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DEMATEL-based analysis of critical success factors for the development of Indonesia's aircraft component supporting industry

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A B S T R A C T

The development of Indonesia's aircraft component supporting industry requires a systematic understanding of the factors that drive and inhibit industrial capability enhancement. This study identifies and analyzes 22 critical success factors (CSFs) using the Decision-Making Trial and Evaluation Laboratory method to uncover their causal structure and relative influence. Expert evaluations were obtained from government policymakers and practitioners within the aircraft component supporting industry, and these inputs were used to develop the direct-relation, normalized, and total influence matrices, enabling a comprehensive cause-effect analysis. The results reveal a clear hierarchical structure in which several factors, particularly research and technology, market conditions, performance capability, technological infrastructure and availability, safety, technological reliability, and management support, emerge as primary causal drivers within the ecosystem. These elements exert significant influence on downstream factors, such as industry-government coordination, customer support, measurable demand, team composition, team competency, and contractual aspects. The findings emphasize that strengthening technological infrastructure, regulatory facilitation, and internal managerial capability is essential for improving supplier readiness and integrating domestic firms into global aerospace value chains. This study contributes to the literature by demonstrating the applicability of DEMATEL in structuring industrial development priorities within emerging aerospace economies. Practically, the results offer policymakers and industry leaders a strategic foundation for directing investments, designing capability-building initiatives, and formulating long-term industrial development strategies.

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1. Introduction

Over the past few decades, the global aviation industry has expanded substantially, especially across emerging regions such as Asia and Latin America. This growth has been driven by globalization, sustained economic development, deregulation, and the liberalization of air transport markets, which collectively increased passenger and cargo traffic. Rising demand for air transportation has also stimulated airport development and related services, positioning aviation as a key sector contributing to industrial transformation and regional economic development (Zuniga & Boosten, 2021). At the same time, rapid technological progress continues to reshape the aviation sector, making aircraft a critical enabler of modern mobility and connectivity. Maintaining high levels of safety, reliability, and operational performance in such complex systems remains a persistent challenge. To remain competitive, aerospace manufacturers and their supporting industries must adopt emerging technologies, employ advanced materials, and embrace digital transformation to ensure efficiency and quality (Ichou & Veress, 2024). This dynamic environment underscores the strategic importance of strengthening supporting industries, particularly those engaged in aircraft component manufacturing, as a foundation for long-term competitiveness in the global aviation ecosystem. The aerospace sector is widely recognized as one of the most technologically sophisticated manufacturing industries, integrating advanced engineering, management, and regulatory disciplines. Although innovation in this sector

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progresses steadily, the adoption of disruptive technologies remains cautious due to stringent certification requirements, high safety standards, and long product life cycles (Hanus et al., 2017). In Indonesia, PT Dirgantara Indonesia (PTDI) represents the nation's primary aerospace manufacturing capability; however, its overall competitiveness remains constrained, with Indonesia ranking 33rd globally and fourth within Southeast Asia (Harsudiono et al., 2022). The aircraft component supporting industry continues to face persistent challenges, including financial limitations, shortages of skilled human resources, restricted access to advanced technologies, and demanding certification requirements imposed by international OEMs. Comparable conditions observed in other emerging economies demonstrate that technological capability gaps, institutional constraints, and financial barriers significantly hinder firms' integration into global value chains, underscoring the importance of coordinated strategies that enhance supplier capabilities, strengthen technological readiness, and promote sustained collaboration with global industry actors (Elshaarawy & Ezzat, 2023; Kano et al., 2020). Identifying critical success factors (CSFs) is therefore essential to accelerating the competitiveness of the aerospace component supporting industry. CSFs help policymakers and industry stakeholders prioritize actions, allocate resources, and design effective development strategies. While previous studies have examined CSFs in sectors such as manufacturing (Wahab et al., 2020), telecommunications (Maulana & Raharjo, 2021), automotive (Mauricio & Jabbour, 2017), electric power (Mathew & Pretorius, 2017), and oil and gas (Tsiga et al., 2017), research focusing on aerospace supporting industries, particularly in emerging economies, remains limited. Existing studies also tend to treat success factors as independent variables, overlooking the causal interactions that influence industrial performance.

This study aims to identify the CSFs that influence the development of Indonesia's aircraft component supporting industry and analyze their interrelationships using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. DEMATEL enables the construction of a causal structure that reveals how different dimensions strengthen or constrain one another in shaping industrial competitiveness. From an academic standpoint, this study contributes to the limited literature on aerospace-related CSFs by applying DEMATEL to move beyond factor identification toward understanding systemic causality. From a practical perspective, the findings offer a strategic reference for policymakers and industry stakeholders in Indonesia to prioritize key success factors, strengthen industrial capabilities, and design targeted policies that enhance the competitiveness and long-term sustainability of the aerospace component supporting industry.

2. Literature Reviews

2.1 Critical success factors

The concept of critical success factors (CSFs) was first introduced in (Bullen & Rockart, 1981) as a strategic management framework to identify the key determinants that enable organizations to achieve their objectives. Since its introduction, the CSF framework has been widely adopted across industries to evaluate organizational performance and support managerial decision-making. Although specific factors vary across sectors, prior studies consistently highlight managerial capability, skilled human resources, and effective stakeholder collaboration as central determinants of success. Team commitment is also frequently recognized as one of the most influential success drivers. In project-based industries, such as turnkey engineering, effective communication, collaboration, and leadership are commonly identified as essential CSFs. These elements enhance the alignment of client expectations and improve organizational responsiveness to changing project conditions. Furthermore, teams with strong experience, problem-solving capabilities, and risk-management competencies, supported by well-structured organizational systems, tend to deliver superior project outcomes, achieve higher stakeholder satisfaction, and strengthen overall competitiveness (Gupta et al., 2024; Pereira et al., 2022; Roux et al., 2024).

