

Article

Development of Strategies for Taiwan's Corrugated Box Precision Printing Machine Industry—An Implementation for SWOT and EDAS Methods

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Abstract: The small scale of Taiwan's domestic market due to its land area requires businesses in the corrugated box precision printing machine (CBPPM) industry to formulate developmental strategies to compete on the global market. This study uses the decision-making trial and evaluation laboratory-based analytic network process, an evaluation based on distance from the average solution, and Strengths–Weaknesses–Opportunities–Threats analysis to construct and evaluate a model for the Taiwanese CBPPM industry's developmental strategies. A hierarchy of five strategies with 16 criteria is established. The results indicate the most critical dimension is Strengths, followed by Threats, Weaknesses, and Opportunities, and that the optimal developmental strategy is a strategic alliance. The findings can provide the CBPPM industry with insights for developing developmental strategies.

Keywords: strategic alliances; corrugated box precision printing machine (CBPPM); Strengths–Weaknesses–Opportunities–Threats (SWOT); DEMATEL-based ANP (DANP); evaluation based on distance from average solution (EDAS)



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1. Introduction

In recent years, the global e-commerce market has developed rapidly. Whether it is the scale of online and TV shopping transactions or the demand in the global express delivery market, it is all explosive growth. Because in the distribution process of Internet and TV shopping (e-commerce), most of the products are packaged in corrugated boxes, the vigorous development of e-commerce is promoting the prosperity of the corrugated box industry. With the continuous and rapid development of the e-commerce market, as the main product of packaging, corrugated boxes will inevitably develop rapidly with the development of the packaging industry, thereby driving the rapid growth of the CBPPM industry.

Statista [1] predicted that the sales value of the global ecommerce market would reach USD 4.5 trillion in 2021, a 250% growth from USD 1.3 trillion in 2014. Smithers [2] indicated that the global coronavirus pandemic has profoundly disrupted the global printing industry, the total value of which fell from USD 814.7 billion in 2019 to an estimated USD 743.4 billion in 2020. In an era with advanced Internet and television shopping technology, consumer packaging has become a key part of people's daily living, and corrugated boxes are an essential packaging material in online shopping. This has contributed to a rapid increase in the demand for corrugated boxes worldwide, which has led to an increase in the requirements for the functionality of CBPPMs.

To gain a competitive advantage in the market, businesses must constantly increase their core competitiveness, formulate market strategies, expand their market share, and consolidate their customer base. Strengths–Weaknesses–Opportunities–Threats (SWOT) analysis helps companies, organizations, and governmental departments identify their strengths, weaknesses, opportunities, and threats, enabling them to effectively adjust their

positions and resource allocation, formulate appropriate development strategies in a scientifically justifiable manner, and understand the internal and external environment [3]. Researchers often use SWOT analysis to evaluate businesses and propose effective development strategies that can offer businesses a competitive advantage. SWOT analysis involves exploring key factors affecting a business' operations from the perspective of industrial competition and identifying its advantages, enabling the business to concentrate its resources on its strengths and opportunities for development and success. There are small and medium-sized enterprises (SMEs) in the CBPPM industry. The purpose of this research is to construct a new three-stage enterprise development strategy evaluation model, so that small and medium-sized enterprises can adopt the new enterprise development strategy evaluation model, aiming at the global sales market and developing into a well-known international large-scale enterprise. This study adopts SWOT as the dimension and integrates internal and external environment analysis as the basis of enterprise development strategy. Through industry analysis, with the help of scientific analysis models and methods, we can grasp the strengths of enterprises, reduce the weaknesses, seize the opportunities, and avoid the threats. After calculating the weight of the criteria by DANP (DEMATEL-based ANP) method, the best development strategy will be selected as a reference for formulating development strategy by adopting EDAS method.

Section 2 presents a review of literature and documents related to theories related to these topics. Section 3 introduces the development strategy selection model for the CBPPM industry, which was constructed using SWOT analysis, DANP, and EDAS. Section 4 presents the empirical results and discussion. Section 5 puts forward the study conclusions.

2. Materials

2.1. CBPPM Industry

Corrugated boxes are a type of paper packaging with features that make them suitable for packaging and printing, such as being lightweight, pressure resistant, impact reducing, shockproof, and easy to process. Because they are recyclable, reusable, economical, and lightweight, these boxes have been widely used in packaging. The earliest documentation of corrugated paper was in the United Kingdom in 1856; brothers Edward Healy and Edward Allen applied pressure to paper to create a wavy shape and used the paper as a hat lining to make it breathable and sweat absorbent. In 1871, American Albert Jones invented one-sided corrugated paper for packaging fragile objects, such as glass lampshades, which earned him the first US patent [4]. Since then, corrugated paper has become a commonly used, long-standing, rapidly developing packaging material.

In Taiwan, the CBPPM industry is relatively unpopular and closed, with 14 original brand manufacturers (OBMs). These OBMs do not interact and are not overseen by a trade union; they encounter each other only occasionally at exhibitions. Most CBPPM manufacturers are located in Europe, the United States, Taiwan, Japan, and China; Taiwan and Japan are leaders in terms of manufacturing technology and are largely responsible for high-end manufacturing. However, emerging countries, such as China, have experienced rapid economic development and an increase in the demand for CBPPMs. The global CBPPM manufacturing market will soon experience intense competition, concentrated demand, a stronger division of labor, and more specialization in the industry.

As society advances and consumption levels increase, requirements for product packaging have been elevated. The CBPPM industry must work toward high speed, high performance, low energy consumption, zero ink pollution, and computerized operations. The rapid growth of corrugated box production contributes to a high market demand and growth in the CBPPM industry.

2.2. SWOT

SWOT analysis is a tool for planning and managing organizational strategies; it can be used to effectively construct organizational and competitive strategies. According to the system approach, an organization is a collective whole consisting of various subsystems,

and its internal and external environments are interdependent. In response to the dynamics of the internal environment of an organization and the external competitive market, businesses must simplify complex problems to identify their advantages and concentrate resources on their strengths and potential to succeed and develop strategies for gaining a competitive advantage. This process of evaluating the internal and external environments is SWOT analysis [5].

SWOT analysis, introduced by Weihrich [6], is a qualitative analytical tool numerous businesses are familiar with and have commonly applied. SWOT analysis can be performed to identify opportunities and threats to a business in an industry, thus facilitating sustainable operations. Furthermore, only after a business has confirmed its advantages and disadvantages can it identify its own strengths and weaknesses and improve and utilize its capabilities and resources for growth. Lin [7] used SWOT analysis and the buyer utility map to analyze the marketing strategies of the packaging printing industry and to study how businesses in this industry determine their core competitiveness to identify market opportunities and maintain profitability. Shri et al. [8] performed SWOT analysis to develop strategies for the Indian corrugated paper industry and enhance their performance. Chen [9] used SWOT analysis to investigate how disruptive innovation by second movers in the automotive parts industry surprise their competitors and customers, enabling entry into the industry. Karyono and Agustina [10] identified the optimal strategy for implementing e-government through SWOT analysis. Haque [11] performed SWOT analysis to examine development strategies in the tourism industry and identified an action plan for the sustainable development of the Bangladeshi tourism industry that suited the local conditions. Through SWOT analysis, the Taiwanese machine tool controller industry promoted Industry 4.0, developed various methods to foster talent for the industry, and reinvented itself by using smart manufacturing to increase its competitiveness [12]. Muhammad Irfan et al. [13] performed SWOT analysis to develop a value chain model for the wind power industry in South Asia and to review the internal and external factors. They provided a reference for the stable, safe, and sustainable development of the wind power industry in South Asia by investigating the industry's position in a competitive environment and attempting to prevent potential energy crises. Zhang et al. [14] recommended that the UK electric vehicle battery industry diversify its supply chain through expansion to other regions, such as India, Africa, and the United States, to decrease its reliance on Chinese suppliers, maintain healthy relationships with suppliers, and continue innovating. Stoilova and Munier [15] employed SWOT analysis to evaluate the operational policy of Bulgarian Railways and provided stakeholders with simple, objective, and unbiased information regarding infrastructure reconstruction and the purchase of new train cars to facilitate decision making.

