APPLYING CFAHP TO EXPLORE THE KEY MODELS OF SEMICONDUCTOR PRE-SALES

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ABSTRACT

This study applies the Consistent Fuzzy Analytic Hierarchy Process (CFAHP) to enhance pre-sales decision-making in the semiconductor industry, addressing its complexity and uncertainty. A hierarchical model was developed with three key dimensions—market, competitive, and technological environments—and nine critical criteria. Based on expert evaluations from eight industry professionals, results indicate that the market environment holds the greatest influence, with customer needs identified as the top priority. Technology trends and risk assessment also emerged as significant factors. The proposed CFAHP model provides a practical and systematic tool to support strategic planning, resource allocation, and risk management in pre-sales processes.

KEYWORDS

Consistent Fuzzy AHP (CFAHP), Pre-sales Strategy, Semiconductor Industry, Multi-Criteria Decision Analysis (MCDA), Customer Needs, Technology Trends

1. INTRODUCTION

In recent years, the global semiconductor industry has encountered a multitude of challenges and opportunities, driven by rapid technological advancement, diversified application scenarios, and intensified international competition. The emergence of new domains such as artificial intelligence (AI), high-performance computing (HPC), automotive electronics, the Internet of Things (IoT), and green energy has imposed higher demands on chip design, manufacturing, and service models. To maintain technological leadership and market share in this evolving landscape, enterprises must strategically grasp customer needs and market dynamics during the pre-sales phase—before a product officially enters the market. Strategic analysis and resource allocation during this phase are essential to building trust and collaborative foundations with potential customers [1].

Traditionally considered a phase of product introduction and technical support, the pre-sales stage has evolved into a strategic process encompassing market research, demand shaping, value proposition development, and risk management. Effective pre-sales planning can improve customer satisfaction, accelerate product adoption, and enhance project success rates and customer lifetime value (CLV). Moreover, pre-sales activities can help firms identify market opportunities and potential threats early, serving as a basis for internal resource integration and technology planning. This enhances organizational agility and competitive resilience. However, under conditions of high technical barriers, market uncertainty, and rapid change, pre-sales decision-making often involves multi-dimensional, multi-level, and highly fuzzy evaluation elements. Traditional decision-making tools such as the Analytic Hierarchy Process (AHP) or

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expert intuition methods are prone to subjective bias and information asymmetry, leading to inadequate decision accuracy and poor consensus-building across teams. Thus, it becomes imperative for enterprises to adopt a decision-support tool that balances professional judgment, operational flexibility, and logical consistency [2][3].

To address these challenges, this study introduces the Consistent Fuzzy Analytic Hierarchy Process (CFAHP), which integrates the structural rigor of AHP with the flexibility of fuzzy logic and the consistency principle of fuzzy preference relations. This method helps reduce semantic ambiguity and logical inconsistency in expert assessments and supports the construction of a decision evaluation model tailored to the pre-sales stage of the semiconductor industry. The proposed framework incorporates three major dimensions—Market Environment, Competitive Environment, and Technological Environment—further decomposed into nine evaluation criteria. Expert questionnaires from industry professionals are employed for pairwise comparison and weight analysis, aiming to offer practical and actionable references for pre-sales decision-making, resource allocation, and strategic planning.

This research aims to assist semiconductor firms in identifying critical success factors at the early stages of project development, thereby enhancing the strategic foresight and operational adaptability of their pre-sales processes, and ultimately strengthening their overall competitiveness in the global market.

2. LITERATURE REVIEW

In order to construct a systematic and operational semiconductor pre-sales evaluation model, this study first reviews and summarizes relevant academic and industry literature, conducts in-depth discussions on the three major dimensions that affect pre-sales strategy planning - market environment, competitive environment, and technological environment - and extends to the nine core criteria under each dimension to provide a theoretical basis for research model construction and questionnaire design.

2.1. Market Environment

The market environment dimension focuses on the overall changes in the external market and customer behavior, and is the first step for companies to formulate product positioning and presales strategies [4][5], covering the following three key criteria.

2.1.1. Market Demand

Market demand represents the overall industry's willingness to purchase a certain type of product or technology and its expected growth potential. Understanding market demand trends helps companies adjust resource allocation and predict future revenue contributions. In the semiconductor field, changes in demand are often synchronized with terminal applications. If companies can accurately predict the demand expansion point, they will be able to enter the market earlier and improve their competitiveness.