2.2 Indonesia's Aircraft Component Supporting Industry

The manufacturing sector plays a strategic role in Indonesia's economic development and is positioned as a key driver of long-term industrial transformation toward advanced and digitally enabled manufacturing. Despite this strategic importance, manufacturing industries in emerging economies frequently face structural constraints, including weak supply chain coordination, limited technological diffusion, and capability gaps among small and medium suppliers, which may undermine competitiveness and integration into global value chains (Porter, 1998; WTO, 2017). In this context, Indonesia's aircraft component supporting industry represents a highly specialized manufacturing segment characterized by strict certification requirements, long product life cycles, and strong dependence on global OEMs. PT Dirgantara Indonesia functions as the anchor firm within the national aerospace ecosystem, providing opportunities for learning and capability spillovers among local suppliers. However, the supporting industry remains limited in scope, with activities largely concentrated on aerostructure components, while higher-value subsystems such as avionics, propulsion, and control technologies are predominantly sourced from abroad. Similar conditions have been observed in other emerging aerospace economies, where limited technological depth, organizational maturity, and system integration constrain industrial upgrading (Liu & White, 2001; Niosi & Zhegu, 2005; Tang & Veelenturf, 2019). Consequently, the literature emphasizes the need for a coordinated development approach involving government support, industrial collaboration, technology investment, and market-driven demand to enable suppliers to progress toward higher-value-added roles within global aerospace supply chains (Gereffi et al., 2005; Humphrey & Schmitz, 2002).

2.3 Critical Success Factors for Indonesia's Aircraft Component Supporting Industry

The critical success factor (CSF) framework has been widely applied by policymakers and industry practitioners to identify key drivers of industrial performance and long-term sustainability (Nurbossynova et al., 2021). A synthesis of prior studies reveals four overarching CSF dimensions: industry, government, technology, and customer, which collectively encompass 22 specific factors frequently reported in the literature. These dimensions provide the analytical foundation of this study and guide the identification of the most relevant success factors for Indonesia's aircraft component supporting industry through expert judgment, as summarized in Table 1.

Table 1
Summary of Critical Success Factors Identified in the Literature

Dimension	Critical success factors	References	Description
Industry	Management Support	(Hakim et al., 2021; Kabak et al., 2016; Mauricio & Jabbour, 2017; Nurbossynova et al., 2021; Paul et al., 2022; Rehman et al., 2015; Tsiga et al., 2017; Wahab et al., 2020)	Allocation of adequate resources and strengthened collaboration to ensure successful industrial development
	Management Competency	(Hakim et al., 2021; Kabak et al., 2016; Maulana & Raharjo, 2021; Mohanta & Mahanty, 2021; Nurbossynova et al., 2021; Rodríguez-Segura et al., 2016; Tsiga et al., 2017; Wahab et al., 2020)	Effective leadership in coordinating activities, motivating teams, and maintaining strong organizational control.
	Team Competency	(Hakim et al., 2021; Kabak et al., 2016; Maulana & Raharjo, 2021; Mauricio & Jabbour, 2017; Nurbossynova et al., 2021; Tsiga et al., 2017; Wahab et al., 2020)	Skilled and adaptable workforce capable of sound planning and decision-making
	Team Composition	(Mauricio & Jabbour, 2017; Nurbossynova et al., 2021; Rehman et al., 2015; Tsiga et al., 2017)	Well-structured teams with clear roles across planning, execution, budgeting, and evaluation
	Contractual Aspects	(Tsiga et al., 2017)	Efficient contracting, tendering, and procurement processes that enable smooth operational governance
	External Challenges	(Tsiga et al., 2017)	Conditions in the economic, social, political, and regulatory environment that influence industry performance.
	Financial Factors	(Hakim et al., 2021; Liang et al., 2016; Nurbossynova et al., 2021; Sivakumaran et al., 2015)	Efficient allocation of production and marketing resources to maintain cost competitiveness.
	Measurable Demand	Expert Judgment (Delphi Round 1)	Quantified customer needs that support reliable demand forecasting and production planning.
Government	Government Support	(Hakim et al., 2021; Liang et al., 2016; Nurbossynova et al., 2021; Paul et al., 2022; Rodríguez-Segura et al., 2016; Talib et al., 2015)	Consistent and supportive policy and regulatory frameworks that enable industry development.
	Industry-Government Coordination	(Kabak et al., 2016; Liang et al., 2016; Paul et al., 2022; Talib et al., 2015)	Strengthened collaboration between authorities and industry players to enhance national industrial competitiveness.
	Infrastructure	(Kabak et al., 2016)	Availability of essential facilities that support efficient production and supply chain operations.
	Financing and Taxation Facilities	(Kabak et al., 2016)	Access to financial incentives and favorable tax policies that stimulate industrial growth.
	Research and Technology	(Talib et al., 2015)	Investment in R&D capabilities to drive innovation and strengthen sector competitiveness.
Technology	Technological infrastructure availability	(Hakim et al., 2021; Khan & Narawane, 2011; Mauricio & Jabbour, 2017; Mohanta & Mahanty, 2021; Nurbossynova et al., 2021; Paul et al., 2022; Rehman et al., 2015)	Readiness and accessibility of advanced technology are required for participation in global aerospace supply chains.
	Technological Reliability	(Kabak et al., 2016; Mohanta & Mahanty, 2021; Nurbossynova et al., 2021; Paul et al., 2022)	Stable and dependable technological systems that ensure consistent operational performance in aviation manufacturing.
Customer	Customer Support	(Nurbossynova et al., 2021; Paul et al., 2022; Rodríguez-Segura et al., 2016)	Customer awareness and engagement encourage manufacturers to align with regulatory requirements and meet market expectations.
	Product Quality	(Duy & Hoang, 2017; Hakim et al., 2021; Kabak et al., 2016; Khan & Narawane, 2011; Paul et al., 2022)	Attributes such as durability, reliability, and precision shape overall customer satisfaction.
	Market Conditions	(Hakim et al., 2021; Kabak et al., 2016; Sivakumaran et al., 2015)	Understanding industry dynamics, competitive pressures, and entry barriers that influence customer preferences and purchasing behavior.
	Price Appropriateness	(Duy & Hoang, 2017; Hanif et al., 2010; Khan & Narawane, 2011)	Pricing practices play a critical role in shaping buyer choices and perceived value.
	Service Quality	(Duy & Hoang, 2017; Hanif et al., 2010)	The effectiveness and responsiveness of after-sales services contribute to customer satisfaction.
	Performance	Expert Judgment (Delphi Round 1)	Operational effectiveness reflects how well the product meets functional and technical requirements.
	Safety	Expert Judgment (Delphi Round 1)	Compliance with safety standards and features that protect users and meet regulatory expectations.