In all of these studies, SWOT analysis was performed to explore internal conditions and external environments in various industries. This study adopts SWOT analysis to explore the internal conditions of the CBPPM industry as well as opportunities and threats in the external environment and to position the industry in the market. Practical industrial development strategies are also proposed.

2.3. DANP

DEMATEL was proposed by the Battelle Memorial Institute in Geneva in 1972–1976 to plan scientific and human affairs. The method is mainly used to develop approaches to multicriteria decision making; understand complex, unique, and complicated problems; and propose feasible solutions through a hierarchical structure [16,17]. Saaty [18] proposed the ANP, a decision-making method adapted to an interdependent hierarchical structure. The ANP can be used to explore nonlinear and complex hierarchical relationships and to ensure the decision-making process accurately reflects real-world phenomena, unlike the analytic hierarchy process, thus resulting in high applicability. According to Yang et al. [19], the ANP assumes that each group of clusters has the same level of influence, although the level may differ among different groups. Therefore, they proposed DEMATEL-based

ANP (DANP), a method that combines DEMATEL with ANP, to solve this problem. DANP can be used to identify different levels of influence among dimensions and criteria and to determine their priority level on the basis of their weights, enabling the most critical dimensions and factors affecting the outcome to be identified.

Chou and Chao [20] employed DANP to establish and evaluate a technological innovation development strategy model for the Taiwanese uncrewed vehicle industry and provided government agencies with valuable insights into the promotion of technological innovation development in the industry through case studies on remote control cars and uncrewed aerial vehicles. In an era of global population aging, spinal conditions and degenerative joint conditions have become a major challenge for older adults. Huang et al. [21] used DANP to help venture capital companies acknowledge the need to invest in innovative products and equipment for the spine. They focused on three start-up companies that manufactured devices for vertebral compression fracture surgery and proposed an effective tool that ranked alternatives for investment projects. Hsu et al. [22] adopted DANP to help a parent company select representatives of the local culture for middle and top management positions in their overseas subsidiaries; according to an analysis by an expert panel, positive psychological capital, managerial competencies, integration, and professional competencies should be considered in the selection process. Balog et al. [23] employed DANP to evaluate intelligent wearable Internet-of-Things devices and determined the priority level of each dimension and criterion on the basis of which manufacturers can research and develop strategies to improve the quality of such devices. The tourism industry has struggled since the outbreak of the COVID-19 pandemic; to combat these challenges, the Taiwanese government has launched a training program for travel agencies. Liu and Liu [24] studied this training program and developed an evaluation model for the potential influence of COVID-19 on travel agencies upon resumption of normal operations. This study uses DANP to determine the level of importance of each dimension and criterion, ensuring that the outcome reflects the current situation of CBPPM businesses.

Kim et al. [25] used the DANP method to develop a three-stage complexity prioritization after investigating the reliability and feasibility options, and their case study validation results showed that consultant competency, uncertainty of scope, site compensation and permitting, stakeholder communication between parties, administrative procedures, and project deadlines are the most important criteria for the project. Marko et al. [26] used the DANP methodology and employed 50 experts in the field, developing a new model to consider the procurement of company vehicles from four perspectives: construction technology, financial, operational, and environmental aspects. A total of 13 relevant criteria are defined in the vehicle, and the relevant weights are obtained. The most important criteria for obtaining vehicle purchases are vehicle price, vehicle maintenance, vehicle sales price, and fuel/energy cost. Morteza et al. [27] used three dimensions of the DANP method, namely water quality, soil quality, infrastructure, and land use, and 21 criteria according to land suitability, to explore and investigate aquaculture options in Lorestan Province, Iran—a comprehensive approach to address. What is consumer cognition and evaluation of Corporate Social Responsibility (CSR) efforts? And whether the concentric circle model, pyramid model, intersecting circle model or a combination of aforementioned ones can be used to conduct research? Yen and Tsao [28] uses the cause-effect relation of DANP to identify and examine consumer cognition and evaluation of these CSR efforts through importance performance analysis (IPA).

2.4. EDAS

EDAS, an evaluation method proposed by Ghorabae et al. [29], can be used to determine the advantages of each alternative by calculating their positive and negative distances from the average solution. Once this distance is calculated, each alternative is comprehensively rated to determine their ranking. EDAS is used to solve multicriteria decision-making (MCDM) problems with a finite number of pieces of information. In EDAS, the first two criteria are presented as the positive distance from the average (PDA) and the

negative distance from the average (NDA); these two criteria can be used to determine the difference between an alternative solution and an average solution. A long PDA and short NDA indicate that the alternative outperforms the average solution and is thus optimal.

EDAS is a common method used in comprehensive decision-making models. A reason for its use in research is that it employs a type of normalization for the average solution of each criterion that other MCDM ranking methods do not. For example, Stanujkic et al. [30] proposed an extended version of EDAS involving interval gray numbers that account for uncertainty in the evaluation process in each step. Ghorabae et al. [29] further extended EDAS by using interval type-2 fuzzy set theory. Kahraman et al. [31] developed a decision-making tool based on fuzzy EDAS for waste management problems and used EDAS to evaluate waste treatment technologies. Kundakci [32] employed a decision-making tool combining attractiveness measured through a categorical evaluation technique and EDAS to evaluate alternatives to steam boiler technology. On the basis of fuzzy set theory, Zindani et al. [33] proposed an EDAS-based MCDM model to study material selection problems by comparing and ranking various materials. Torkayesh et al. [34] used a comprehensive decision-making model involving EDAS and entropy to select the optimal neighborhood for new residents of Istanbul, Turkey, by accounting for technical, environmental, and social factors. Naik et al. [35] investigated the effectiveness of marble powder and fly ash as partial replacements for cement in concrete mixtures and tested hardened concrete in terms of overall strength, splitting tensile strength, and flexural strength to determine the mechanical properties of the prepared concrete, minimize environmental pollution, and reduce construction costs. Rashid et al. [36] used EDAS to select optimal industrial robots for companies to combat fierce market competition on the basis of load capacity, repeatability, velocity, and degrees of freedom; the robots increased the productivity and profitability of the companies.

With the rapid development of 3D-printing technology, it is difficult for enterprises to select high-quality 3D printers for industrial production. Lei et al. [37] build and apply the EDAS method to the selection of high-quality 3D printers. The electric wheelchair (EPWC) is a vehicle to solve the problem of disabled people. Sahoo and Choudhury [38] use COPRAS and EDAS methods to evaluate and rank alternatives for selecting wheelchair models, respectively. For Naik et al. [39], the main purpose of the study is to conduct a prequalification evaluation of contractors in the construction industry and classify contractors by the EDAS method, so as to recognize the potential of contractors before competitive bidding. Finally, a prequalification evaluation procedure is developed to obtain the ranking of each contractor. Chairman et al. [40] utilized fiberglass-, epoxy-, and titanium-dioxide-filled composites, and the three different weight percentages are mixed with the polymer to form the mechanical- and abrasive-wear characteristics of the composite. In order to improve the wear resistance of the filled composite, the correct proportion of filler required by the resin is evaluated by the EDAS method, and multi-standard decision-making technology is applied to find the best filler content.

3. Methods

3.1. Establishment of the Developmental Strategy Selection Model

This study establishes a three-stage developmental strategy selection model for the CBPPM industry by combining SWOT, DANP, and EDAS. The first stage involves using SWOT analysis to construct a hierarchical structure for the CBPPM industry's developmental strategies. The second stage involves the use of DANP to calculate the weight of each criterion. In the third stage, EDAS is used to select the optimal solution. Figure 1 presents the procedure.

