Benchmarking-based Analytic Network Process Model for Strategic Management

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ABSTRACT. *Benchmarking theory involves treating the evaluation of gaps with benchmarks as the criterion for strategic planning and organizational learning to enhance corporate operational performance. However, benchmark performance evaluation is mostly based on public financial statements. The research concerning only financial indices may not reflect the complete picture. This study aims to adopt the Analytic Network Process (ANP) as a tool to construct a benchmark-based model, to effectively apply ANP in five stages (plan, search, observe, analyze and adapt), and to design a practical evaluation model for strategic management. The proposed model was applied by the case company to analyze the performance indices of successful operations for a select group of benchmark enterprises and to examine the current situation of the company. According to comparison of ANP evaluation, K_{jk} is calculated. It is the difference from benchmarks. This study further defines the categories of performance indicators: reinforcement and control performance indicators. Finally, proper strategies and resource distribution are established to effectively help organizations plan future operational and strategic management and to enhance corporate operational performance and competitiveness.*
Keywords: benchmarking, strategic management, performance evaluation.

1. **Introduction.** In the 21st century, as information, technology and operational environments change, enterprises are facing increasing challenges and competition. Strategic management is the key factor for enterprises to maintain competitiveness. In such changeable and severely competitive markets, establishing proper business direction and strategic management is complicated but important [1]. Among the tools of corporate operation planning, benchmarking is one of the most common methods adopted by enterprises [2].

By evaluating gaps between their current position and the best comparable model, firms learn at an organizational level and develop strategic plans to enhance corporate operational performance [3-5]. However, performance evaluation of selected benchmarks is based mostly on public financial statements and current operations. If enterprises are only concerned about financial performance, they may not easily learn the overall aspects of operations [6, 7]. The reason for this focus on financial performance, and the challenge with finding proper learning models in different industries, is that it is difficult to collect the necessary data on benchmark companies, as the data are often confidential [8]. Sometimes, two parties acquire important data by signing a contract. However, as firms have different performance indicators, they tend to only learn the superficial aspects of the other party, which does not foster effective organizational learning [9]. It is critical for firms to design practical and exhaustive performance evaluation models that measure the gaps between their performance and that of benchmark enterprises and that help them assess the effectiveness of organizational internal strategy execution. Accordingly, this study adopts ANP as an analytical tool to properly solve multi-objective, multi-criteria and multi-behavior decision-making problems [10] and to analyze key performance indicators of successful benchmark enterprises. Furthermore, this study examines the current situation of strategic management and resource distribution. This study aims to construct a benchmarking-based ANP model for strategic management as an important reference for future operations and strategic management of organizations.

2. **Literature Review.** For research purposes, this paper reviews the literature on benchmarking and ANP to identify the characteristics of both and find correlations for further application.

2.1. **Benchmarking.** The term benchmarking means that enterprises find the best enterprises as models in order to improve corporate efficiency and integrate internal business units [11, 12]. It is the practical measure to modestly admit that others operations are superior and to learn from others in order to catch up with or surpass them [1]. Benchmarking is generally categorized as follows: 1) internal benchmarking comparing to internal businesses; 2) competitive benchmarking comparing specific rivals or functions; 3) functional benchmarking comparing similar departments in a specific industry; 4) category benchmarking comparing functions or procedures of business units in different industries [13]. Benchmarking results in organizational breakthrough improvement as it helps organizations to advance the pace of prior, gradual improvements. By assessing the highest benchmarks and innovating on their own processes, organizations are encouraged to fulfill their operational potential [14]. Benchmarking is a process of practice, and it is based on five stages: plan, search, observe, analyze and adapt [1, 15]. The main steps of benchmarking are shown in Table 1: (1) Plan: select and record a benchmarking process and develop a performance evaluation process; (2) Search: search for and confirm benchmarking partners; (3) Observe: investigate and study the models selected to understand their operational process and success metrics; (4) Analyze: analyze and explore performance gaps to aid in the review and improvement process; (5) Adapt: select the best practices that are suitable for organizational reform. Noticeably, benchmarking is a continuous process [9]. The implication of this cycle is a reminder to enterprises that practice benchmarking that they should consistently pursue success. Only by following others and then appraising themselves can enterprises improve their business and become prominent. Table 1 Descriptions of benchmarking steps

2.2. **Benchmarking tools.** The main difference across benchmark studies is the selection of performance indicators and the methods of performance evaluation. Performance