Building on this literature, the CSFs are categorized into 4 theoretical domains. Industry-related factors include managerial capability, workforce competence, team structure, contractual mechanisms, and financial resource strength, consistent with organizational capability theory, which emphasizes the role of internal coordination and resource deployment in driving production and supply chain performance (Porter, 1998). Government-related factors comprise policy stability, regulatory support, industry-government coordination, fiscal incentives, and public investment in research and technology, reflecting institutional theory, which stresses the importance of regulatory coherence in certification-intensive industries (Talib et al., 2015). Technology-related factors encompass innovation capability, infrastructure readiness, and access to advanced manufacturing technologies, aligning with the technology-push perspective, which argues that technological maturity facilitates supplier integration into global value chains (Mohanta & Mahanty, 2021). Consumer-related factors capture expectations regarding product quality, service performance, pricing, and market characteristics, drawing on demand-side theory, which posits that customer requirements influence operational priorities and competitive strategies in business-to-business markets (Hanif et al., 2010). Collectively, the 22 critical success factors (CSFs) constitute the conceptual basis for understanding the conditions required to strengthen Indonesia's aircraft component supporting industry and serve as inputs for the empirical validation conducted in this study, as listed in Table 3.

3. Methodology

The Decision-Making Trial and Evaluation Laboratory method is widely recognized as an effective analytical approach for examining causal structures among strategic factors that influence system performance. Previous studies have applied DEMATEL across diverse industrial and technological settings, including maritime safety improvement (Veltsin et al., 2025), antipiracy strategies in the media and entertainment sector through blockchain adoption (Mittal et al., 2025), IoT implementation in the Indonesian automotive industry (Hakim et al., 2022), the integration of generative AI in higher education practices (Wang & Zhang, 2025), and circular economy adoption in the photovoltaic sector (de Amorim et al., 2025). These applications demonstrate DEMATEL's robustness in capturing interdependencies and distinguishing cause-effect relationships among complex variables. Given its proven analytical capability, DEMATEL was employed in this study to evaluate the critical success factors that influence the development of Indonesia's aircraft component supporting industry. The method enables a systematic classification of CSFs into influential and dependent categories, allowing the identification of key leverage factors that should be prioritized to enhance industrial readiness and strengthen national competitiveness within the aerospace supply chain. This section describes the DEMATEL technique and outlines the computational procedures implemented in this study (Mittal et al., 2025):

Step 1: Development of the initial direct-relation matrix

Experts were asked to evaluate the degree of direct influence of each factor *i* on factor *j*, denoted as a_{ij}. A five-point scale was used to represent the strength of influence, where 0 indicates no influence, and 4 indicates very high influence. The rating criteria are summarized in Table 2.

Table 2
Five-point scale for evaluating direct influence

Score	Description
0	No influence
1	Very low influence
2	Low influence
3	High influence
4	Very high influence

The initial direct-relation matrix $A = [a_{ij}]$ is then constructed, where each element a_{ij} represents the mean value of the judgments provided by all experts, as shown in Eq. (1).

$$A = \begin{bmatrix} 0 & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ a_{21} & 0 & \dots & a_{2j} & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{2j} & \cdots & a_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nj} & \cdots & 0 \end{bmatrix} \quad (1)$$

Step 2: Normalization of the direct relationship matrix

The initial direct-relation matrix *X* is normalized using Eq. (2) and Eq. (3) to obtain the normalized direct-relation matrix *D*.

$$D = k\bar{X} \quad (2)$$

$$k = \frac{1}{\sum_{j=1}^{n} a_{ij}} \quad (3)$$

Step 3: Computation of the total influence matrix

The total influence matrix T is derived using Eq. (4) based on the normalized direct-relation matrix obtained in the previous step.

$$T = D + D^2 + \cdots + D^m = D(I - D)^{-1} \quad (4)$$

where $D^m = [0]_{n \times m}$

Step 4: Calculation of dispatch and receive influence scores

The total influence matrix is expressed as follows:

$$T = [t_{ij}]_{n \times n} \quad i, j = 1.2.3 \ldots n \quad (5)$$

The dispatch influence score (D), representing the total influence that factor i exerts on other factors, is computed as follows:

$$D = [\sum_{j=1}^{n} t_{ij}]_{n \times 1} \quad (6)$$

Meanwhile, the **receive influence score (R)**, indicating the total influence that factor i receives from the others, is determined as follows:

$$R = [\sum_{i=1}^{n} t_{ij}]_{n \times 1} \quad (7)$$

Step 5: Causal Diagram Construction

The causal diagram is developed by mapping each factor using 2 structural indicators: ($D_i + R_i$) and ($D_i - R_i$).