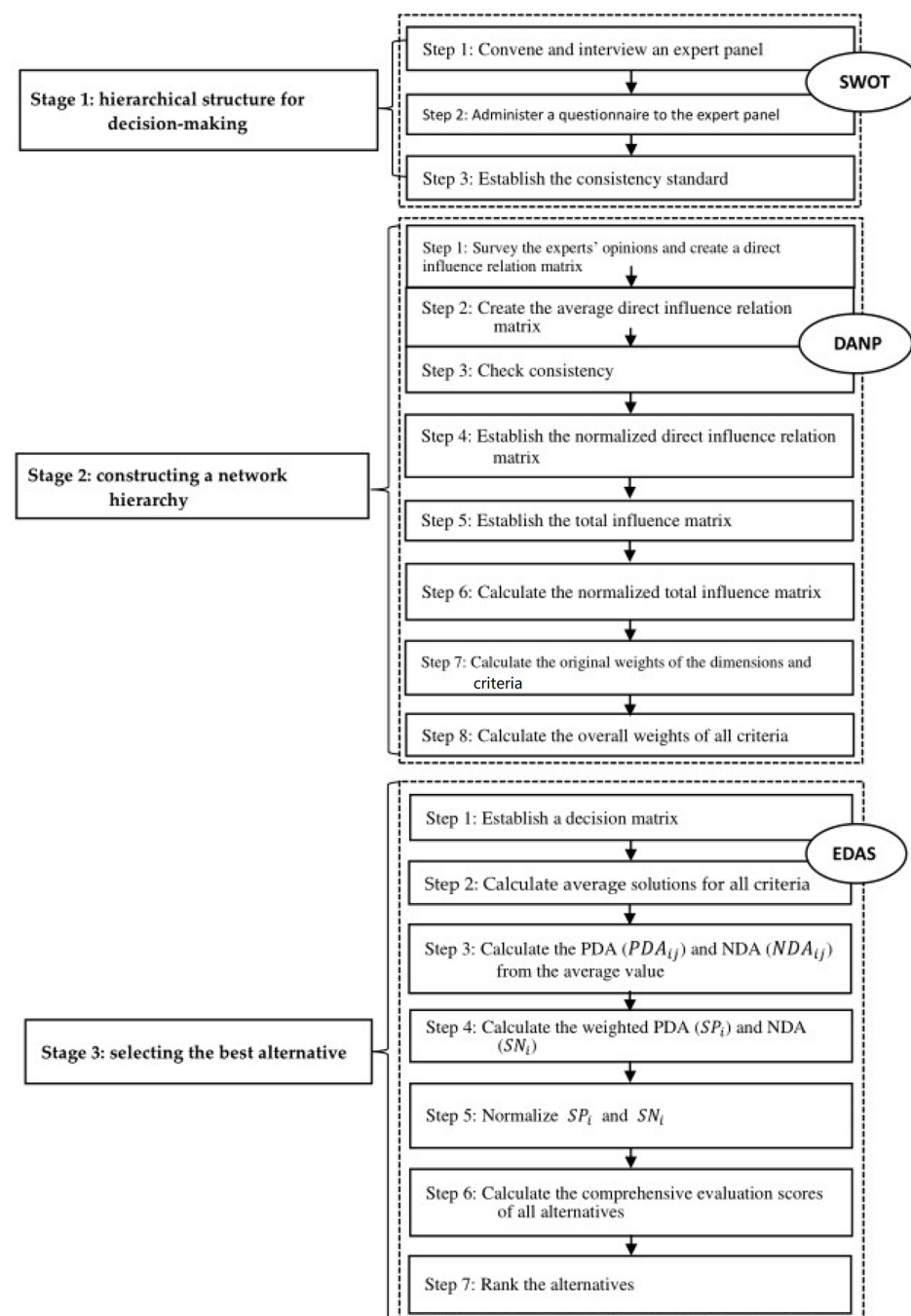


Figure 1. Three-stage developmental strategy model.

3.2. SWOT Analysis

The selection model constructed in this study comprises four levels. The first level consists of goals to be accomplished through the decision making; the second level comprises dimensions to be addressed through decision making presented in terms of Strengths–Weaknesses–Opportunities–Threats; the third level consists of the criteria in each dimension; and the fourth level consists of the alternative strategies.

Figure 2 depicts the hierarchical structure of the SWOT analysis [41,42]. In Stage 1, the lines represent the relationships in the hierarchical structure, and the symbols represent the relative weights of the relationships and the efficiency of each strategy for achieving the goals in the previous level of the hierarchy.

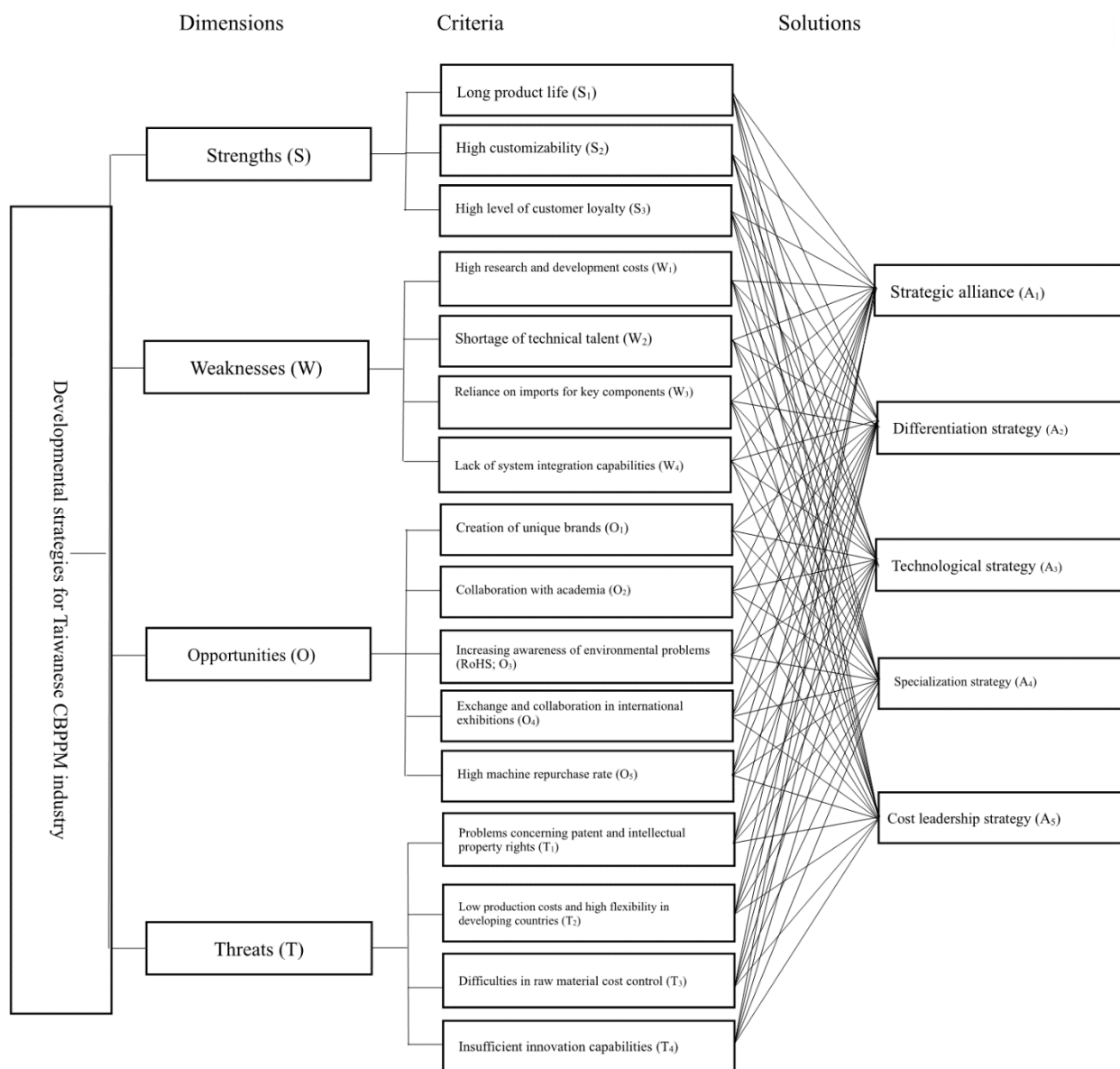


Figure 2. Hierarchical structure of CBPPM industry's developmental strategies.