TABLE 1. Descriptions of benchmarking steps

Steps	Descriptions
1. Plan	(1) According to organizational strategy, the benchmarking process is selected. (2) Benchmarking team is formed. (3) Understand and record the benchmarking process. (4) Performance evaluation on the quality, time and cost of the process to discover important success factors of the benchmarked organizations and to assess the effect of these factors on these organizations operations.
2. Search	(1) Design the standard for ideal benchmarking partners. (2) Search for potential benchmarking partners with superior performance. (3) Compare the candidates and select the best and most appropriate models. (4) Develop the connection with benchmarks and invite them to participate in a benchmarking study upon agreement.
3. Observe	(1) Performance levels: in comparison to the company, the partners performance is assessed. (2) Practice and method: possible methods to accomplish the performance level. (3) Enables: using both performance levels and practice and methods to accomplish the entire process.
4. Analyse	(1) Classify the information and data collected. (2) Perform quality control on information and data. (3) Normalize the data. (4) Confirm performance gaps. (5) Confirm causes of performance gaps.
5. Adapt	(1) Show the findings of analysis and identify information acquisition and actual participation. (2) Construct functional improvement goals, based on other improvement plans. (3) Establish specific improvement plan. (4) Implement the plan. (5) Control progress and adjustment of errors. (6) Prepare the report of case closure.

evaluation includes financial statement analysis, multivariate analysis, Analytic Network Process (ANP), Data Envelopment Analysis (DEA) and Grey Relation Analysis. DEA is the most common management model to establish business goals [16]. The aim of DEA is to achieve the maximum output through minimum investment and to help a company establish a leading position among its peers. If the company cannot be the market leader or top-ranked, they will try to find the gap they need to bridge in order to catch up with the industry leaders [17, 18]. The DEA limitations are as follows[19, 20]: (1) The input and output data should be measurable; (2) The decision-making units should be highly homogeneous, and formal data should be utilized; (3) The results obtained lead to relative efficiency instead of absolute efficiency; (4) DEA is extremely data-sensitive and easily influenced by extremes; (5) The number of decision-making units must be at least

twice that of both the output and input data; (6) Input and output should match basic requirements of linear planning.

Good evaluation criteria have two characteristics. First, each criterion is related to a success goal; second, evaluation criteria should form complete and controllable conditions, with important conditions not being neglected [21]. Corporate performance should not be evaluated simply based on financial data, as this approach may deprioritize the companys strategies for superior customer service. Non-financial indicators, such as quality, customer satisfaction, innovation and market share, in comparison to profits, are more likely to reflect economic conditions and the firms prospects. Increasingly more managers change corporate performance evaluation systems and include non-financial indicators to create and enhance their competitive strategies [6]. For instance, the Shipping Corporation of India applied AHP to construct a benchmarking framework for service quality and included seven criteria and 48 attributes, which served as reference to reinforce service quality [7]. To learn the potential areas for improvement, AHP was used to establish a benchmarking framework to assess the function, advantages, and disadvantages of products [5]. The importance of exhaustive evaluation of firms is obvious. The main framework of exhaustive evaluation in the present study includes: finance, customer, process and innovation [6]. As many criteria influence one another or are related to one another, this study adopts ANP, which can solve multi-criteria decision-making problems and consider feedback from interdependent data clusters, as the main analytical benchmarking tool.

2.3. **Analytic Network Process.** AHP (Analytic Hierarchy Process), proposed by Satty in 1980, is suitable for solving complicated problems. When multiple decisions are involved in multi-objective, multi-criteria and multi-behavior decision making, AHP provides a highly compatible framework. The basic assumption of AHP is that parts or clusters at different levels are independent. In fact, decision-making often cannot be driven by a hierarchy of decision-making criteria given the interdependent relationship of the criteria and the interdependent nature of other high and low-level factors. In addition, a practical model should be constructed based on feedback in clusters [22]. In 1996, Satty proposed ANP, which is applied to interdependent projects or decision-making criteria. ANP application is to set the prior weight values of the objectives and confirm the framework of relationships among objectives and criteria, as well as their interdependent hierarchical relationships. ANP is a non-linear structure, and an interdependent correlation exists among the decision factors. Moreover, ANP is an important tool for decision makers to select criteria and projects.

The main steps of ANP in decision-making analysis are shown below [22, 23].

(1) Construct problem structure. The overall structure of decision-making is established. According to the characteristics of the problem, the researcher confirms the goals, sub-criteria of decision-making, main criteria, criteria clusters, and the mutual effects among criteria. When a mutual effect exists, it means that outer-dependence of criteria also exists. When sub-criteria of criteria clusters influence one another, it is called inner-dependence.