The value ($D_i + R_i$) expresses the degree of involvement of factor i in the system, considering both influence is sent and received. Meanwhile, ($D_i - R_i$) determines the directional role of each factor:

(D_i-R_i) > 0: **cause group** (net influencers)
(D_i-R_i) <0: **effect group** (net receivers)

These metrics provide the foundation for visualizing causal relationships and identifying the most influential CSFs within the DEMATEL framework.

Step 6: Threshold determination for digraph construction

To construct the causal digraph, a threshold value is applied to the total influence matrix (T) to filter out negligible relationships and highlight the most significant causal interactions among the critical success factors. This step is commonly adopted in DEMATEL applications to reduce model complexity and improve the interpretability of the cause-effect structure when dealing with multiple interrelated factors. Only influence values exceeding the threshold are retained for the construction of the causal diagram, ensuring that the resulting map reflects meaningful and decision-relevant relationships (Chatterjee et al., 2022). The overall methodological workflow of the Delphi-DEMATEL process, including the threshold-based digraph construction, is illustrated in Fig. 1.

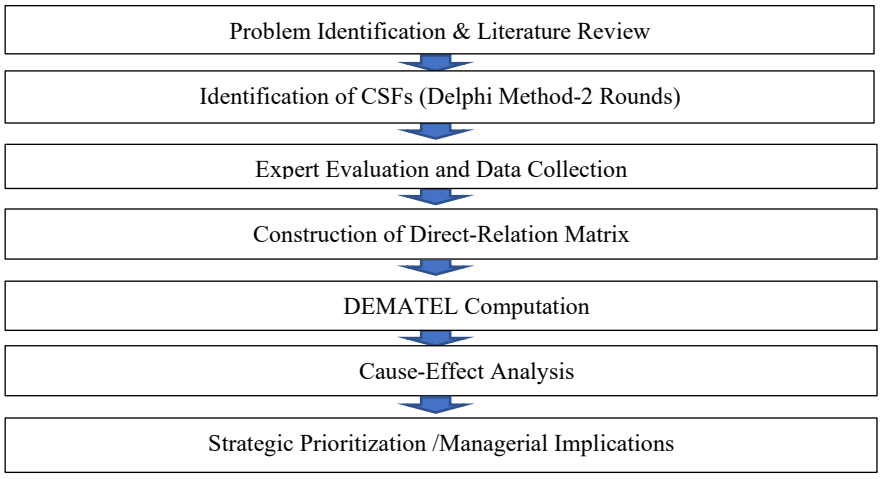

Fig. 1. Methodological process flow for identifying and analyzing critical success factors using the Delphi-DEMATEL approach.

4. Results

Based on the average scores derived from expert evaluations, the initial set of factors was assessed using predefined consensus criteria. As a result, 22 factors met the agreement threshold and were confirmed as critical success factors for this study. The finalized list of CSFs is summarized in Table 3.

Table 3
Final list of critical success factors

Code	Critical success factors	Code	Critical success factors	Code	Critical success factors
C1	Management Support	C9	Government Support	C17	Product Quality
C2	Management Competency	C10	Industry-Government	C18	Market Conditions
C3	Team Competency	C11	Infrastructure	C19	Price Appropriateness
C4	Team Composition	C12	Financing and taxation	C20	Service Quality
C5	Contractual Aspects	C13	Research and Technology	C21	Performance
C6	External Challenges	C14	Technological	C22	Safety
C7	Financial Factors	C15	Technological Reliability		
C8	Measurable Demand	C16	Customer Support		

To construct the initial direct-relation matrix for the 22 identified CSFs, assessments were obtained from a panel of 6 experts, comprising 2 representatives from government policy and 4 from the aircraft component supporting industry. The individual influence judgments were aggregated to generate a consolidated evaluation of interrelationships among the CSFs. The resulting average direct-relation matrix is reported in Table 4.