3.3. DANP

Saaty [18] used ANP and assumed that each group of clusters had the same level of influence during the normalization of the supermatrices; this assumption ignores the fact that different groups of clusters may have different levels of influence [19]. Yang et al. (2008) proposed DANP to resolve this problem and obtained empirical results demonstrating the suitability of DANP for real-world problems. This study uses DANP, which comprises the following eight steps [16,17,43]:

3.3.1. Step 1: Establishing Expert Opinions and a Direct-Influence Relation Matrix

An expert questionnaire is used to obtain experts' ratings of the level of influence between indicators; these ratings are then averaged to construct a direct-influence relation matrix. The level of influence is assessed through the following rating scale: 0 = *negligible*, 1 = *minor*, 2 = *moderate*, 3 = *major*, and 4 = *severe*. If H experts and n factors are examined and a pairwise comparison of the factors is conducted, e_{ij} represents the effect of factor i on factor j . The score given by each expert is a non-negative $n \times n$ matrix, and $E^h = [e_{ij}^h]$ $1 \leq h \leq H$. $E^1, E^2, \dots, E^H$ represents the experts' response matrix, and each factor of E^h is

expressed as e_{ij}^h . The individual direct relation matrix E^h for each expert's $n \times n$ matrix can be calculated using Equation (1).

$$E^h = \begin{bmatrix} e_{11}^h & \cdots & e_{1j}^h & \cdots & e_{1n}^h \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ e_{i1}^h & \cdots & e_{ij}^h & \cdots & e_{in}^h \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ e_{n1}^h & \cdots & e_{nj}^h & \cdots & e_{nn}^h \end{bmatrix} \quad (1)$$

3.3.2. Step 2: Calculating the Average Direct-Influence Relation Matrix

Average direct-influence relation matrix $A = [a_{ij}]$, where $a_{ij} = \frac{1}{H} \sum_{h=1}^H e_{ij}^h$ and A denotes that a factor affects other factors and is affected by all the other factors, as expressed in Equation (2).

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{n1} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix} \quad (2)$$

3.3.3. Step 3: Checking Consistency

This step involves determining whether agreement exists among the experts' responses, and Equation (3) is used for the consistency check. If the consistency is lower than the significance level (which is usually $\alpha = 5\%$), a satisfactory level of consistency and consensus has been reached among the experts; otherwise, the experts are asked to provide responses again. Equation (3) is used to calculate the average difference (%) among the experts' responses, where n denotes the number of factors and H the number of experts.

$$\frac{1}{n(n-1)} \sum_{i=1}^n \sum_{j=1}^n \left(\left| a_{ij}^H - a_{ij}^{H-1} \right| / a_{ij}^H \right) \times 100\%, \quad (3)$$

3.3.4. Step 4: Establishing the Normalized Direct-Influence Relation Matrix

Average direct-influence relation matrix A , obtained in Step 2, is normalized to generate normalized direct-influence relation matrix D , as shown in Equations (4) and (5):

$$D = \tilde{s} \cdot A \quad 1, 2, \dots, n \quad (4)$$

where

$$\tilde{s} = \min_{i,j} \left[\frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}}, \frac{1}{\max_{1 \leq j \leq n} \sum_{i=1}^n a_{ij}} \right], \quad i, j = 1, 2, \dots, n \quad (5)$$

3.3.5. Step 5: Establishing the Total-Influence Relation Matrix

Indirect influence decreases as the number of times that D is multiplied by itself increases. Additionally, $\lim_{m \rightarrow \infty} D^m = [O]_{n \times n}$ and $\lim_{m \rightarrow \infty} (I + D + D^2 + \dots + D^m) = (I - D)^{-1}$, where I is an $n \times n$ unit matrix. Total influence matrix T is an $n \times n$ matrix $= [t_{ij}]_{n \times n}$, $D_i = \sum_{j=1}^n t_{ij}$, $S_j = \sum_{i=1}^n t_{ij}$, $i, j = 1, 2, \dots, n$, where

$$m \rightarrow \infty, \quad T = D(I - D)^{-1} \quad (6)$$

3.3.6. Step 6: Calculating the Normalized Total-Influence Relation Matrix

The normalized total-influence matrix (T_c^{nor}) is obtained using Equation (7). Subsequently, the normalized matrix is transposed to obtain the transpose of the total-influence matrix or unweighted supermatrix, W , as follows:

$$T_c^{nor} = [t_{ij}]_{n \times n} / D_i \quad (7)$$

$$W = (T_D^{nor})^T \quad (8)$$

3.3.7. Step 7: Calculating the Original Weights of the Dimensions and Criteria

As demonstrated in Equation (9), W is multiplied by itself α times until it converges to the long-term equilibrium value, through which the weight of each dimension and criterion is obtained.

$$\lim_{\alpha \rightarrow \infty} (W)^\alpha \quad (9)$$

3.3.8. Step 8: Calculating the Overall Weight of All Criteria

The original weight of each criterion (W_c^{local}) is multiplied by the original weight of the corresponding dimension (W_D^{local}) to obtain its overall weight (W_c^{global}), as illustrated in Equation (10).

$$W_c^{global} = W_c^{local} \times W_D^{local} \quad (10)$$

3.4. EDAS

Keshavarz et al. [44,45] proposed EDAS, which comprises the following seven steps:

3.4.1. Step 1: Establishing a Decision Matrix

Decision matrix X , with n alternatives and m criteria, is established as shown in Equation (11):

$$X = [X_{ij}]_{n \times m} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix} \quad (11)$$

where X_{ij} denotes the performance of the i th alternative to the j th criterion.

3.4.2. Step 2: Calculating the Average Solution of All Criteria

$$AV_j = \frac{\sum_{i=1}^n X_{ij}}{n} \quad (12)$$

3.4.3. Step 3: Calculating the PDA (PDA_{ij}) and NDA (NDA_{ij}) from the Average Value

$$PDA_{ij} = \frac{\max(0, (AV_j - X_{ij}))}{AV_j} \quad (13)$$

$$NDA_{ij} = \frac{\max(0, (X_{ij} - AV_j))}{AV_j} \quad (14)$$

3.4.4. Step 4: Calculating the Weighted PDA (SP_i) and NDA (SN_i)

$$SP_i = \sum_{j=1}^m w_j PDA_{ij} \quad (15)$$

$$SN_i = \sum_{j=1}^m w_j NDA_{ij} \quad (16)$$

3.4.5. Step 5: Normalizing SP_i and SN_i

$$NSP_i = \frac{SP_i}{\max_i (SP_i)} \quad (17)$$

$$NSN_i = 1 - \frac{SN_i}{\max_i (SN_i)} \quad (18)$$

3.4.6. Step 6: Calculating the Comprehensive Evaluation Scores (AS_i) of All Alternatives

$$AS_i = \frac{1}{2}(NSP_i + NSN_i), \quad (19)$$

where $0 \leq AS_i \leq 1$.

3.4.7. Step 7: Ranking the Alternatives

The alternatives are ranked by their comprehensive evaluation scores (AS_i) and calculated using Equation (19) to identify the optimal alternative.

This study defines and evaluates each SWOT dimension and variable on the basis of related theories and studies. The collected data are integrated into the research framework to design the questionnaire; DANP is used to calculate the weight of each dimension and criterion. Finally, EDAS is employed to analyze and select the optimal solution.