2.1.2. Customer Needs

Compared with the overall market trend, the needs of individual customers are more detailed and project-oriented. The purchasing decisions of corporate customers include multiple aspects such as functional adaptation, technical support and after-sales service; therefore, the pre-sales team must have an in-depth understanding of the customer's product specification requirements, design process, implementation schedule and risk preferences to improve product fit and proposal hit rate.

2.1.3. Market Entry Strategy

When companies enter new markets, they must consider product introduction timing, segmentation choices, regulatory risks, and resource-bearing capacity. Market entry strategies can be divided into pre-entry analysis, model selection (such as licensing, joint ventures, direct investment) and localization adjustments. For semiconductor manufacturers, whether to prioritize winning lead customers or adopt a wait-and-see strategy to observe the maturity of standards are both key pre-sale decisions.

2.2. Competitive Environment

The competitive environment dimension focuses on the company's own positioning, value proposition and market response capabilities, reflecting its relative attractiveness in the minds of customers [6][7], covering the following three key criteria.

2.2.1. Competitive Advantage

According to the value chain theory, if a company can have differentiation capabilities in any aspect of technology, delivery time, service or quality, it can establish a sustainable competitive advantage. Dynamic capabilities are the key to maintaining the competitiveness of contemporary high-tech companies. Rapid customized design and instant technical support are important conditions for the success of semiconductor pre-sales.

2.2.2. Pricing Strategy

During the pre-sales evaluation stage, pricing strategy not only affects the profit structure, but also affects customers' perception and acceptance of product value. Value-Based Pricing in the enterprise customer market can better reflect the actual contribution of the product in the customer system than cost-based pricing. If semiconductor products can effectively quantify their value such as reducing power consumption and shortening development cycle, it will help increase bargaining space.

2.2.3. Value Proposition

The value proposition is the main tool for a company to convey its core value and product advantages, and is the core content of pre-sales briefings, proposals and bidding. The value proposition is "the sum of benefits that the company promises to deliver to customers" and should cover aspects such as technical capabilities, problem-solving solutions, and risk protection. For semiconductor companies, a clear and differentiated value proposition can effectively enhance customer trust and project success rate.

2.3.Technological Environment

The technological environment dimension reflects the industry innovation trend and project introduction risk, and is a key factor that cannot be ignored in the decision-making process of the high-tech industry [8][9]. It includes three criteria, which are described as follows.

2.3.1. Technology Trends

The semiconductor industry is undergoing technological changes at an extremely fast pace; the introduction of new processes, architectures, and materials often determines the product life cycle and competitive window. The acceptance and diffusion speed of innovation directly affect customer adoption willingness and corporate return on investment. If a company can grasp and communicate the potential of future technological development that can be supported in the presales stage, it will enhance its attractiveness as a strategic partner.

2.3.2. Risk and Opportunity Assessment

If there is no thorough evaluation during the pre-sales stage, the introduction of technology may easily lead to R&D failure, delivery delay or customer loss. Enterprises should analyze the risks of technology introduction and potential business opportunities in parallel, and use tools such as simulation scenarios and risk matrices to assist in decision-making. Especially at key nodes such as wafer processing and packaging modules, it is crucial to evaluate trial production risks and back-end compatibility.

2.3.3. Existing Technology Development

The company's current technology maturity, application experience and scalability are also important bases for pre-sales evaluation. The accumulation of technical capabilities and operational experience can significantly reduce project uncertainty and enhance customer adoption willingness and depth of cooperation. If the pre-sales team can clearly present existing technological achievements and existing customer success stories, it will help improve the persuasiveness of the project.

In summary, the formulation of pre-sales decisions needs to consider multiple factors such as market trends, customer needs, corporate competitiveness, and technological variables. Existing literature shows that these dimensions not only interact with each other, but also have fuzzy and subjective characteristics. Therefore, this study uses FAHP for hierarchical construction and weight evaluation as the theoretical basis for the subsequent decision-making model design.

3. RESEARCH METHODOLOGY

This section elaborates on the research design and methodology adopted in this study, including the research framework, introduction to the Consistent Fuzzy Analytic Hierarchy Process (CFAHP), questionnaire design, data collection, and analytical procedures to ensure logical consistency and methodological robustness in the weighting analysis.

3.1. Research Framework

The objective of this study is to construct an evaluative model for pre-sales decision-making in the semiconductor industry. The model is structured around three primary dimensions and nine criteria as follows:

(1)Market Environment (A):
A1. Market Demand
A2. Customer Needs
A3. Market Entry Strategy
(2)Competitive Environment (B):

B1. Competitive Advantage
B2. Pricing Strategy
B3. Value Proposition
(3)Technological Environment (C):
C1. Technology Trends
C2. Risk and Opportunity Assessment
C3. Existing Technology Development

These nine criteria form the hierarchical structure used in the subsequent CFAHP comparative analysis.