Table 4
Average direct-relation matrix of critical success factors

Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
C1	0.00	4.00	4.00	4.00	3.50	3.50	3.67	3.83	4.00	3.83	4.00	4.00	3.83	3.67	3.67	3.50	4.00	4.00	3.33	4.00	3.67	3.33
C2	4.00	0.00	4.00	3.83	3.83	3.33	4.00	4.00	3.50	3.17	3.83	3.00	3.50	2.67	4.00	3.50	3.17	3.50	3.50	3.17	2.50	2.50
C3	2.83	3.50	0.00	3.83	3.67	3.17	3.00	2.50	2.67	3.50	3.17	3.67	3.33	3.17	3.00	3.67	2.67	2.83	3.17	3.67	3.50	4.00
C4	3.33	3.67	3.67	0.00	2.83	2.67	3.50	3.67	3.50	3.17	3.17	2.17	3.00	2.83	2.67	3.50	4.00	2.33	2.50	4.00	3.50	3.67
C5	3.67	2.67	3.50	2.83	0.00	2.50	2.67	3.67	2.33	3.50	3.33	3.50	2.67	2.67	3.33	3.50	3.67	2.17	2.50	2.83	3.50	3.50
C6	2.67	3.33	3.33	3.50	3.33	0.00	3.17	3.00	3.17	3.67	3.50	3.17	3.67	3.33	3.67	3.67	3.67	3.67	3.50	3.67	2.83	2.50
C7	3.67	3.67	2.83	3.00	3.00	3.00	0.00	3.50	3.50	3.83	4.00	3.50	3.50	3.83	4.00	2.83	3.00	3.00	3.50	3.67	3.33	2.67
C8	3.67	3.17	2.83	3.00	3.50	3.33	3.00	0.00	3.50	2.83	3.50	3.17	2.67	2.83	3.00	2.83	2.67	3.50	3.50	2.50	2.33	2.17
C9	4.00	4.00	2.83	2.33	2.83	3.50	3.50	3.50	0.00	4.00	3.67	3.50	4.00	3.67	3.50	2.17	3.33	3.50	3.50	1.67	1.50	1.50
C10	3.00	2.83	2.83	3.00	2.67	3.17	3.00	2.83	3.50	0.00	3.17	3.33	3.00	3.00	2.50	3.00	2.33	3.17	3.17	1.83	1.83	1.83
C11	3.00	3.17	3.00	3.33	3.50	3.67	3.33	3.67	2.83	3.00	0.00	3.00	2.83	3.00	3.00	3.17	3.00	2.83	2.83	2.83	2.50	1.83
C12	2.67	3.17	3.17	3.17	3.50	3.50	3.50	3.17	3.67	3.17	3.50	0.00	3.50	3.00	2.67	2.33	1.83	3.67	3.50	1.33	1.33	1.33
C13	3.83	4.00	4.00	3.33	2.67	3.33	3.33	3.17	3.17	3.00	3.33	3.50	0.00	3.50	3.67	2.83	3.67	3.50	2.83	1.83	2.83	2.83
C14	3.50	3.33	3.83	3.50	3.00	2.83	3.00	2.00	3.17	2.33	1.00	3.67	3.50	0.00	3.67	3.83	3.67	2.83	3.83	3.83	4.00	3.67
C15	3.50	4.00	4.00	3.33	4.00	3.00	3.17	2.33	3.67	2.17	3.00	0.83	3.33	3.50	0.00	3.83	3.83	1.67	3.50	3.83	3.50	3.17
C16	3.67	3.00	2.67	2.83	3.00	3.00	2.67	2.83	2.00	2.33	3.00	3.00	1.83	2.83	2.83	0.00	2.67	3.50	3.67	2.67	3.67	3.50
C17	2.67	2.83	2.67	2.67	3.50	3.67	3.50	2.83	3.00	2.00	2.67	2.33	2.67	2.67	3.00	3.67	0.00	2.50	3.67	3.50	3.67	3.67
C18	3.67	4.00	3.83	3.00	2.50	3.33	3.00	2.67	2.83	3.67	3.67	3.50	2.33	3.67	3.83	3.33	1.83	0.00	3.83	1.67	1.67	1.67
C19	1.83	2.33	3.33	3.33	3.17	3.67	3.33	3.50	3.00	3.83	2.33	2.67	2.83	2.33	2.33	3.50	2.50	3.67	0.00	2.67	2.67	2.33
C20	1.83	2.50	2.67	3.50	4.00	2.83	2.17	3.50	2.00	1.67	2.50	2.17	1.50	2.67	2.17	3.83	3.50	1.83	3.50	0.00	3.50	3.50
C21	3.50	3.33	3.50	3.50	3.50	3.00	2.50	2.67	2.33	1.83	2.50	2.67	2.33	2.33	2.67	4.00	3.50	1.83	3.67	3.50	0.00	3.67
C22	2.33	2.33	2.33	2.33	2.33	2.33	2.67	3.67	2.50	2.33	2.33	2.67	2.33	2.33	2.67	4.00	4.00	1.83	3.83	3.67	3.33	0.00

Based on the initial direct-relation matrix, normalization was applied to obtain the normalized direct-relation matrix, as presented in Table 5. Subsequently, the total influence matrix was derived from the normalized matrix following the DEMATEL computational procedure. The resulting total influence values are reported in Table 6.