(2) Pair comparison of decision-making criteria. The researcher will compare criteria in pairs. The comparison includes two parts: the pair comparison of criteria and the sub-criteria comparison in criteria clusters. Pair comparison of sub-criteria is divided into pair comparison of the same cluster and that of different clusters. The relative importance values are based on the 1-9 scale of Satty [10], as shown in Table 2. When the score is 1, an equal importance of the two elements is indicated; however, when the score is 9, the element (rank of matrix) is absolutely important in comparison to another element (field of matrix). In pair comparison, when the positions of two elements are the opposite,

their values can be substituted by the reciprocal: $a_{ij} = 1/a_{ij}$. In ANP, pair comparison provides a matrix framework and original priority vector to evaluate and compare the relative importance of the elements or the matrix. The formula is shown in Eq. (1):

$$A \times w = \lambda_{\max} \times w \tag{1}$$

where A is matrix of pair comparison, w is eigenvector, $\lambda_{\max}$ is maximum eigenvalue of A. Finally, according to each subjects questionnaire result, the reasonability of weight distribution is examined, and the C.R. (Consistency Ratio) is adopted as a criterion of judgment, as shown in Eq. (2). When the C.R. is lower than 0.1, the consistency is acceptable; otherwise, judgment matrices should be adjusted. Hence, the consistency of total level ranking of level can be satisfactory. The C.I.(Consistency Index) is a consistency indicator, and the R.I.(Random Inconsistency) is a randomness indicator.

$$C.R. = C.I./R.I. \tag{2}$$

Table 2. Description of evaluation and comparison scale of ANP

Interval scale	Corresponding nominal scale	Descriptions
1	Equally important	Parameter a and parameter b are equally important.
3	Slightly important	Slightly supported; parameter a is more important than parameter b; however, it is not decisive.
5	Relatively important	Supported by sufficient reasons and reasonable criteria: parameter a is more important than parameter b.
7	Extremely important	Supported by specific reasons: parameter a is more important than parameter b.
9	Absolutely important	Supported by high degree of certainty: parameter a is more important than parameter b.
2, 4, 6, 8	Medium degree of importance	When the adjacent scales should be compromised.

(3) Formation of super-matrix. Super-matrix is the method to effectively deal with criteria interdependence in the system; it consists of several sub-matrices, and each sub-matrix includes interaction among the elements of each cluster. Pair comparison is conducted on the interacting elements of other clusters. Weight values of each sub-matrix are eigen vectors calculated by pair comparison. A super-matrix is finally formed. ANP calculation includes three matrices: un-weighted super-matrix, weighted super-matrix and limit super-matrix. Un-weighted matrix means weight obtained by original pair comparison. Weighted matrix refers to weight of the same factor in un-weighted matrix multiplied by related cluster weight. Thus, the total of lines is 1 ($W_{weighted}$). Limited matrix refers to multiple power of multiplied weighted matrix until convergence. The limited value will be fixed and the weights ($W_{\lim}$) of performance indicators are obtained by Eq.(3).

$$W_{\lim} = \lim_{k \to \infty} (W_{weighted})^k \tag{3}$$

(4) Selections. Based on several super-matrix operations, the weights are the suggested ranking of the plans after matrix-processing. The plan with the highest value is the outcome of ANP, and this is the best plan for decision makers. Accordingly, when there are several plans regarding multi-objective, multi-criteria and multi-behavior decision making, ANP provides a highly compatible framework and ranking of plans for decision makers

[24, 25]. In addition, in performance evaluation systems, the importance of performance indicators is different. Some factors or indicators are critical for the success and competitive advantage of enterprises [26]. Hence, the relative importance of performance indicators is analyzed as the reference for strategy execution and resource distribution [27, 28]. Hence, by analysis of ANP, this study acquires current performance indicators of enterprises and relative importance of performance indicators in the benchmarks. This study analyzes the gap of the relative importance, and explores and content to serve as reference for future operational strategy of enterprises.

3. **Research Design.** For research purposes and literature review, when implementing benchmarking, enterprises must establish corresponding performance indicators and analyze the advantages of benchmark firms to find gaps and construct improvement measures. This study applies ANP to benchmarking data analysis to validate the importance of performance indicators. The process includes 5 steps, as shown below.

(1) Plan. Establish a professional team for the benchmarking process, and select a benchmarking process according to organizational vision. Analyze key success factors (performance indicators) of the organizations operations together with trends of the external environment, and evaluate the effect of these indicators on the organizations operational processes. In addition, these performance indicators are interdependent, and ANP should be used as an analytical tool.

(2) Search. Search for and confirm benchmarking partners, i.e., the organizations with better performance. This step compares all candidates and analyzes trends of industrial development as a reference for future organizational development.