4. Results and Discussion

4.1. Using SWOT Analysis to Construct a Hierarchy of Developmental Strategies

According to Murry and Hammons [46], an expert panel should comprise more than 10 experts without exceeding a certain number. Therefore, this study recruited 14 senior managers in the CBPPM industry, averaging 21.3 years of work experience, for the expert panel. An interview lasting approximately 40 min was conducted with each of the managers. During the interviews, questions related to the four SWOT dimensions, the state of the industry, and successful and unsuccessful strategies their companies have used were posed. A total of 27 criteria and 12 developmental strategies were identified from the interview data (Tables 1 and 2).

Table 1. Statistical results of consistency of selection criteria.

	Selection Criteria	Importance	Quartile Range	Removed or Not Removed
Strength	Long product life	4.64	0.50	Not removed
	High customizability	4.73	0.50	Not removed
	Small industrial scale	3.91	0.00	Removed
	Difficult entry into the industry and few competitors	3.73	0.50	Removed
	Low substitutability	3.91	0.00	Removed
	High level of customer loyalty	4.55	0.50	Not removed
Weakness	Small industrial scale and weak research and development capabilities	3.82	0.50	Removed
	High research and development costs	4.64	0.50	Not removed
	Shortage of technical talent	4.73	0.50	Not removed
	Reliance on imports for key components	4.64	0.50	Not removed
	Difficulties in professional training of sales teams	3.82	0.50	Removed
	Lack of system integration capabilities	4.55	0.50	Not removed
	Unestablished specifications and standards for printing machines	3.91	0.00	Removed

Table 1. Cont.

	Selection Criteria	Importance	Quartile Range	Removed or Not Removed
Opportunities	Creation of a unique brand	4.55	0.50	Not removed
	Expansion of blue ocean market	3.82	0.50	Removed
	Collaboration with academia	4.64	0.50	Not removed
	Increasing awareness of environmental problems (Restrictions of Hazardous Substances Directive [RoHS])	4.55	0.50	Not removed
	Exchange and collaboration through international exhibitions	4.64	0.50	Not removed
	High machine repurchase rate	4.73	0.50	Not removed
	Disparities among businesses in the industry	3.73	0.50	Removed
	Emerging markets as potential markets	3.91	0.00	Removed
Threats	Problems concerning patent and intellectual property rights	4.64	0.50	Not removed
	Low production costs and high flexibility in developing countries	4.64	0.50	Not removed
	Few brand benefits	3.55	0.50	Removed
	Difficulties in raw material cost control	4.55	0.50	Not removed
	Insufficient innovation capabilities	4.55	0.50	Not removed
	Susceptibility to global economic trends and fluctuations in exchange rates	3.64	0.50	Removed

Table 2. Developmental strategy scores.

Criteria	Developmental Strategy	Importance	Quartile Range	Removed or Not
Strategy	Strategic alliance	4.73	0.50	Not removed
	Analysis strategy	3.64	0.50	Removed
	Differentiation strategy	4.55	0.50	Not removed
	Diversification strategy	3.91	0.00	Removed
	Technology strategy	4.73	0.50	Not removed
	Specialization strategy	4.64	0.50	Not removed
	Product strategy	3.64	0.50	Removed
	BCG matrix	3.91	0.00	Removed
	Cost leadership strategy	4.73	0.50	Not removed
	Competitive strategy	3.73	0.50	Removed
	Co-opetition strategy	3.64	0.50	Removed
	Innovation strategy	3.55	0.50	Removed

The interview content was compiled to produce a SWOT questionnaire, the items of which are rated on a five-point Likert scale (from 1 = *strongly disagree* to 5 = *strongly agree*). Questionnaires were mailed to the 14 experts, and 14 valid responses were returned, yielding a valid response rate of 100%. The interquartile range method proposed by Faherty [47] and Holden and Wedman [48] was used to exclude items with an interquartile range of less than or equal to 0.50 and a Likert scale rating of less than four points, which indicates a satisfactory level of consistency in the expert panel. After irrelevant items were excluded, 16 criteria and five developmental strategies remained (Tables 1 and 2). The criteria and strategies were used to construct a new hierarchy for the CBPPM industry's developmental strategies (Figure 2).

4.2. DANP Analysis

First, a questionnaire was administered to 14 experts to obtain their ratings for the direct-influence relationships between the dimensions and criteria, which were used to establish the relation matrix on the direct influence between the dimensions and criteria according to expert h (E^h). The average relation matrix of the expert panel on the direct influence between the dimensions and criteria was then calculated (Table 3).

Table 3. Average direct-influence relation matrix *A* of dimensions and criteria.

Dimensions	S	W	O	T	
S	0.000	2.571	2.000	1.429	
W	3.857	0.000	1.571	1.714	
O	3.714	2.571	0.000	3.714	
T	3.571	1.000	2.000	0.000	
Strengths	S ₁	S ₂	S ₃		
S ₁	0.000	3.286	3.571		
S ₂	4.000	0.000	3.286		
S ₃	3.857	3.714	0.000		
Weaknesses	W ₁	W ₂	W ₃	W ₄	
W ₁	0.000	3.429	3.571	3.286	
W ₂	3.857	0.000	3.429	3.000	
W ₃	3.429	3.714	0.000	3.286	
W ₄	4.000	3.857	3.714	0.000	
Opportunities	O ₁	O ₂	O ₃	O ₄	O ₅
O ₁	0.000	2.857	3.714	3.857	3.143
O ₂	3.286	0.000	3.429	3.714	3.714
O ₃	3.714	3.286	0.000	3.857	3.286
O ₄	3.571	3.571	3.286	0.000	3.429
O ₅	3.429	3.571	3.571	3.286	0.000
Threats	T ₁	T ₂	T ₃	T ₄	
T ₁	0.000	3.714	3.286	3.714	
T ₂	3.857	0.000	3.429	3.429	
T ₃	3.429	3.143	0.000	4.000	
T ₄	3.571	3.571	3.857	0.000	

The questionnaire had a response rate of 100%. All of the responses were used in the consistency analysis, as expressed in Equation (3). The consistency threshold was 0.05, with a value less than 0.05 indicating consistency. The overall consistency was 0.004; the respective consistency was 0.006 for Strengths, 0.033 for Weaknesses, 0.032 for Opportunities, and 0.033 for Threats. All of the consistency values were below 0.05, suggesting satisfactory consistency.

Subsequently, Equations (4) and (5) were used to calculate that the overall $\tilde{s}$ was 0.1, and the $\tilde{s}$ of each dimension is as follows: 0.132 for Strengths, 0.086 for Weaknesses, 0.071 for Opportunities, and 0.091 for Threats. These values were used to establish the total influence matrix (Table 4).

Table 4. Total influence matrix *T* of dimensions and criteria.

SWOT	S	W	O	T
S	0.640	0.617	0.538	0.566
W	1.024	0.478	0.572	0.675
O	1.219	0.806	0.555	0.924
T	0.932	0.529	0.560	0.455
Strengths	S ₁	S ₂	S ₃	
S ₁	6.922	6.696	6.642	
S ₂	7.542	6.646	6.875	
S ₃	7.735	7.162	6.757	
Weakness	W ₁	W ₂	W ₃	W ₄
W ₁	2.667	2.843	2.800	2.574
W ₂	2.912	2.609	2.788	2.554
W ₃	2.923	2.885	2.591	2.598
W ₄	3.177	3.112	3.050	2.575

Table 4. Cont.

Opportunities	O ₁	O ₂	O ₃	O ₄	O ₅
O ₁	11.735	11.412	11.928	12.421	11.609
O ₂	12.323	11.627	12.315	12.829	12.026
O ₃	12.336	11.808	12.113	12.829	11.999
O ₄	12.135	11.636	12.108	12.413	11.817
O ₅	12.133	11.640	12.126	12.607	11.627
Threats	T ₁	T ₂	T ₃	T ₄	
T ₁	10.720	10.660	10.746	11.188	
T ₂	10.975	10.403	10.748	11.168	
T ₃	10.852	10.528	10.414	11.096	
T ₄	11.174	10.855	10.981	11.149	

Finally, Table 4 and Equations (7)–(10) were used to calculate the weights of each dimension and the overall weights of the criteria (Table 5).