Table 5
Normalized direct-relation matrix

Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
C1	0.00	0.05	0.05	0.05	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.04	0.05	0.05	0.04
C2	0.06	0.00	0.05	0.05	0.05	0.04	0.05	0.05	0.04	0.04	0.05	0.04	0.04	0.03	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03
C3	0.04	0.05	0.00	0.05	0.05	0.04	0.04	0.03	0.03	0.04	0.04	0.05	0.04	0.04	0.04	0.05	0.03	0.04	0.04	0.05	0.04	0.05
C4	0.05	0.05	0.05	0.00	0.04	0.03	0.04	0.05	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.04	0.05	0.03	0.03	0.05	0.04	0.05
C5	0.05	0.04	0.05	0.04	0.00	0.03	0.03	0.05	0.03	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.05	0.03	0.03	0.04	0.04	0.04
C6	0.04	0.05	0.05	0.05	0.05	0.00	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.04	0.05	0.04	0.03
C7	0.05	0.05	0.04	0.04	0.04	0.04	0.00	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.04	0.03
C8	0.05	0.04	0.04	0.04	0.05	0.05	0.04	0.00	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.03	0.03
C9	0.06	0.06	0.04	0.03	0.04	0.05	0.05	0.05	0.00	0.05	0.05	0.04	0.05	0.05	0.04	0.03	0.04	0.04	0.04	0.02	0.02	0.02
C10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.00	0.04	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.04	0.02	0.02	0.02
C11	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.02
C12	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.05	0.04	0.05	0.00	0.04	0.04	0.03	0.03	0.02	0.05	0.04	0.02	0.02	0.02
C13	0.05	0.06	0.06	0.05	0.04	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.00	0.04	0.05	0.04	0.05	0.04	0.04	0.02	0.04	0.04
C14	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.04	0.03	0.01	0.05	0.05	0.00	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.05
C15	0.05	0.06	0.06	0.05	0.06	0.04	0.04	0.03	0.05	0.03	0.04	0.01	0.05	0.05	0.00	0.05	0.05	0.02	0.04	0.05	0.04	0.04
C16	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.00	0.03	0.04	0.05	0.03	0.05	0.04
C17	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.03	0.04	0.03	0.04	0.04	0.04	0.05	0.00	0.03	0.05	0.04	0.05	0.05
C18	0.05	0.06	0.05	0.04	0.04	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.03	0.00	0.05	0.02	0.02	0.02
C19	0.03	0.03	0.05	0.05	0.04	0.05	0.05	0.05	0.04	0.05	0.03	0.04	0.04	0.03	0.03	0.05	0.04	0.05	0.00	0.03	0.03	0.03
C20	0.03	0.04	0.04	0.05	0.06	0.04	0.03	0.05	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.05	0.05	0.03	0.05	0.00	0.04	0.04
C21	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.06	0.05	0.03	0.05	0.05	0.00	0.05
C22	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.06	0.06	0.03	0.05	0.05	0.05	0.00

Table 6
Total influence matrix

Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	Ri
C1	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	**0.35**
C2	0.02	0.00	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	**0.30**
C3	0.01	0.02	0.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	**0.27**
C4	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	**0.27**
C5	0.02	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.25**
C6	0.01	0.02	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	**0.29**
C7	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.30**
C8	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.25**
C9	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.00	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	**0.28**
C10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.22**
C11	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.26**
C12	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	**0.25**
C13	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.00	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	**0.31**
C14	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.02	0.00	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	**0.30**
C15	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.02	0.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01	**0.30**
C16	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	**0.25**
C17	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.01	0.01	0.01	**0.27**
C18	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.00	0.02	0.01	0.01	0.01	**0.29**
C19	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.00	0.01	0.01	0.01	**0.26**
C20	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.00	0.01	0.01	**0.23**
C21	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.00	0.01	**0.28**
C22	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.00	**0.24**
Ci	**0.32**	**0.33**	**0.33**	**0.31**	**0.31**	**0.30**	**0.29**	**0.29**	**0.27**	**0.26**	**0.27**	**0.25**	**0.24**	**0.25**	**0.27**	**0.30**	**0.27**	**0.22**	**0.29**	**0.23**	**0.22**	**0.20**	

To construct the two-dimensional cause–effect map, the coordinates of each factor were determined using the sum of influences ($D_i + R_i$) as the horizontal axis and the net influence ($D_i - R_i$) as the vertical axis. Factors with positive $D_i - R_i$ values are classified as cause factors, while those with negative values are categorized as effect factors. Based on these parameters, the calculated coordinates for all critical success factors are summarized in Table 7, which forms the basis for the cause–effect diagram.

Table 7
Coordinates and classification of critical success factors in the cause–effect diagram

CSF	Ri	Ci	Di + Ri	Di - Ri	Identity
C1	0.353	0.318	0.671	0.035	Cause
C2	0.303	0.333	0.636	-0.030	Effect
C3	0.270	0.330	0.600	-0.059	Effect
C4	0.268	0.310	0.577	-0.042	Effect
C5	0.248	0.313	0.561	-0.066	Effect
C6	0.293	0.297	0.590	-0.004	Effect
C7	0.303	0.287	0.591	0.016	Cause
C8	0.251	0.291	0.542	-0.039	Effect
C9	0.278	0.267	0.544	0.011	Cause
C10	0.224	0.256	0.479	-0.032	Effect
C11	0.259	0.271	0.530	-0.011	Effect
C12	0.246	0.252	0.498	-0.006	Effect
C13	0.306	0.242	0.548	0.065	Cause
C14	0.301	0.249	0.550	0.052	Cause
C15	0.302	0.265	0.568	0.037	Cause
C16	0.249	0.303	0.552	-0.054	Effect
C17	0.270	0.266	0.537	0.004	Cause
C18	0.285	0.225	0.510	0.061	Cause
C19	0.260	0.225	0.485	0.035	Cause
C20	0.231	0.232	0.463	-0.001	Effect
C21	0.276	0.219	0.495	0.058	Cause
C22	0.243	0.201	0.444	0.042	Cause

Based on the influence–relation mapping, the factors with positive values of (Di - Ri), namely, C1, C7, C9, C13, C14, C15, C17, C18, C19, C21, and C22, are positioned on the upper side of the causal axis, indicating that they act as net cause factors within the system. Conversely, the remaining factors (C2, C3, C4, C5, C6, C8, C10, C11, C12, C16, and C20) exhibit negative ($D_i - R_i$) values, placing them on the lower side of the axis as net effect factors, meaning they are more influenced by other elements of the system. The resulting cause–effect structure of the validated CSFs is illustrated in Fig. 2. Based on the DEMATEL results, a group of factors emerged as dominant causal drivers that exert substantial influence on the competitiveness of Indonesia's aircraft component supporting industry. These causal factors include C1 (Management Support), C7 (Financial Factors), C9 (Government Support), C13 (Research and Technology), C14 (Technological Infrastructure and availability), C15 (Technological Reliability), C17 (Product Quality), C18 (Market Conditions), C19 (Price Appropriateness), C21 (Performance), and C22 (Safety). As net cause variables, improvements in these areas are expected to generate cascading effects across the industrial system, reinforcing ecosystem resilience and enhancing sustainable competitiveness within global aerospace supply chains.