(3) Observe. As the old adage says, To know one's own strength and the enemy's is the sure way to victory. There are two key points at this stage. The first step is to analyze the relative importance of performance indicators on benchmarking subjects, by ANP, to determine their operational process and success model. The second step is to analyze the execution of performance indicators of organizations, again by ANP, to define the organizations current situation. BW_{jk} is the eigen vector of sub-criteria of item k of criterion j in the ANP evaluation model of benchmark performance indicators. It refers to the relative importance of performance indicators. Likewise, W_{jk} is the eigen vector of the sub-criteria of item k of criterion j in ANP evaluation model of current execution of organizational performance indicators. W_{jk} represents the importance of performance indicators for case company.

(4) Analyze. Analysis of performance gaps is one of the key components of benchmarking. Exploration of gaps and the causes for these gaps can serve as a reference for reflection and improvement. This study suggests a general comparison of relative importance of performance indicators of both the benchmark companies and the organization, as shown in Eq. (4). K_{jk} is calculated. It is the gap of relative importance of performance indicators between the case company and benchmarks. This study defines the types of performance indicators, and finds the cause of overall low performance. Criteria of types of performance indicators are shown below. (a) When $K_{jk} \leq 1$, the indicator is a reinforcement performance indicator (RPI). Importance of the indicator to the case company is not as significant as benchmarks. It shows that the case company does not value the indicator and it can be the reason that its performance is inferior to benchmarks. It is necessary to further analyze it, find the real cause and properly improve it to have the most effective use by limited resources. (b) When $K_{jk} > 1$, the indicator is a control performance indicator (CPI). Importance of the indicator to the case company is higher than benchmarks. It shows that the case company pays too much attention on the indicator and Return on Investment is not as expected. It wastes the resources. It is necessary to

analyze the point from perspective of optimization and properly control it to result in the optimal resource distribution.

$$K_{jk} = {}^{W_{jk}}/_{BW_{jk}} \qquad (4)$$

(5) Adapt. Depending on the results of the analysis, different types of performance indicators can be defined. The case company can clearly recognize the situation between internal organization and benchmarks instead of blindly investing in all resources. For instance, reinforcement performance indicators show that the organization does not focus on these indicators. These types of indicators must properly reinforce themselves and invest in more resources. However, control performance indicators mean the organization invests too many resources on the related business and that there should be adjustment and control. Therefore, according to types of performance indicators, the organization constructs improvement objectives and plans, follows other improvement projects, effectively controls execution progress, and adjusts the error.

4. **Results and Discussion.** This section discusses the research findings by a case company.

4.1. **Research result and discussion.** The case company is a small-to-medium sized traditional manufacturer in Taiwan. It aims to improve operational performance by benchmarking to enhance corporate competitiveness. Implementation results of the case company are shown below.

4.1.1. *Plan.* First, the case company forms benchmarking project team (project team for short). The members include general manager, 4 department supervisors and 2 hired experts, with a total of 7 members. This study adopts ANP as the tool to evaluate relative importance of performance indicators. Hence, it can include several non-financial performance indicators to have effective total evaluation and planning. By literature review on successful corporate operation and vision of the case company, this study analyzes and generalizes important factors and 12 performance indicators, as shown in Figure 1, to be the important indicators to measure operational performance of the case company. Performance indicators are as follows: (1) finance; (2) customer; (3) process and (4) innovation. They include 1-1 cost management, 1-2 productivity, 1-3 financial incomes, 2-1 customer satisfaction, 2-2 market share, 2-3 customer complaint handling, 3-1 quality management, 3-2 supply chain management, 3-3 employee education, 4-1 product innovation, 4-2 process innovation and 4-3 sustainable operation. They are the indicators of ANP performance evaluation model of benchmarking of the case company.

