Article

A Study on the Key Factors of CSR Indicators for Tenderers in Procurement Screening Using the Delphi Method and DEMATEL-Based Analytic Network Process

Kuo-Yu Peng [1,*] and Hsiu-Li Liao [2]

1 College of Business, Chung Yuan Christian University, 200 Chung Pei Road, Chung Li District, Taoyuan City 32023, Taiwan
2 Department of Information Management, Chung Yuan Christian University, Taoyuan City 32023, Taiwan
* Correspondence: x941951@gmail.com

Abstract: European Union public procurement law increasingly allows countries' authorities to take corporate social responsibility (CSR) into account in public procurement decisions. Up to 2022, few public procurements were determined by these key factors of CSR scoring items. It is worthy to study whether there is consistency in tenderers' views on CSR indicators and factors. In this study, 10 experts working in companies from different government entities were invited to participate in a questionnaire survey. In this study, a DEMATEL-based analytic network process (DANP) was applied to find out the weights of each indicator. Our finding shows the important criteria selected for tenderers were measures to support "work–life balance" for employees and "salary increase for employees". These are important responses to the problems encountered by companies in CSR practices and can be used as a reference to enhance corporations' CSR goals or pursue future sustainable business excellence.

Keywords: corporate social responsibility (CSR); public procurement; employees' compensation; decision-making trial and evaluation laboratory (DEMATEL); DEMATEL-based analytic network process (DANP); green procurement

JEL Classification: C650 Miscellaneous Mathematical Tools; D700 Analysis of Collective Decision-Making: General; D710 Social Choice; Clubs; Committees; Associations; D790 Analysis of Collective Decision-Making: Other; D260 Production and Organizations: Crowd-Based Firms; D210 Firm Behavior: Theory

1. Introduction

In 2019, Taiwan followed other countries in including CSR as a criterion in procurement screening. The issue of CSR has already formed a global trend. Information disclosure and certification related to the CSR code of conduct put forth by many domestic and foreign organizations have sprung up. However, why do companies have multiple procurement standards? This is because companies have high standards for compliance with laws and regulations, attention to business ethics, damage to the environment and natural ecology in the production process, concern for labor rights, and the amount of investment in social welfare (Székely and Knirsch 2005). In addition, Snider et al. (2013) proposed four CSR domains as a measurement of CSR orientation for public procurement: (1) expectations of corporate stockholders (economic); (2) expectations of government and the law (legal); (3) the philanthropic and charitable expectations of society (discretionary); and (4) expectations of societal mores and ethical norms (ethical). Ankersmit (2020) believed that in public procurement in the European Union (EU), companies are not only producing units for a government contractor. They often engage in broader economic activities that may have both positive and negative impacts on society or the environment, and may also turn a

blind eye to the above four CSR issues. Because companies have the right to compete for tenders, rather than being suppliers chosen by government authorities on the grounds of public interest, it is difficult to examine their CSR practices.

The importance of CSR is that it can not only improve the profit of the company, but also help to maintain close relationships and good interactions with stakeholders (employees, customers, suppliers, and shareholders), strengthen the brand image of corporate integrity, and enhance corporate competitiveness (Ling 2022). However, there is still controversy in Taiwan about the inclusion of CSR-related conditions in the Government Procurement Act (hereinafter referred to as "the Act") as procurement standards. In this study, an assessment methodology was developed to assess internal and external CSR-related factors and identify relevant solutions that would benefit stakeholders. This study uses the Delphi method to construct a systematic framework, and then uses systematic methods (i.e., the decision laboratory method [DEMATEL] and network analysis method [ANP]) to identify key factors and their causal relationships, and then applies a systems perspective to formulate solutions that may benefit all stakeholders. The contribution of this research is the application of original assessment methods and processes, qualitative thinking, and quantitative analysis, combining the strengths of these three approaches to address complex systemic problems.