Table 5. DANP weight analysis.

Dimensions	Original Weights	Rank	Criteria	Original Weights	Rank	Overall Weights	Rank
Strengths(S)	0.342	1	S ₁	0.352	1	0.120	1
			S ₂	0.326	2	0.111	2
			S ₃	0.322	3	0.110	3
Weakness(W)	0.220	3	W ₁	0.261	1	0.057	6–8
			W ₂	0.256	2	0.056	9
			W ₃	0.251	3	0.055	10
			W ₄	0.231	4	0.051	11
Opportunities(O)	0.205	4	O ₁	0.201	2–3	0.041	13–14
			O ₂	0.192	5	0.039	16
			O ₃	0.201	2–3	0.041	13–14
			O ₄	0.210	1	0.043	12
			O ₅	0.197	4	0.040	15
Threats(T)	0.233	2	T ₁	0.251	2	0.059	5
			T ₂	0.244	4	0.057	6–8
			T ₃	0.246	3	0.057	6–8
			T ₄	0.258	1	0.060	4

The weights were as follows: 0.342 for Strengths, 0.233 for Threats, 0.220 for Weaknesses, and 0.205 for Opportunities (Table 5). Strengths was the most critical dimension, followed by Threats, meaning that the CBPPM industry should emphasize these two factors. When developing strategies, the industry should emphasize their strengths, which are internal conditions, and avoid threats in the external environment. This is consistent with statements provided by the experts in the interviews. Long product life (S₁) in the Strengths dimension was the most critical factor (weight = 0.120) and thus should be continually developed and reinforced. Collaboration with academia (O₂) in the Opportunities dimension had the lowest importance (weight = 0.039), indicating that the industry should strengthen their strategic collaborations and customer relations.

4.3. EDAS

This study applied the overall weights of the criteria, as presented in the previous section, in EDAS to determine the optimal developmental strategy for the CBPPM industry.

First, Equation (12) was used to obtain the average solution AV_j of the criteria (Table 6).

Table 6. Average solutions of the criteria.

Criteria	A_1	A_2	A_3	A_4	A_5	AV_j
S_1	0.880	0.857	0.855	0.843	0.827	0.852
S_2	0.702	0.752	0.780	0.730	0.739	0.740
S_3	0.868	0.820	0.830	0.841	0.880	0.848
W_1	0.757	0.807	0.830	0.807	0.805	0.801
W_2	0.855	0.818	0.805	0.766	0.809	0.810
W_3	0.889	0.766	0.766	0.741	0.780	0.788
W_4	0.818	0.802	0.820	0.795	0.793	0.806
O_1	0.855	0.877	0.866	0.782	0.841	0.844
O_2	0.727	0.818	0.780	0.809	0.768	0.780
O_3	0.777	0.755	0.768	0.798	0.727	0.765
O_4	0.827	0.816	0.857	0.823	0.782	0.821
O_5	0.891	0.880	0.830	0.843	0.857	0.860
T_1	0.855	0.805	0.830	0.843	0.855	0.837
T_2	0.805	0.789	0.784	0.782	0.770	0.786
T_3	0.818	0.805	0.766	0.793	0.782	0.793
T_4	0.766	0.830	0.816	0.777	0.805	0.799

Next, Equations (13) and (14) were used to calculate the PDA (PDA_{ij}) and NDA (NDA_{ij}) from the averages (Table 7).

Table 7. PDA_{ij} and NDA_{ij} .

Criteria	PDA (PDA_{ij})					NDA (NDA_{ij})				
	A_1	A_2	A_3	A_4	A_5	A_1	A_2	A_3	A_4	A_5
S_1	0.135	0.067	0.062	0	0	0	0	0	0.082	0.129
S_2	0	0.087	0.173	0	0	0.172	0	0	0.086	0.059
S_3	0.117	0	0	0	0.156	0	0.141	0.112	0.071	0
W_1	0.196	0	0	0	0	0	0.070	0.146	0.067	0.064
W_2	0	0	0.069	0.198	0.004	0.195	0.073	0	0	0
W_3	0	0.123	0.126	0.204	0.027	0.363	0	0	0	0
W_4	0	0.061	0	0.079	0.055	0.082	0	0.090	0	0
O_1	0.080	0.154	0.117	0	0	0	0	0	0.248	0.057
O_2	0	0.165	0	0.137	0	0.216	0	0.052	0	0.087
O_3	0.089	0	0.060	0.155	0	0	0.085	0	0	0.174
O_4	0.078	0	0.168	0.057	0	0	0.073	0	0	0.179
O_5	0.151	0.113	0	0	0	0	0	0.151	0.105	0.058
T_1	0	0.149	0.025	0	0	0.100	0	0	0.066	0.100
T_2	0	0	0.018	0.066	0.102	0.111	0.062	0	0	0
T_3	0	0	0.088	0	0.083	0.127	0.086	0	0.051	0
T_4	(0.119)	0	0	0.118	0	0	0.142	0.104	0	0.071

Finally, Tables 5 and 7 as well as Equations (15)–(19) were employed to calculate the comprehensive evaluation score (AS_i) of the five alternatives (Table 8).

Table 8. Weighted sum of distances, their normalized values, and the appraisal scores.

Alternative	SP_i	SN_i	NSP_i	NSN_i	AS_i	Rank
A_1	0.182	0.342	0.666	0.964	0.815	1
A_2	0.230	0.183	0.843	0.517	0.680	3
A_3	0.226	0.164	0.829	0.462	0.645	4
A_4	0.253	0.194	0.929	0.547	0.738	2
A_5	0.107	0.245	0.391	0.690	0.541	5

In descending order of their comprehensive evaluation scores, the alternatives were as follows: strategic alliance (A_1 ; 0.815), specialization strategy (A_4 ; 0.738), differentiation strategy (A_2 ; 0.680), technological strategy (A_3 ; 0.645), and cost leadership strategy (A_5 ; 0.541) (Table 8). In other words, strategic alliance > specialization strategy > differentiation

strategy > technological strategy > cost leadership strategy. Therefore, business operators in the CBPPM industry should prioritize strategic alliances.

5. Conclusions and Suggestions

5.1. Conclusions

This study recruited a panel of 14 experts from the CBPPM industry and employed SWOT analysis to construct a hierarchy of the industry's developmental strategies. According to the results, 16 criteria and five developmental strategies were selected. The following order of importance for the SWOT dimensions was determined: Strengths (0.342), Threats (0.233), Weaknesses (0.220), and Opportunities (0.205).

DANP was used to calculate the weights of all criteria, and their importance, in descending order, is as follows: long product life (0.120), high customizability (0.111), high level of customer loyalty (0.110), insufficient innovation capabilities (0.060), problems concerning patent and intellectual property rights (0.059), high research and development costs (0.057), low production cost and high flexibility in developing countries (0.057), difficulties in raw material cost control (0.057), shortage of technical talent (0.056), reliance on imports for key components (0.055), lack of system integration capabilities (0.051), exchange and collaboration in international exhibitions (0.043), creation of unique brands (0.041), increasing awareness of environmental problems (RoHs; 0.041), high machine repurchase rate (0.040), and collaboration with academia (0.039). Accordingly, the three most important criteria all belonged to the Strengths dimension. The empirical results of this study are closer to practical application values than those of the existing studies.

After the EDAS research analysis, we found that the importance of the developmental strategies for the Taiwanese CBPPM industry, in descending order, is as follows: strategic alliance, specialization strategy, differentiation strategy, technological strategy, and cost leadership strategy. The empirical results of this study are consistent with the actual operational state of the industry.

This study combines SWOT analysis, DANP, and EDAS to construct a three-stage developmental strategy model for the CBPPM industry. The empirical results demonstrate that the model is practical, stable, and valuable for both academic and industrial use.