4.1.2. *Search.* Project team selects 6 benchmarks which are highly similar to the case company upon the elements and perform better than the case company in some dimensions. Through benchmarking questionnaire survey, project team members treat 12 performance indicators as criteria and score 6 companies from 1 10. When the score is high, it means that the performance indicator of the company is more satisfying. This study analyzes the means of 12 indicators of benchmarks, as shown in Table 3. After the discussion of project team, top 3 companies A, C and B (Company A is 7.58, Company C is 7.34 and Company B is 7.01) are regarded as reference of benchmarking and analysis of industrial development trend. This study adopts ANP as tool to analyze operational performance of benchmarks in order to evaluate development of industry. Therefore, through characteristics of ANP, the number of benchmarks searched can be reduced. In addition, pairwise comparison of ANP can avoid the difficulty to acquire data of the benchmarks.
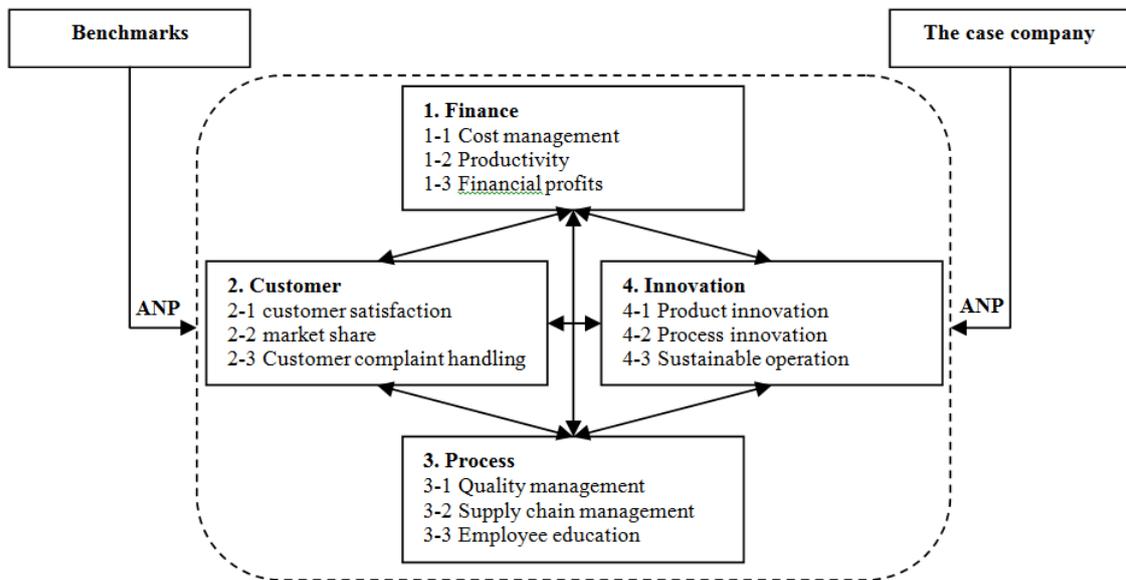
FIGURE 1. Correlation of ANP performance indicators of benchmarking

TABLE 3. Statistics of evaluation of benchmarks

construct	Performance Indicators	A	B	C	D	E	F
1. finance	1-1 cost management	7.73	3.61	7.67	9.78	7.45	4.32
	1-2 productivity	6.36	7.84	7.96	5.63	4.65	6.22
	1-3 financial incomes	5.30	6.16	6.35	9.83	4.89	8.32
2. customer	2-1 customer satisfaction	5.71	9.35	4.21	3.01	7.30	4.97
	2-2 market share	7.46	7.61	8.86	4.77	8.46	8.01
	2-3 customer complaint handling	7.20	9.98	6.45	9.45	7.39	4.11
3. process	3-1 quality management	8.47	5.18	7.06	5.14	6.87	4.86
	3-2 supply chain management	8.10	6.35	8.35	5.78	7.06	6.80
	3-3 employee education	9.08	6.59	8.91	3.75	8.10	7.32
4. innovation	4-1 product innovation	9.94	7.01	6.52	4.38	4.00	4.60
	4-2 process innovation	6.05	5.77	6.66	4.11	6.66	9.50
	4-3 sustainable operation	9.59	8.69	9.05	3.07	5.99	5.14
Average		7.58	7.01	7.34	5.73	6.57	6.18
Rank		1	3	2	6	4	5

4.1.3. *Observe.* It includes two parts. In Part 1, by ANP, this study analyzes the execution of the case company in 12 performance indicators in order to explore the current operation. Thus, it calculates W_{jk}. In Part 2, ANP analyzes the relative importance of 12 performance indicators of the benchmarks in order to find their successful operation model as reference for the case company to enhance operational performance. It calculates BW_{jk}.

(1) Calculation of W_{jk}, Based on 12 performance indicators, the project team evaluates current situation of the case company by ANP. According to the current operation, pairwise comparison is conducted on 12 performance indicators. Upon evaluation steps of ANP, as shown in 2.2, comparison matrix is constructed. Super Decision is used

to obtain super-matrix (un-weighted super-matrix, weighted super-matrix and limited super-matrix) of current operation of the case company. Evaluation result W_{jk} of relative importance of performance indicators of the case company is shown in Table 4. Regarding current operation of the case company, order of relative importance of performance indicators is as follows: 3-1 quality management (0.145), 4-1 product innovation (0.124), 2-1 customer satisfaction (0.114), 3-2 supply chain management (0.114), 3-3 employee education (0.098), 2-3 customer complaint handling (0.094), 4-3 sustainable operation (0.073), 1-2 productivity (0.062), 1-3 financial income (0.062), 2-2 market share (0.053), 4-2 process innovation (0.036) and 1-1 cost management (0.024). It shows that current operation of the case company is based on 3-1, 4-1, 2-1, 3-2 and 3-3, emphasizing the enhancement of performance of quality management, supply chain management and employee education. In addition, the performance of product innovation and customer satisfaction are highly valued. Hence, this paper gains an overview of the current operation and strategic execution of the case company and its resource distribution.