The objectives of this study were as follows:

(1) The Delphi method is used to construct the key criteria for enterprises to fulfill CSR in government procurement for their reference and (2) to explore the fact that implementation of CSR in public procurement can bring added value to companies and promote more incentives for them to fulfill their social responsibilities. As for the research subjects, this study was conducted based on the tenderers that have undertaken government procurement tenders. In order to make the comparison benchmarks consistent, the construction industry, computer companies that outsource information, and the paper products and printing industry were chosen as the main research scope.

2. Literature Review

2.1. Public Procurement in Taiwan

In Taiwan, government entities handle procurement through a screening process to select partners to acquire resources. According to the nature, procurement can be divided into construction work, property, and services; and according to the prescribed procedures, it can be divided into open tendering, selective tendering, and limited tendering (Li 2021), as described below.

(1) In accordance with Article 18, paragraph 2 of the Act, open tendering means inviting unspecified suppliers to tender by means of public notice. According to Article 27, paragraph 1 of the Act, the so-called "means of public notice", which refers to the notice of invitation to tender, will be published in the government procurement gazette and made public on the information network; the so-called "inviting unspecified suppliers to tender" does not mean that all unspecified suppliers may participate in the tendering. As long as the restrictions on the scope of tender qualification pursuant to the related laws or regulations apply, the restrictions imposed by the entities in the case will not change the nature of open tendering.

(2) According to Article 18, paragraph 3 of the Act, "selective tendering" refers to inviting qualified suppliers to tender after completing qualification evaluation in accordance with certain qualifications by means of public notice. This type of tendering was implemented to enhance procurement efficiency. In the second stage, entities will examine the specifications and prices of tenders, and then award the tender to the lowest or most advantageous tenderer. (3) "Limited tendering", as stipulated in Article 18, paragraph 4 of the Act, refers to inviting more than two tenderers for price competition or inviting only one tenderer for price negotiation without public notice. This type of tendering was mostly used owing to the special nature of the procurement case.

There are three principles of evaluating and awarding tenders, i.e., the lowest tender, the most advantageous tender, and multiple awards.

The lowest tender principle is that after a government estimate is set, the lowest tender within the estimate will be selected as the awarded tenderer, according to Article 52, paragraph 1, clause 1 of the Act. The most advantageous tender is for professional services, technical services, information services, social welfare services, or cultural and creative services, pursuant to Article 52, paragraph 2 of the Act. Because of the differences in technology, quality, functions, benefits, features, or commercial terms offered by different tenderers, if only tender price is used as the standard of contract awarding, it may not be the most economically efficient for the entity to screen the tenderer. In this case, the entity may adopt the principle of the most advantageous tender for contract awarding, including factors other than price, and the CSR indicators described in this study are the evaluation factors for this. The multiple awards principle, as stipulated in Article 52, paragraph 1, clause 4 of the Act, is that an entity may give notice in the tender documents that it reserves the right to award the contract to different tenderers by different items or different quantities, with the purpose of improving procurement efficiency and preventing monopoly and tender rigging. In recent years, procurement screening including CSR indicators is just beginning in Taiwan. The proportion of the volume of literature found is relatively small. Lu (2020) pointed out that for environmentally friendly green restaurants, the public and private sectors can formulate effective strategies (i.e., tender screening) that meet the needs of green restaurants. Su (2019) studied the possible impact of the Act on the society and economy, and expressed his expectation that from a practical perspective it will serve as a reference for the government to adjust the Act to include CSR in the future.