3.2. Overview of the Consistent Fuzzy Analytic Hierarchy Process (CFAHP)

3.2.1. Method Introduction

The Consistent Fuzzy Analytic Hierarchy Process (CFAHP) is an advanced hybrid decision making method that integrates the structural rigor of the traditional Analytic Hierarchy Process (AHP) with the flexibility of fuzzy logic and the consistency advantages of Consistent Fuzzy Preference Relations (CFPR). CFAHP effectively addresses the logical inconsistency issues often encountered in traditional AHP when dealing with large-scale criteria comparisons [10][11].

Unlike traditional AHP, which requires $\frac{n(n-1)}{2}$ pairwise comparisons, CFAHP reduces this to $n(n-1)$ comparisons through a mathematical transformation process. This reduction significantly decreases the respondent's burden and enhances the consistency and reliability of the input data (Chen & Lee, 2015).

3.2.2. Theoretical Principles

CFAHP constructs a fuzzy preference matrix P based on consistent principles. Given any two criteria a_i and a_j the preference value $P_{ij} \in [0,1]$ satisfies the following properties:

(1) Additive Reciprocity:

$$P\text{ij} + P\text{ji} = 1$$

(2) Additive Consistency:

$$P_{ij} + P_{jk} + P_{ki} = \frac{3}{2} \text{ for all } i, j, k$$

A normalization transformation function $f(x) = \frac{x+m}{1+2m}$ is used to convert any out-of-bound $,&- values into the standard interval.

3.2.3. Weight Computation Procedure

The CFAHP weighting process, adapted from Chen & Lee (2015), involves the following five steps:

(1) Questionnaire Design and Data Input

A 1–9 scale is adopted (e.g., “A is extremely more important than B” = 9; vice versa = 1/9) to need to n$(n-1)$comparison. Expert judgments are aggregated using geometric means.

(2) Construction of the Consistent Fuzzy Preference Matrix P

Linguistic scores are converted into fuzzy preference values P_{ij} to form the $n \times n$ matrix.

(3) Normalization and Matrix Transformation

Values outside the [0,1] range are normalized using a transformation function.

(4) Weight Calculation

The fuzzy preference matrix P' is transformed into a fuzzy pairwise comparison matrix A', and the weight for each criterion is computed by summing each row:

$$r_i = \sum_{j=1}^{n} a'_{ij}$$

$$w_i = \frac{r_i}{\sum_{i=1}^{n} r_i}$$

(5) Ranking and Consistency Check

If the additive consistency P_{ij} condition is met for all combinations, the data is considered consistent; otherwise, expert inputs are reviewed or revised.

3.2.4. Comparative Advantages of CFAHP

As shown in Table 1, CFAHP offers notable advantages over AHP and FAHP in terms of consistency, efficiency, and suitability for complex decision-making environments, making it particularly applicable for this study.

Table 1. Comparative Analysis of CFAHP Advantages

Item	AHP	FAHP	CFAHP
Number of Comparisons	n(n−1)/2	Same	n−1
Consistency Control	Yes	Moderate	Built-in Logical Consistency
Applicability	Few criteria	Moderate criteria	Many criteria with strict ordering needs
Respondent Burden	High	Moderate	Low

3.3. Questionnaire Design and Data Collection

3.3.1. Questionnaire Design Principles

The questionnaire was designed in accordance with the features of the CFAHP methodology, which requires only $n-1$ pairwise comparisons to construct a consistent preference matrix. Given the nine criteria in the proposed framework, only eight pairwise comparisons were required to complete a single valid questionnaire. This design significantly reduced the cognitive load on respondents and minimized potential input errors.

3.3.2. Expert Sampling Criteria

This study employed judgment sampling to recruit domain experts who possessed extensive experience in semiconductor industry practices such as pre-sales operations, product marketing, project evaluation, or technical implementation. The expert selection criteria were as follows:

(1) Currently or previously served as senior executives, strategists, product managers, client developers, systems engineers, application engineers, or technical sales representatives;
(2) Possessed over 20 years of experience in the semiconductor field;
(3) Had professional familiarity with technical implementation and pre-sales assessment, and were capable of making informed comparisons among criteria.