TABLE 4. Limited matrix of weights of performance indicators regarding current operation of the case company

construct		1. finance			2. customer			3. process			4. innovation			rank
	Performance Indicators	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	4-2	4-3	
1.	1-1 cost management	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	12
	1-2 productivity	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	8
	1-3 financial incomes	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	8
2.	2-1 customer satisfaction	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	3
	2-2 market share	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	10
	2-3 customer complaint handling	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	6
3.	3-1 quality management	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	1
	3-2 supply chain management	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	3
	3-3 employee education	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	5
4.	4-1 product innovation	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	2
	4-2 process innovation	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	11
	4-3 sustainable operation	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	7

(2) Calculation of BW_{jk}, ANP is conducted to analyze the relative importance of performance indicators in Benchmarks A, B and C to find their successful operational model. First, project team conducts pairwise comparison of operational models of Benchmarks A, B and C and 12 performance indicators. It follows evaluation steps of ANP, as shown in 2.2. Super Decision is used to obtain relative importance of performance indicators of 3 super-matrixes (un-weighted super-matrix, weighted super-matrix and limited super-matrix) in current operation of the benchmarks. BW_{jk} is shown in Table 5. Order of relative importance of performance indicators is 3-1 quality management (0.177), 4-1 product innovation (0.145), 2-1 customer satisfaction (0.137), 3-2 supply chain management (0.113), 2-3 customer complaint handling (0.089), 1-2 productivity (0.079), 3-3 employee education (0.061), 4-3 sustainable operation (0.054), 1-3 financial income (0.045), 2-2

market share (0.034), 1-1 cost management (0.033) and 4-2 process innovation (0.031). It shows that project team tends to suggest that successful factors of benchmarks are the emphasis of enhancement of 3-1, 4-1, 2-1, 3-2 and 2-3. They focus on quality management, actively involve in product innovation, and value customer satisfaction. In addition, they vertically integrate the feedback of suppliers and customers, and further enhance supply chain management and customer complaint handling. Therefore, management of the case company recognizes the key success factors of benchmarks, and all employees realize the trend of industrial development.

TABLE 5. Limited matrix of weights of performance indicators of operational model of benchmarks

construct		1. finance			2. customer			3. process			4. innovation			rank
	Performance Indicators	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	4-2	4-3	
1.	1-1 cost management	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	11
	1-2 productivity	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	6
	1-3 financial incomes	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	9
2.	2-1 customer satisfaction	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	0.137	3
	2-2 market share	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	10
	2-3 customer complaint handling	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	5
3.	3-1 quality management	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	1
	3-2 supply chain management	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	4
	3-3 employee education	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	7
4.	4-1 product innovation	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	2
	4-2 process innovation	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	12
	4-3 sustainable operation	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	8

4.1.4. *Analyze.* This study evaluates relative importance of performance indicators of benchmarks and the case company by ANP. BW_{jk} and W_{jk} are calculated and it conducts general comparison to find the gap. This study defines the types of performance indicators and the cause of the gap as reference for review and improvement of the case company. According to Eq. (4), K_{jk} is calculated. Analytical result is shown in Table 6.

TABLE 6. General analysis of performance indicators

NO.	Names of indicators	BW_{jk}	W_{jk}	K_{jk}	Types of indicators
1-1	Cost management	0.033	0.024	0.727	RPI
1-2	Productivity	0.079	0.062	0.785	RPI
1-3	Financial profits	0.045	0.062	1.378	CPI
2-1	Customer satisfaction	0.137	0.114	0.832	RPI
2-2	Market share	0.034	0.053	1.559	CPI
2-3	Customer complaint handling	0.089	0.094	1.056	CPI
3-1	Quality management	0.177	0.145	0.819	RPI
3-2	Supply chain management	0.113	0.114	1.009	CPI
3-3	Employee education	0.061	0.098	1.607	CPI
4-1	Product innovation	0.145	0.124	0.855	RPI
4-2	Process innovation	0.031	0.036	1.161	CPI
4-3	Sustainable operation	0.054	0.073	1.352	CPI

(a)$K_{jk} \leq 1$: RPI include 1-1 cost management (0.727), 1-2 productivity (0.785), 2-1 customer satisfaction (0.832), 3-1 quality management (0.819) and 4-1 product innovation (0.855). According to the study, in comparison to benchmarks, the 5 performance indicators are less important for the case company and they are treated as key performance indicators. It shows that importance of the 5 indicators to the case company is low and its total performance is inferior to benchmarks. According to further analysis, importance of Indicator 2-1, 3-1 and 4-1 to the case company is top 5 and similar to benchmarks. However, the weights are lower than benchmarks. Thus, the case company should reinforce innovation and RD of goods and pay attention to quality control in order to strengthen customer satisfaction. In addition, importance of Indicator 1-1 and 1-2 to the case company is not top 5 and it is similar to benchmarks. However, the weights are lower than benchmarks. Hence, the case company should actively reinforce cost management and productivity in order to use the limited resources the most effectively and demonstrate its characteristics.

