reliability and, in the long-term, result in a sustainable business.

## 5. Conclusions

Regulatory factors and high safety standards influence the air frame manufacturing industry's operation. Therefore, ensuring that all stakeholders in an industry are appropriately aligned and working towards the same goals based on the same values can increase the reliability and sustainability of the business. Hence, it is crucial to establish clear roles and responsibilities for each stakeholder and to foster a culture of collaboration and communication to facilitate close relationships between actors. The role setting is a practical implication of using value network analysis in the industry, where the interrelationships between actors are mapped clearly and provide an overview of the role of each actor in the industry ecosystem.

Since promoting close interrelationships between stakeholders is critical, other strategies are recommended for businesses to increase their reliability and sustainability. This strategy may include implementing robust processes and systems for managing risk and ensuring quality, investing in infrastructure and supporting equipment designed to be durable and efficient, and adopting environmentally-friendly practices to reduce the impact of the business on the environment. A holistic approach to these issues can improve performance and long-term success.

Several limitations of this study can be used as inputs or opportunities for further, more in-depth research; namely, the study approaches can be quantitative research by conducting surveys on actors in the industry. In addition, the classification of airframe manufacturers based on the type of their business scale may also be a factor that needs to be explored further. Moreover, the results of this study can be used as inputs for analysis of the airframe manufacturing company strategy in future research.

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