A total of eight valid questionnaires were distributed and collected. The expert profiles are summarized in Table 2, demonstrating compliance with the CFAHP requirement for multi-expert geometric mean aggregation, while ensuring both practical relevance and academic rigor.

Table 2. Expert Profiles

No.	Experience (Years)	Industry	Position
1	40	Semiconductor Equipment Agent	Chairman
2	35	Semiconductor Equipment Agent	Marketing Director
3	30	IC Design House	Vice President
4	30	Japanese Semiconductor Equipment	Vice President
5	25	Semiconductor Equipment Agent	CEO
6	25	Semiconductor Equipment Agent	CEO
7	25	Precision Processing	CEO
8	20	Korean Precision Equipment Company	Vice President

3.3.3. Data Aggregation and Consistency Validation

Although the CFAHP method inherently incorporates consistency validation through its design and does not require a traditional consistency ratio (CR) check, this study implemented additional measures to ensure data quality:

(1) Expert Opinion Aggregation: A geometric mean was applied to synthesize expert judgments for each pairwise comparison, generating a single representative preference matrix.
(2) Pre-Test and Review Mechanism: Prior to formal deployment, the questionnaire was reviewed by two senior industry executives and one academic professor to confirm clarity, semantic accuracy, and logical coherence.
(3) Outlier Treatment: If any respondent's input significantly deviated from the aggregated expert consensus, the data was verified with the respondent or excluded to ensure the robustness and internal consistency of the dataset.

In conclusion, this study adopted the Consistent Fuzzy Analytic Hierarchy Process (CFAHP) to effectively address the complex, multi-criteria, and linguistically ambiguous nature of pre-sales decision-making in the semiconductor sector. By combining the structural robustness of AHP with the linguistic flexibility of fuzzy logic and the logical consistency of CFPR, CFAHP significantly reduces the burden on experts while enhancing the accuracy and integrity of the resulting preference matrix.

To streamline data collection, the questionnaire was designed with only eight pairwise comparisons, leveraging the advantages of CFAHP. Respondents were selected based on their deep industry expertise (20+ years) and specialization in product, technical, or strategic domains, ensuring that the results reflect both practical insight and academic robustness.

4. RESEARCH ANALYSIS

This study applies the Consistent Fuzzy Analytic Hierarchy Process (CFAHP) to examine the critical factors influencing pre-sales decision-making in the semiconductor industry. By integrating fuzzy logic with hierarchical analysis, the CFAHP framework improves both the precision and adaptability of decision outcomes. The hierarchical structure consists of three dimensions and nine evaluation criteria. After collecting expert responses through structured questionnaires, global and local weights were computed (as shown in Table 3) and served as the basis for strategic recommendations.

Table 3. Results of CFAHP Weight Analysis

Dimension Code	Dimension Name	Global Weight	Criterion Code	Criterion Name	Local Weight	Overall Weight	Rank
A	Market Environment	0.4857	A1	Market Demand	0.1519	0.0738	6
			A2	Customer Needs	0.6789	0.3397	1
			A3	Market Entry Strategy	0.1692	0.0821	4
B	Competitive Environment	0.1933	B1	Competitive Advantage	0.273	0.0528	9
			B2	Pricing Strategy	0.4161	0.0804	5
			B3	Value Proposition	0.3109	0.0601	7

Dimension Code	Dimension Name	Global Weight	Criterion Code	Criterion Name	Local Weight	Overall Weight	Rank
C	Technological Environment	0.3209	C1	Technology Trends	0.4135	0.1327	2
			C2	Risk and Opportunity Assessment	0.3965	0.1272	3
			C3	Existing Technology Development	0.19	0.0610	8

4.1. Market Environment

The Market Environment dimension received the highest global weight of 0.4857, indicating that firms prioritize market dynamics and customer orientation during the pre-sales phase. Specifically, Customer Needs (A2) emerged as the most critical criterion with an overall weight of 0.3397, reflecting the semiconductor industry's reliance on rapid, accurate responses to customer-specific demands in order to gain market traction. Additionally, Market Entry Strategy (A3) with a weight of 0.0821 and Market Demand (A1) with 0.0738 further emphasize the necessity of forecasting market shifts and tailoring entry strategies to maintain competitiveness.

4.2. Technological Environment

The Technological Environment ranked second among the three dimensions with a global weight of 0.3209. Within this domain, Technology Trends (C1) was the second most important criterion overall, with a weight of 0.1327, underscoring the importance of continuous monitoring of innovations such as advanced packaging, AI-driven EDA, and EUV lithography. Similarly, Risk and Opportunity Assessment (C2) scored 0.1272, emphasizing the dual imperative of risk control and opportunity identification when shaping pre-sales technological strategies. While Existing Technology Development (C3) had relatively lower weight (0.0610), it remains an important supporting factor for demonstrating technological maturity and deployment readiness.