2.2. Green Procurement in Taiwan

Taiwan started to implement green procurement under the Act in 1998. In addition to requiring the entities to regularly report the results of green procurement, the government also requires that the target amount and weights of green procurement to be increased year by year. The government actively promotes "green consumption" and encourages consumers to purchase green products in order to reduce the environmental impact caused by overproduction and overconsumption. Green procurement is defined as the procurement of items made from recycled materials, with priority given to the environment, and the products procured must cause the least harm to the environment and human health (Environmental Protection Administration 2022). Green procurement can also be described as sustainable procurement, which is promoted by the government by specifying product categories, preferential rates, and procurement by preference, as well as setting up relevant incentive norms, to encourage entities to implement green procurement. For example, in Taiwan, equipment manufacturers and designers in the electrical and electronics industry have adopted green procurement and green manufacturing practices to address the current wave of international green issues, and have brought good environmental and financial performance to their respective companies (Chien and Shih 2007). EPSON, for example, in order to achieve social responsibility throughout the supply chain, is committed to promoting "CSR procurement" activities and supply chain management, and reducing environmental impacts in the procurement process for different supply chain stages (EPSON 2021). Through bibliometric analysis, scholars (Masudin et al. 2022) analyzed 220 articles on the procurement policies in the public and private sectors; the choice of suppliers' green procurement will affect the competitiveness of enterprises and the performance of the entire green supply chain. As a result, both the public and private sectors face increasing pressure to consider environmental aspects in purchasing policies (Ma et al. 2021). In this study, it is the first screening item in the three major dimensions of CSR indicators.

2.3. CSR Indicators

Taiwan's public procurement has been slower than overseas in incorporating CSR indicators. The three major dimensions of the indicators are: (1) salary increase for employ-

ees; (2) measures to support "work–life balance" for employees; and (3) handling green procurement. We will explore each dimension and the relative criteria.

(1) Job performance is defined as the basic responsibility for which employees are hired in exchange for their compensation package (Williams and Anderson 1991). Employees are one of the important stakeholders of a company, not only because they determine the quality of products or services that customers receive but also because employee well-being is directly related to job performance (Luo and Bhattacharya 2006). Chaudhary (2020) revealed that employees' attention to their employers' CSR efforts significantly influences employee performance. With regard to the salary increase policy for employees, Compal Electronics in Taiwan clearly states that employees' salary is based on the principle of equal pay for equal work and job performance. In addition, employees will be paid different salaries according to their education, experience, assigned rank and title, and work nature. Employees are given a share in company's profits based on its annual earnings.

(2) CSR shows to employees the extent to which employers value their stakeholders (Maignan and Ferrell 2000). Aguinis and Glavas (2019) stated that employees' perceptions of their employers' CSR can provide an additional source of engagement beyond the traditional job characteristics. For example, some companies offer on-site fitness facilities, free lunches, work massage services, and vacations for inclusion in their employment strategies. These benefits are costly to maintain. CSR should be well perceived if it has a positive influence on employees and contributes to the recruitment of potential employees, employee satisfaction and morale, and employee retention (Lee et al. 2012). The pro-social image and reputation resulting from corporate involvement in philanthropy can boost employee self-esteem and thus increase productivity (Gao and Yang 2016). The impact of work engagement on employee health and organizational productivity is an important link to CSR (Rupp et al. 2018). Employee occupational health and safety issues are one of the areas of CSR that will strongly affect employees' assessment of their workplace and motivation (Eweje and Bentley 2006).

(3) Green purchasing can have a positive influence on the environmental and financial performance of a company, either directly or indirectly (Carter et al. 2000). According to Song and Zhang (Song et al. 2017), the adoption of green procurement provides a competitive advantage to companies, and can drive the relevant companies to actively fulfill their environmental responsibilities and improve their environmental responsibility performance. Companies receive environmental certification for their products. For example, the ISO 14024 Type I ecolabel, which is also endorsed by the Global Ecolabelling Network (GEN), was developed to convey to consumers that a product is in compliance with the green label requirements (Cai et al. 2017). In this regard, environmental certification has been gradually recognized by society and has brought many benefits to companies. For example, AcBel Polytech Inc. (2020) implements local green procurement, takes production or services into environmental consideration, and develops strategic alliances with local suppliers to ensure real-time and stable supply of raw materials and reduce the environmental impact of production on the value chain. It procures raw materials that are 100% green, lead- and halogen- free, complies with the EU RoHS Directive for restricted substances, and continues the procurement and use of green materials.