Strategic alliances are the optimal strategy for the CBPPM industry. A CBPPM consists of more than 20,000 components, and strategic alliances enable manufacturers to obtain high-quality components, secure competitive pricing, develop innovative technology, and provide a stable supply, thereby facilitating sustainable operations. The results of this study are consistent with those of Meng [49], Mamédo et al. [50], Huang and Lin [51], Tsai and Chen [52], and Liao and Wei [53].

5.2. Study Limitations

The main limitation of this study is that because the industry is relatively closed, the number of interviewees and the number of people who fill out the questionnaire is limited. In the future, the number of interviewed experts or experts from the field of the industry from abroad can be increased, and the opinions of more relevant experts can be widely accepted. The background should also cover the broad distribution of the relevant fields of the industry.

This study is aimed at the development strategy of the CBPPM industry. It does not include the front-end- and back-end-related products of the equipment as the study scope, such as the box rolling machine, box pasting machine, box folding machine, and box nailing machine, etc. Although this equipment is not necessary, for the equipment of peripheral commodities purchased by CBPPM, it is suggested that the follow-up study can include the expert opinions of front-end and back-end manufacturers, which can significantly improve the objectivity of decision making.

5.3. Recommendations for Follow-Up Study

The Taiwanese CBPPM industry is a relatively closed industry, but it is a hidden champion industry in Taiwan. Mutually beneficial relationships should be established between businesses in the industry so that businesses can encourage each other to grow and innovate through co-opetition and planned collaboration.

The CBPPMs discussed in this study are large machines consisting of composite materials, such as steel materials, programmable logic controllers, integrated circuits, motors, and monitors. To resolve the lack of talent with expertise in the materials used in the industry, the industry should collaborate with academia to develop talent cultivation plans and bridge the gap between the two domains. Ensuring a continuous supply of talent for the industry is the only method of securing its place in the industrial chain.

This study constructs the SWOT-dimension level of the CBPPM development strategy. In the future, other dimensions and criteria such as finance can be considered, which can be considered by subsequent researchers, or discussed from a cross-industry perspective or from the perspective of other suppliers, so as to make it more comprehensive and perfect.

There is no study on the CBPPM industry at present. This study is the first to explore the development strategy of the CBPPM industry. This study is the first to use the methods of Strengths–Weaknesses–Opportunities–Threats (SWOT), DANP, and EDAS to explore the CBPPM industry. Subsequent researchers can select models for other industrial development strategies in this three-stage process and provide a reference for companies to formulate development strategies.

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References

1. TransBiz. Available online: <https://transbiz.com.tw/amazon-alibaba-globalmarketstrategy/> (accessed on 1 February 2021).
2. What They Think. Available online: <https://whattheythink.com/articles/104174-how-will-print-industry-change-2021-beyond/> (accessed on 1 January 2021).
3. Weng, J.; Liu, T. Enterprise strategy analysis based on SWOT analysis, advances in social science. *Educ. Hum. Res.* **2018**, *199*, 274–277.
4. Wang, X.F. In the History of Corrugated Paper. Available online: <https://xueqiu.com/4787692535/159606473> (accessed on 1 September 2020).
5. Gürel, E.; Tat, M. SWOT analysis: A theoretical review SWOT. *J. Int. Soc. Res.* **2017**, *10*, 994–1004. [CrossRef]
6. Weihrich, H. The TOWS matrix—A tool for situational analysis. *Long Range Plan.* **1982**, *15*, 54–66. [CrossRef]
7. Lin, Y.T. *Investigating the Marketing Strategy of Packaging and Printing Industry from the Perspective of SWOT and Buyer Utility Matrix—The Case of a Company*; National University of Kaohsiung, Department of International Business Administration: Kaohsiung, Taiwan, 2018; Unpublished Paper.
8. Shri, C.; Gupta, M.; Agrawal, A. Strategy formulation for performance improvement of Indian corrugated industry: An application of SWOT analysis and QSPM matrix. *J. Appl. Packag. Res.* **2015**, *17*, 60–75.

9. Chen, C.H. *A Successful Business Model Based on SWOT-Scorecard Analysis: A Case Study of Jin Hong Sheng Industrial Company*; ASIA University, Department of Business Administration: Taichung, Taiwan, 2016; *Unpublished Paper*.
10. Karyono, O.; Agustina, K. Determining the priority strategy in the implementation of E-Government through SWOT analysis model. *Budapest Int. Res. Crit. Inst. J.* **2019**, *2*, 66–74. [[CrossRef](#)]
11. Sanaul, H. SWOT analysis and strategies to develop sustainable tourism in Bangladesh. *UTMS J. Econ.* **2017**, *8*, 159–167.
12. Chen, Z.M.; Huang, K.I.; Wang, K.L. *Research on the Competitive Strategy of Taiwan Machine Tool Industry Controller*; TungHai University, Department of Business Administration: Taichung, Taiwan, 2019; *Unpublished Paper*.
13. Irfan, M.; Hao, Y.; Panjwani, M.K.; Khan, D.; Chandio, A.A.; Li, H. Competitive assessment of South Asia's wind power industry: SWOT analysis and value chain combined model. *Energy Strat. Rev.* **2020**, *32*, 100540. [[CrossRef](#)]
14. Zhang, Y.; Rysiecki, L.; Gong, Y.; Shi, Q. A SWOT analysis of the UK EV battery supply chain. *Sustainability* **2020**, *12*, 9807. [[CrossRef](#)]
15. Stoilova, S.; Munier, N. Analysis of policies of railway operators using SWOT criteria and the SIMUS method: A case for the Bulgarian railway network. *Sustainability* **2021**, *13*, 6948. [[CrossRef](#)]
16. Fontela, E.; Gabus, A. (Eds.) *The DEMATEL Observer*; Battelle Institute, Geneva Research Center: Geneva, Switzerland, 1976.
17. Chang, S.S. *Fuzzy Multi-Criteria Decision Making for Evaluation Method*, 2nd ed.; Wu-Nan Book: Taipei, Taiwan, 2016.
18. Saaty, T.L. *Decision Making with Dependence and Feedback: The Analytic Network Process*, 1st ed.; RWS Publications: Pittsburgh, Pennsylvania, 1996.
19. Ou Yang, Y.P.; Shieh, H.M.; Tzeng, G.H. A novel hybrid MCDM model combined with DEMATEL and ANP with applications. *Int. J. Oper. Res.* **2008**, *5*, 160–168. Available online: https://scholar.google.com.tw/scholar?q=A+novel+hybrid+MCDM+model+combined+with+DEMATEL+and+ANP+with+applications&hl=zh-TW&as_sdt=0&as_vis=1&oi=scholar (accessed on 24 February 2022).
20. Chou, H.W.; Chao, C.H. *Development of Strategies for Taiwan's Unmanned Vehicle Industry—An Implementation for SWOT and DANP Methods*; National Central University, Department of Information Management: Taoyuan, Taiwan, 2019.
21. Huang, C.Y.; Hsieh, H.L.; Chen, H. Evaluating the investment projects of spinal medical device firms using the real option and DANP-mV based MCDM methods. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3335. [[CrossRef](#)] [[PubMed](#)]
22. Hsu, I.C.; Shih, Y.J.; Pai, F.Y. Applying the modified Delphi method and DANP to determine the critical selection criteria for local middle and top management in multinational enterprises. *Mathematics* **2020**, *8*, 1396. [[CrossRef](#)]
23. Balog, A.; Băjenaru, L.; Cristescu, I. Analyzing the factors affecting the quality of IoT-based smart wearable devices using the DANP method. *Stud. Inform. Control* **2019**, *28*, 431–442. [[CrossRef](#)]
24. Liu, C.H.; Liu, B. Using DANP-mV model to improve the paid training measures for travel agents amid the COVID-19 pandemic. *Mathematics* **2021**, *9*, 1924. [[CrossRef](#)]
25. Kim, S.Y.; Nguyen, M.V.; Dao, T.T.N. Prioritizing complexity using fuzzy DANP: Case study of international development projects. *Eng. Constr. Archit. Manag.* **2021**, *28*, 1114–1133. [[CrossRef](#)]
26. Stokic, M.; Vujanovic, D.; Sekulic, D. A New Comprehensive Approach for Efficient Road Vehicle Procurement Using Hybrid DANP-TOPSIS Method. *Sustainability* **2020**, *12*, 4044. [[CrossRef](#)]
27. Ghobadia, M.; Nasria, M.; Ahmadipari, M. Land suitability assessment (LSA) for aquaculture site selection via an integrated GIS-DANP multi-criteria method; a case study of Lorestan province, Iran. *Aquaculture* **2021**, *530*, 735776. [[CrossRef](#)]
28. Yen, G.F.; Tsao, H.C. Reexamining Consumers' Cognition and Evaluation of Corporate Social Responsibility via a DANP and IPA Method. *Sustainability* **2020**, *12*, 529. [[CrossRef](#)]
29. Ghorabae, M.K.; Amiri, M.; Zavadskas, E.K.; Turskis, Z. Multi-criteria group decision-making using an extended EDAS method with interval type-2 fuzzy sets. *Ekon. Manag.* **2017**, *20*, 48–68. [[CrossRef](#)]
30. Stanujkic, D.; Zavadskas, E.K.; Ghorabae, M.K.; Turskis, Z. An extension of the EDAS method based on the use of interval grey numbers. *Stud. Inform. Control* **2017**, *26*, 5–12. [[CrossRef](#)]
31. Kahraman, C.; Keshavarz Ghorabae, M.; Zavadskas, E.K.; Cevik Onar, S.; Yazdani, M.; Oztaysi, B. Intuitionistic fuzzy EDAS method: An application to solid waste disposal site selection. *J. Environ. Eng. Landsc. Manag.* **2017**, *25*, 1–12. [[CrossRef](#)]
32. Kundakci, N. An integrated method using MACBETH and EDAS methods for evaluating steam boiler alternatives. *J. Multi-Criteria Decis. Anal.* **2019**, *26*, 27–34. [[CrossRef](#)]
33. Zindani, D.; Maity, S.R.; Bhowmik, S. Fuzzy-EDAS (Evaluation based on distance from average solution) for material selection problems. In *Advances in Computational Methods in Manufacturing*; Zindani, D., Maity, S.R., Bhowmik, S., Eds.; Springer: Singapore, 2019; pp. 755–771.
34. Torkayesh, S.E.; Amiri, A.; Iranizad, A.; Torkayesh, A.E. Entropy based EDAS decision making model for neighborhood selection: A case study in Istanbul. *J. Ind. Eng. Decis. Mak.* **2020**, *1*, 1–11. [[CrossRef](#)]
35. Naik, B.; Paul, S.; Mishra, S.P.; Rout, S.P.; Barua, A.; Bagal, D.K. Performance analysis of M40 grade concrete by partial replacement of Portland Pozzolana cement with marble powder and fly ash using Taguchi-EDAS method. *J. Appl. Sci. Comput.* **2019**, *6*, 733. Available online: <https://www.researchgate.net/publication/333776237> (accessed on 24 February 2022).
36. Rashid, T.; Ali, A.; Chu, Y.M. Hybrid BW-EDAS MCDM methodology for optimal industrial robot selection. *PLoS ONE* **2021**, *16*, e0246738. [[CrossRef](#)] [[PubMed](#)]
37. Lei, F.; Wei, G.; Shen, W.; Guo, Y. PDHL-EDAS method for multiple attribute group decision making and its application to 3D printer selection. *Technol. Econ. Dev. Econ.* **2022**, *28*, 179–200. [[CrossRef](#)]