(b)$K_{jk} > 1$: CPI include 1-3 financial incomes (1.378), 2-2 market share (1.559), 2-3 customer complaint handling (1.056), 3-2 supply chain management (1.009), 3-3 employee education (1.607), 4-2 process innovation (1.161) and 4-3 sustainable operation (1.352). Based on research, the levels of concern by the case company on the 7 performance indicators are all higher than the benchmarks. Compared to the benchmark company, the works of the case company on the 7 performance indicators have reached an acceptable level. From the perspective of optimization, the case company should establish work regulations and principles, conduct supervision and control, transfer the resources to the insufficient dimensions, and have the most effective use of limited resources. It is different from traditional benchmarking learning and performance evaluation, demonstrates the difference of importance cognition of performance indicators and resource investment between the case company and benchmarks. According to types of indicators, it establishes the related operational strategies instead of simply accepting and enhancing the business which lowers the effectiveness.

4.1.5. *Adapt.* According to analytical result, this study constructs feasible improvement and suggests the relative importance between benchmarks and the case company. By simply analyzing operational performance of benchmarks, BW_{jk} is obtained and they tend to make more subjective decisions. Using this case as an example, if only analytical result of operational performance of benchmarks is the criterion of decision making, subjective decisions are made to enhance 3-1, 4-1, 2-1, 3-2 and 2-3. This study integrates comparison of operational performance between benchmarks and the case company. K_{jk} is calculated to define the types of performance indicator. There are 5 reinforcement indicators, key performance indicators: 4-1, 2-1, 3-1, 1-2, and1-1 performance indicators. A comparison of the previous analytical results finds that the order of performance indicators is different, and 3-2 and 2-3 are even allocated as control indicators. As to the order of importance of BW_{jk}, 1-2 and 1-1 which are the sixth and eleventh are performance indicators which should be enhanced. In addition, interestingly, through definitions of types of indicators, we recognize the potential problems of the case company. As to finance, the case company does not value 1-1 cost management and 1-2 productivity (RPI); however, it emphasizes 1-3 financial incomes (CPI). Therefore, enhancement of cost management and productivity will increase financial incomes As to customers, the case company does not pay attention to 2-1 customer satisfaction(RPI); however, it emphasizes 2-2 market share and values 2-3 customer complaint handling (CPI). Thus, by active planning in advance and value of customer satisfaction, it will avoid customers complaints. It enhances market share. As to process, the case company does not pay attention to 3-1 quality management (RPI) and it emphasizes 3-2 supply chain management and 3-3 employee education (CPI). It is necessary to enhance quality control and carry out the concept in supply chain management and employee education instead of having remedial measure with manpower and materials on defectives. As to innovation, the case company does not pay attention to 4-1 product innovation (RPI) and it emphasizes 4-2 process innovation and 4-3 sustainable operation (CPI). Therefore, they must treat product innovation as the priority and actively develop product characteristics. Besides, upon the concept of sustainable operation, they establish the model of sustainable operation and new production process.

According to research findings, the case company must establish improvement strategy on cost management, productivity, customer satisfaction, quality management and product innovation, properly enhance them and invest in more resources to strengthen operational performance.

4.2. **ANP model of benchmarking.** This study treats benchmarking as the main framework, and adopts ANP as performance evaluation and analytical tool in benchmarking to develop ANP model of benchmarking, as shown in Figure 2.