4.3. Competitive Environment

The Competitive Environment dimension received a lower global weight of 0.1933, yet its internal criteria hold significant strategic implications. Pricing Strategy (B2) had the highest weight within this group at 0.0804, signifying the need for price flexibility and responsiveness to market competition during the pre-sales phase. Value Proposition (B3) and Competitive Advantage (B1), with weights of 0.0601 and 0.0528 respectively, reflect the importance of clearly articulating product differentiation and core competencies to strengthen client engagement and win rates.

4.4. Strategic Implications

Based on the CFAHP results, this study proposes the following strategic recommendations to guide firms in optimizing their pre-sales approach:

(1) Prioritize customer needs discovery:
Establish data-driven customer feedback systems and AI-enabled predictive models to uncover pain points and anticipate design requirements.

(2) Monitor and align with technological trends:

Leverage patent landscape analysis, trend mapping, and participation in international tech forums to align product development with future industry trajectories.

(3) Develop integrated risk-opportunity management frameworks:
Adopt tools such as risk matrices and SWOT-based scenario planning to proactively address technical uncertainties and commercial opportunities.

(4) Adopt flexible market entry and pricing strategies:
Customize strategies based on application domains (e.g., automotive, AIoT, highperformance computing) and seek early partnerships with lead customers to enhance market penetration.

(5) Enhance value proposition clarity and competitiveness:
Refine messaging to emphasize problem-solving capacity, risk mitigation assurance, and quantifiable value; incorporate successful case studies and technical achievements to build credibility.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This study aims to construct a comprehensive evaluation model tailored for the pre-sales stage of the semiconductor industry. Utilizing the Consistent Fuzzy Analytic Hierarchy Process (CFAHP), the model integrates three primary dimensions — Market Environment, Competitive Environment, and Technological Environment — further decomposed into nine critical evaluation criteria. Expert judgments from seasoned professionals were collected and analyzed to determine relative weightings among the criteria.

The results reveal that the Market Environment has the most significant influence on pre-sales decision-making, with a global weight of 0.4857. Among its sub-criteria, Customer Needs stands out as the most crucial factor (overall weight 0.3397), indicating that in highly dynamic and competitive markets, firms must base their pre-sales strategies on a deep understanding of customer pain points and application scenarios to enhance proposal accuracy and design differentiation.

The second most important dimension is the Technological Environment (global weight 0.3209), where Technology Trends (0.1327) and Risk and Opportunity Assessment (0.1272) rank highly. These findings emphasize the necessity for companies to simultaneously track emerging technologies and incorporate risk control mechanisms at the early stages of engagement to maintain technological leadership and strategic foresight.

Although the Competitive Environment has a comparatively lower global weight (0.1933), its internal criteria — Pricing Strategy, Value Proposition, and Competitive Advantage — possess clear operational significance. These criteria function as essential supporting elements in pre-sales strategies, particularly in conveying differentiated value and responding to market dynamics.

Overall, the CFAHP-based model developed in this study not only identifies the key factors affecting pre-sales decision-making but also provides a practical reference for resource allocation, risk management, and strategic planning. The results offer both theoretical contributions and practical guidance to improve the systematicity and foresight of pre-sales operations in the semiconductor sector.

5.2. Recommendations

Based on the findings, this study offers the following practical and academic recommendations for the semiconductor industry and future research:

5.2.1. Managerial Recommendations

(1) Implement data-driven customer insights and forecasting systems
Firms should build integrated customer data platforms combining CRM, pre-sales visit records, and design requirement databases. AI-based forecasting models can be applied to analyze emerging demand trends, enhancing proposal accuracy and customization capabilities.

(2) Strengthen technology radar and foresight planning
Semiconductor firms are advised to actively participate in international technology conferences, academic symposia, and patent landscape analyses to establish a forwardlooking technology radar. This can guide R&D investments and reduce misjudgment risks.

(3) Establish risk-opportunity balanced evaluation processes
Incorporate tools such as SWOT cross-analysis, risk matrices, and scenario simulations into the pre-sales phase to visualize risks and design opportunity-oriented countermeasures. This enhances project success rates and organizational agility.