Accordingly, the findings offer practical guidance for policymakers and industry stakeholders in identifying strategic intervention priorities, effectively allocating resources, and designing capability development initiatives for the aircraft component supporting industry, particularly amid rising performance expectations and intensifying international competition.

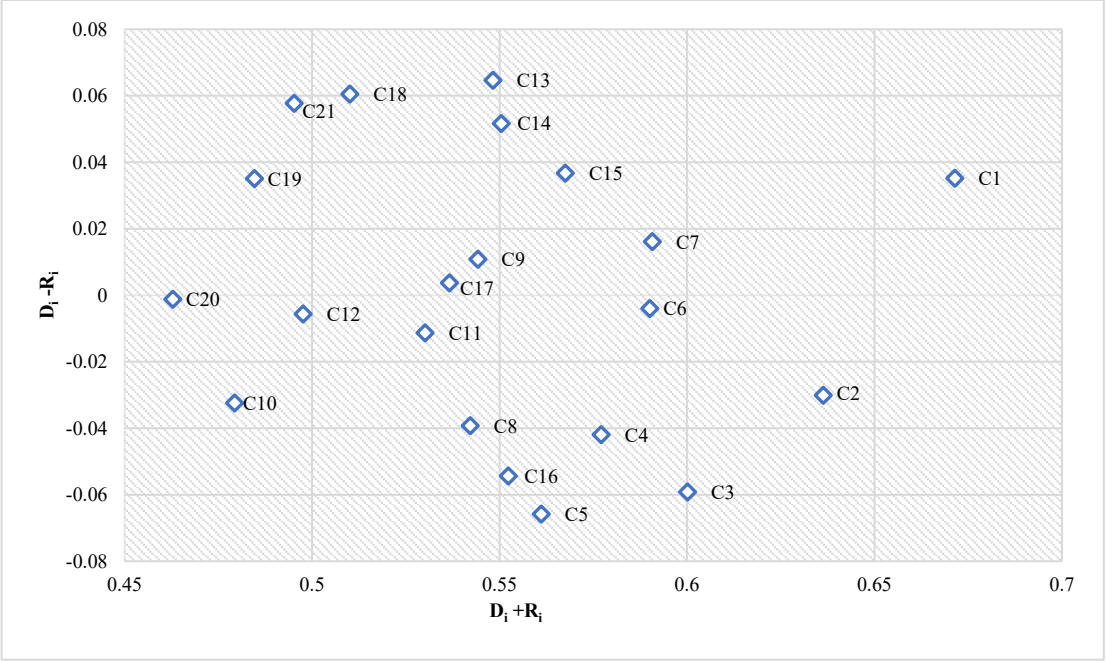

Fig. 2. Cause-effect map of the validated critical success factors.

5. Implications of the Study

5.1 Theoretical Implications

This study contributes to the decision science and industrial development literature by providing a structured causal analysis of critical success factors in the context of an emerging aerospace economy. Unlike prior studies that typically treat CSFs as independent determinants, the application of DEMATEL in this research reveals the directional interdependencies among 22 CSFs and distinguishes between causal drivers and dependent outcomes within Indonesia's aircraft component supporting industry.

The results demonstrate that only a subset of CSFs functions as net causal variables: C1 (Management Support), C7 (Financial Factors), C9 (Government Support), C13 (Research and Technology), C14 (Technological Infrastructure and availability), C15 (Technological Reliability), C17 (Product Quality), C18 (Market Conditions), C19 (Price Appropriateness), C21 (Performance), and C22 (Safety). These findings reinforce systems theory by confirming that industrial competitiveness emerges from a hierarchical structure in which upstream drivers exert disproportionate influence over downstream outcomes. Methodologically, this study strengthens the theoretical relevance of DEMATEL as an effective tool for uncovering causal structures in complex industrial ecosystems, particularly in technology-intensive sectors operating under stringent regulatory constraints.

5.2 Practical Implications

From a practical standpoint, the identified causal CSFs provide clear guidance for industry stakeholders in prioritizing capability development initiatives. Factors such as C13 (Research and Technology), C14 (Technological Infrastructure and availability), and C15 (Technological Reliability) highlight the central role of technological readiness in enabling sustainable participation in global aerospace supply chains. Strengthening these areas is expected to generate cascading improvements in dependent factors, such as team competence, contractual effectiveness, and industry-government coordination.

In addition, managerial and market-oriented drivers, namely C1 (Management Support), C18 (Market Conditions), C19 (Price Appropriateness), and C21 (Performance), underscore the importance of strategic leadership, cost competitiveness, and operational excellence. Firms seeking to advance from low-value participation toward higher-tier supplier roles can utilize the cause-effect hierarchy derived from this study as a strategic reference when allocating investments, designing capability enhancement programs, and evaluating partnership readiness with international Original Equipment Manufacturers (OEMs).