At the planning stage, a benchmarking project team is established to deal with all business. By literature review on operational performance and vision of the case company, this study generalizes 12 key performance indicators as the criteria to measure operational performance of the case company, in order to have effective and complete evaluation and planning. Through searching, the project team looks for excellent companies with similar elements in order to select appropriate benchmarks to evaluate development of industry. At the stage of observation, this study analyzes benchmarking mainly by ANP to assess importance of performance indicators of the benchmarks (BW_{jk}) to recognize successful operational model of benchmarks. ANP is also conducted to analyze the importance of performance indicators for the case company (W_{jk}) to recognize current operation and resource distribution of the case company. As the stage of analysis, this study compares BW_{jk} and W_{jk}, calculates K_{jk} and defines types of performance indicators: (a) reinforcementt performance indicators, and (b) control performance indicators. Hence,
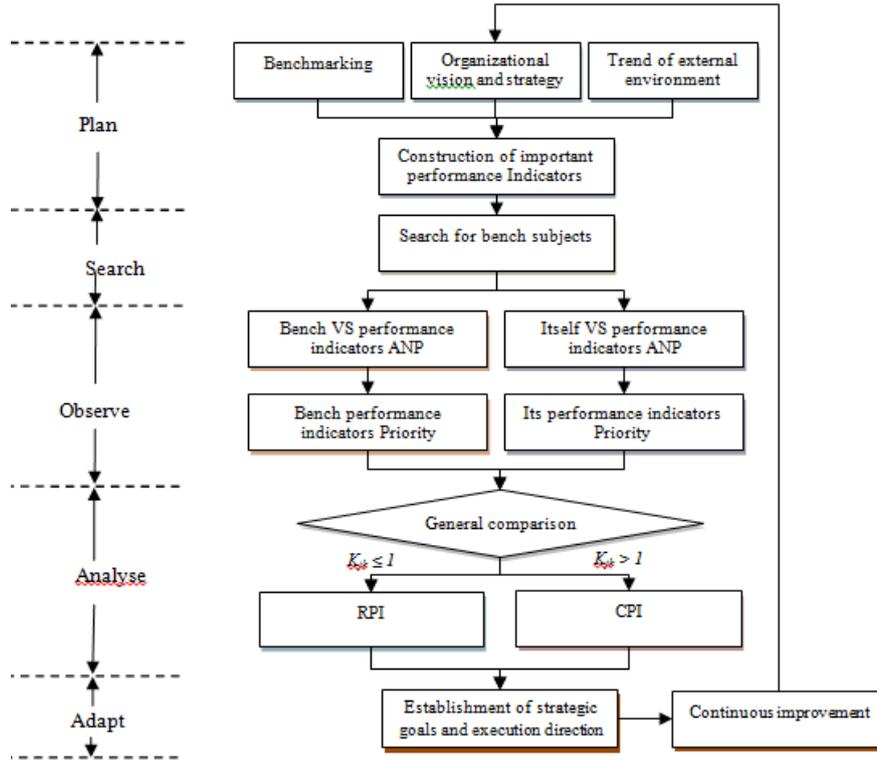
FIGURE 2. ANP model of benchmarking

it validates the causes of low performance as criteria of review and improvement. K_{jk} as decision-making criterion is more objective than BW_{jk} and it matches the need of the case company and helps reinforce improvement effectiveness of the case company. Finally, at the use stage, K_{jk} is treated as decision-making criterion, indicating the difference between organization and benchmarks. Therefore, the case company can effectively follow types of performance indicators, consider the related solution, set up improvement plan and goals and control execution and performance evaluation as critical criteria of continuous improvement.

5. **Conclusion.** In the early implementation of an organization, the expected effectiveness of management tools cannot be accomplished overnight. Due to limitations of structure and organizational qualities, benchmarking cannot completely overcome the shortage of organizations [8, 30]. This study treated ANP as the main analytical tool of benchmarking steps. Given the nature of ANP, the researcher established a network system with a specific structure. At the planning stage, the decision-making team can include different dimensions of performance indicators and systemize complicated issues for complete and overall judgment. The organization will not be limited to the analysis of public financial statements. With a high degree of precision with the ANP analytical results, resource investments can be lowered at the stage of benchmark searching and limit the number of benchmark companies. Per ANP, different and relative weights of performance indicators are acquired. At the observation stage, decision-making teams can clearly recognize the trend of industrial development as well as the organizations current situation. At the analysis stage, ANP results of benchmarks and the organization can be compared, K_{jk} is calculated, and the types of performance indicators are defined (RPI or CPI). This stage involves the general comparison according to attributes and background of the case company, and it can effectively reflect the difference between the case company and the

benchmark companies and specifically define the types of indicators. Therefore, it can serve as an important reference for decision makers at the stage of adaptation. According to the types of indicators, they can establish corresponding and specific behavior and apply them to strategic planning and resource distribution, with continuous improvement of learning. Accordingly, benchmarking ANP in this study can be a specific evaluation tool for benchmarking enterprises or strategic management. Analysis of benchmarks and the organization elucidate the companys gaps compared to the industry leaders. Further analysis can define the types of performance indicators, which can effectively limit the enterprises to the scope of strategic planning and can focus on the establishment of effective strategies. Hence, corporate decision makers can make the right decisions, enhance strategy effectiveness, and reinforce corporate competitiveness.

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