(4) Adopt flexible pricing and market entry strategies
Tailor pricing and market entry approaches based on specific application domains (e.g., automotive, AIoT, high-performance computing). Seek partnerships with lead customers during early product adoption phases to accelerate market diffusion and acceptance.

(5) Reinforce alignment between value propositions and competitive advantages Firms should articulate their value propositions around problem-solving capabilities, risk mitigation commitments, and quantifiable benefits. Integrating technical advantages and past success cases can enhance customer trust and collaboration intent.

5.2.2. Suggestions for Future Research

(1) Expand evaluation dimensions and criteria
While this study focuses on three dimensions and nine criteria, future research may consider incorporating additional factors such as regulatory environment, supply chain resilience, or ESG sustainability to enhance model comprehensiveness.

(2) Incorporate dynamic weighting and fuzzy temporal logic
Given the time-sensitive nature of pre-sales strategy, future studies could integrate fuzzy temporal logic or dynamic AHP to simulate strategic adjustments over time.

(3) Conduct cross-regional and cultural comparisons
Pre-sales strategies may vary across regions (e.g., Taiwan, the United States, Japan) due to differences in market maturity and business culture. Comparative studies across different geographies could further enrich the understanding of contextual influences.

REFERENCE

[1] J. Park et al., “Advancing Condition-Based Maintenance in the Semiconductor Industry: Innovations, Challenges and Future Directions for Predictive Maintenance,” *IEEE Trans. Semicond. Manufact.*, vol. 38, no. 1, pp. 96–105, 2025, doi: 10.1109/TSM.2025.3530964.

[2] S. Tian, M. Wang, L. Wu, A. Kumar, and K. H. Tan, “Sustainability diffusion in the Chinese semiconductor industry: A stakeholder salience perspective,” *Int. J. Prod. Econ.*, vol. 279, 2025, doi: 10.1016/j.ijpe.2024.109470.

[3] G. Chanana, N. Palia, and R. Sharma, “Energy Efficiency and Sustainability Initiatives in the Semiconductor Industry,” in *Proc. 2024 2nd Int. Conf. Advancements and Key Challenges in Green Energy and Computing (AKGEC)*, pp. 1–5, 2024, doi: 10.1109/AKGEC62572.2024.10868430.

[4] J. J. Kim, K. H. Kim, C. L. Lee, J. H. Park, and H. Chung, “The Impact of Technological Capability on Financial Performance in the Semiconductor Industry,” *Sustainability*, 2021, doi: 10.3390/su13020489.

[5] Y. H. Lee, “Supply chain model for the semiconductor industry of global market,” *Special Issue on the New Trends in System Integration: Progesses and Perspectives in Korea*, vol. 10, no. 3, pp. 189– 206, 2001.

[6] W. J. Henisz and J. T. Macher, “Firm- and Country-Level Trade-Offs and Contingencies in the Evaluation of Foreign Investment: The Semiconductor Industry, 1994-2002,” *Organ. Sci.*, vol. 15, no. 5, pp. 537–554, 2004, doi: 10.1287/orsc.1040.0091.

[7] R. Chaudhuri, B. Singh, A. K. Agrawal, S. Chatterjee, S. Gupta, and S. K. Mangla, “A TOE-DCV approach to green supply chain adoption for sustainable operations in the semiconductor industry,” *Int. J. Prod. Econ.*, vol. 275, 2024, doi: 10.1016/j.ijpe.2024.109327.

[8] S. A. Solucis, J. Sreenivasan, and K. L. J. Chong, “Competitive factors of semiconductor industry in Malaysia: the managers’ perspectives,” *Competitiveness Rev.: Int. Bus. J.*, vol. 16, no. 3/4, pp. 197– 211, 2006, doi: 10.1108/cr.2006.16.3_4.197.

[9] M. Bergh and S. Strugholz, *Artificial Intelligence: From Data to Insights: Artificial Intelligence in Digital Transformation Strategies in the Semiconductor Industry*. Linnaeus University, 2023.

[10] T.-K. Hsu and C.-Y. Kuo, “Using CFAHP and IPGA Method to Establish the Importance Criteria on the Haccp System for Hospital Kitchens in Taiwan,” *Int. J. Organ. Innov.*, vol. 17, no. 4, pp. 30–42, 2025.

[11] J.-J. Huang and C.-Y. Chen, “A Generalized Method for Deriving Steady-State Behavior of Consistent Fuzzy Priority for Interdependent Criteria,” *Mathematics*, vol. 12, no. 18, p. 2863, 2024, doi: 10.3390/math12182863.

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