5.3 Policy Implications

The prominence of government and system-level drivers among causal CSFs emphasizes the critical role of public policy in shaping industrial competitiveness. Factors such as C9 (Government Support) and C22 (Safety) indicate that regulatory clarity, certification facilitation, and long-term policy stability are essential enablers for industry upgrading. Policymakers should therefore prioritize consistent regulatory frameworks, targeted fiscal incentives, and sustained investment in research infrastructure to reduce entry barriers for domestic suppliers.

Furthermore, the strong causal influence of financial and technological factors suggests that policy interventions should focus on improving access to financing, supporting technology acquisition, and fostering collaborative research platforms involving industry, universities, and national laboratories. By addressing these causal drivers, public policy can create a conducive environment that allows dependent capabilities, such as coordination mechanisms and workforce effectiveness, to develop organically, thereby strengthening Indonesia's aircraft component supporting industry in a sustainable and globally competitive manner.

5.4 Strategic Prioritization Pathway

Based on the DEMATEL results, the 22 critical success factors can be structured into a strategic prioritization pathway according to their causal strength, as indicated by the D_i-R_i values. This pathway provides a logical sequence for policy and managerial interventions aimed at strengthening Indonesia's aircraft component supporting industry.

The priority layer consists of **dominant causal drivers** with relatively high positive D_i-R_i values, indicating their strong influence on the overall system. These factors include C13 (Research and Technology), C18 (Market Conditions), C21 (Performance), C14 (Technological Infrastructure and availability), C22 (Safety), C15 (Technological Reliability), C1 (Management Support), C19 (Price Appropriateness), C7 (Financial Factors), C9 (Government Support), and C17 (Product Quality). Improvements in these areas are expected to generate cascading effects across the industrial ecosystem. In particular, technological readiness, financial robustness, regulatory support, and performance reliability emerge as foundational drivers that shape supplier capability development and global value chain integration.

The second priority layer comprises **supporting and transitional factors** with D_i-R_i values close to zero, including C20 (Service Quality), C6 (External Challenges), C12 (Financing and taxation facilities), and C11 (Infrastructure). These factors neither strongly drive nor significantly depend on other variables, but they function as enabling conditions that facilitate the effectiveness of the primary drivers. Strengthening this layer enhances institutional stability, resource accessibility, and operational continuity, thereby reinforcing the impact of first-layer interventions.

The third priority layer includes **dependent outcome factors** characterized by negative D_i-R_i values, such as C2 (Management Competency), C10 (Industry-Government Coordination), C8 (Measurable Demand), C4 (Team Composition), C16 (Customer Support), C3 (Team Competency), and C5 (Contractual Aspects). These factors are largely influenced by upstream improvements and should be treated as performance outcomes rather than initial intervention targets. Their development is expected to follow naturally once technological capability, financial support, regulatory clarity, and managerial commitment are adequately strengthened.

Overall, this strategic prioritization pathway suggests a sequential development logic: first, reinforcing core technological, financial, regulatory, and managerial drivers; then, strengthening institutional and infrastructural enablers; and finally, allowing organizational and market-related outcomes to mature. Such a structured approach offers a practical roadmap for policymakers and industry leaders to allocate resources effectively, avoid fragmented interventions, and support the sustainable upgrading of Indonesia's aircraft component supporting industry.

6. Discussion

The DEMATEL results reveal a clear cause-effect structure within Indonesia's aircraft component supporting industry, where a limited set of dominant factors acts as systemic drivers of competitiveness. The cause group primarily comprises management, financial, technological, market, and regulatory related factors, including management support (C1), financial factors (C7), government support (C9), research and technology (C13), technological infrastructure and availability (C14), technological reliability (C15), product quality (C17), market conditions (C18), price appropriateness (C19), performance (C21), and safety (C22). These factors exhibit positive D_i-R_i values, indicating that improvements in these areas generate cascading effects on dependent capabilities, such as coordination mechanisms, customer support, and service quality. The cause-effect map confirms that competitiveness in the supporting industry is not driven by isolated operational improvements but by strengthening upstream enablers that shape the overall industrial environment.

The findings also clarify the distinct roles of key actors within the ecosystem. Government institutions emerge as critical enablers through regulatory stability, safety oversight, and sustained support for research and technological infrastructure,

which reduce entry barriers for domestic suppliers. At the firm level, managerial commitment, financial readiness, and market-oriented performance are essential for translating policy and technological support into tangible industrial outcomes. Meanwhile, effect factors represent performance manifestations that will improve once the causal drivers are reinforced. This structure suggests that policymakers and industry leaders should prioritize interventions on causal factors rather than addressing symptoms at the operational level. By focusing on these leverage points, Indonesia's aircraft component supporting industry can strengthen its position within global aerospace supply chains and pursue sustainable competitiveness more effectively.

7. Conclusion

This study contributes to the literature by presenting a structured causal analysis of critical success factors influencing the development of Indonesia's aircraft component supporting industry through the DEMATEL approach. From a methodological perspective, the study demonstrates how causal relationships among success factors can be systematically identified to distinguish strategic driving factors from dependent outcomes. From a practical standpoint, the findings provide clear guidance for policymakers and industry leaders by highlighting key leverage areas, including management support, financial factors, government support, technological infrastructure, and performance, which play a pivotal role in enhancing industrial competitiveness and facilitating integration into global aerospace supply chains. As a next step, future research is planned to apply the analytical network process to prioritize these causal factors and support more detailed strategic decision-making.

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