38. Sahoo, S.; Choudhury, B. Optimal selection of an electric power wheelchair using an integrated COPRAS and EDAS approach based on Entropy weighting technique. *Decis. Sci. Lett.* **2022**, *11*, 21–34. [[CrossRef](#)]
39. Naik, M.G.; Kishore, R.; Mousavi Dehmourdi, S.A. Modeling A Multi-Criteria Decision Support System for Prequalification Assessment of Construction Contractors Using CRITIC and EDAS Models. *Oper. Res. Eng. Sci. Theory Appl.* **2021**, *4*, 79–101. [[CrossRef](#)]
40. Chairman, C.A.; Ravichandran, M.; Mohanavel, V.; Sathish, T.; Rashedi, A.; Alarifi, I.M.; Badruddin, I.A.; Anqi, A.E.; Afzal, A. Mechanical and Abrasive Wear Performance of Titanium Di-Oxide Filled Woven Glass Fibre Reinforced Polymer Composites by Using Taguchi and EDAS Approach. *Materials* **2021**, *14*, 5257. [[CrossRef](#)]
41. Osuna, E.E.; Aranda, A. Combining SWOT and AHP Techniques for Strategic Planning. In Proceedings of the ISAHP 2007, Viña del Mar, Chile, 2–6 August 2007.
42. Şeker, Ş.; Özgürler, M. Analysis of the Turkish consumer electronics firm using SWOT-AHP method. *Procedia Soc. Behav. Sci.* **2012**, *58*, 1544–1554. [[CrossRef](#)]
43. Tsai, P.H.; Lin, G.Y.; Zheng, Y.L.; Chen, Y.C.; Chen, P.Z.; Su, Z.C. Exploring the effect of Starbucks' green marketing on consumers' purchase decisions from consumers' perspective. *J. Retail. Consum. Serv.* **2020**, *56*, 102162. [[CrossRef](#)]
44. Keshavarz-Ghorabae, M.; Zavadskas, E.K.; Olfat, L.; Turskis, Z. Multi-criteria inventory classification using a new method of Evaluation Based on Distance from Average Solution (EDAS). *Informatica* **2015**, *26*, 435–451. [[CrossRef](#)]
45. Keshavarz-Ghorabae, M.; Zavadskas, E.K.; Amiri, M.; Turskis, Z. Extended EDAS method for fuzzy multi-criteria decision-making: An application to supplier selection. *Int. J. Comput. Commun. Control* **2016**, *11*, 358–371. [[CrossRef](#)]
46. Murry, J.W.; Hommons, J.O. Delphi: A versatile methodology for conducting qualitative research. *Rev. High. Educ.* **1995**, *18*, 423–436. [[CrossRef](#)]
47. Faherty, V. Continuing social work education: Results of a Delphi survey. *J. Educ. Soc. Work* **1979**, *15*, 12–19. [[CrossRef](#)]
48. Holden, M.C.; Wedman, J.F. Future issues of computer-mediated communication: The results of a Delphi study. *Educ. Technol. Res. Dev.* **1993**, *41*, 5–24. [[CrossRef](#)]
49. Meng, X. The influence of Alliance innovation network structure upon enterprise innovation: A case study of China's energy-saving and environment-protection industry. *Int. J. Bus. Manag.* **2018**, *13*, 208–220. [[CrossRef](#)]
50. Mamédio, D.; Rocha, C.; Szczepanik, D.; Kato, H. Strategic alliances and dynamic capabilities: A systematic review. *J. Strategy Manag.* **2019**, *12*, 83–102. [[CrossRef](#)]
51. Huang, W.S.; Lin, C.C. *The Analysis of the Business Model of the Machinery Company in Taiwan—A Case Study of a Domestic Machinery Manufacturer*; Chaoyang University of Technology, Department of Business Administration: Taichung, Taiwan, 2020; Unpublished Paper.
52. Tsai, J.Y.; Chen, C.T. *Business Strategies of Taiwan's Commercial Vehicle Sales under the Internet of Vehicles—An Example from Company A*; Tamkang University, Department of International Business: New Taipei, Taiwan, 2020; Unpublished Paper.
53. Liao, G.J.; Wei, C.S. *A Case Study on the Business Model for Logistics Company: The Case of Jiajia Business Service Co., Ltd.*; Shu-Te University, Department of Management: Kaohsiung, Taiwan, 2020; Unpublished Paper.