3. Research Results

In this study, the Delphi questionnaire survey for experts was used to determine nine criteria, and then the DEMATEL method was used to confirm the interactions between the CSR criteria for tenderer screening. Through the DANP model, we obtained the cause-effect NRM map as well as the final ranking by weighting the ranking order under each criterion.

3.1. DEMATEL Questionnaire Statistics

The questionnaire data were entered into Microsoft Excel to obtain the average values, and the direct-relation matrix is listed as shown in Table 1 below.

Table 1. Direct-Relation Matrix.

Criteria	A1	A2	A3	B1	B2	B3	B4	C1	C2	SUM (Column)
A1	0.000	3.812	3.375	3.125	3.812	3.000	3.000	3.125	3.250	26.500
A2	3.250	0.000	3.375	3.000	4.000	3.812	3.375	2.750	3.125	26.687
A3	3.125	3.437	0.000	3.125	3.375	3.25	2.750	2.187	2.750	24.000
B1	3.000	3.562	2.750	0.000	3.250	2.875	3.562	3.000	2.750	24.750
B2	3.250	3.000	3.562	3.000	0.000	4.000	3.625	3.375	2.500	26.312
B3	3.812	3.687	3.000	3.687	2.750	0.000	3.000	3.437	3.687	27.062
B4	3.000	2.875	2.750	3.375	3.562	3.437	0.000	2.187	2.125	23.312
C1	3.125	3.375	3.375	2.500	3.625	3.375	3.250	0.000	3.437	26.062
C2	3.000	3.375	3.000	3.437	3.250	2.750	3.000	3.000	0.000	24.812
SUM	25.562	27.125	25.187	25.250	27.625	26.500	25.562	23.062	23.625	

Using the direct-relation matrix (Z), the sum of the values of each row was calculated, and the maximum value (27.625) was taken as the denominator and divided by each criterion to obtain the normalized direct-relation matrix (X), as shown in Table 2 below.

Table 2. Normalized Direct-Relation Matrix.

Criteria	A1	A2	A3	B1	B2	B3	B4	C1	C2
A1	0.000	0.138	0.122	0.113	0.138	0.109	0.109	0.113	0.118
A2	0.118	0.000	0.122	0.109	0.145	0.138	0.122	0.100	0.113
A3	0.113	0.124	0.000	0.113	0.122	0.118	0.100	0.080	0.100
B1	0.109	0.129	0.100	0.000	0.118	0.104	0.129	0.109	0.100
B2	0.118	0.109	0.129	0.109	0.000	0.145	0.131	0.122	0.100
B3	0.138	0.134	0.109	0.134	0.100	0.000	0.109	0.124	0.134
B4	0.109	0.104	0.100	0.122	0.129	0.124	0.000	0.080	0.077
C1	0.113	0.122	0.122	0.090	0.131	0.122	0.118	0.000	0.124
C2	0.109	0.122	0.109	0.124	0.118	0.100	0.109	0.109	0.000

The total influence matrix (T) was obtained by substituting its equation in the DEMA-TEL calculation procedure of this study, as shown in Table 3 below.

Table 3. Total Influence Matrix T.

Criteria	A1	A2	A3	B1	B2	B3	B4	C1	C2	D (Influence Given)
A1	1.333	1.524	1.425	1.419	1.549	1.478	1.432	1.320	1.358	12.837
A2	1.448	1.412	1.434	1.425	1.563	1.511	1.451	1.317	1.363	12.924
A3	1.324	1.397	1.207	1.310	1.418	1.371	1.314	1.192	1.240	11.771
B1	1.351	1.432	1.328	1.238	1.447	1.392	1.368	1.243	1.268	12.068
B2	1.440	1.503	1.432	1.418	1.429	1.509	1.451	1.328	1.346	12.856
B3	1.480	1.548	1.439	1.461	1.546	1.405	1.457	1.352	1.395	13.083
B4	1.289	1.347	1.266	1.286	1.389	1.343	1.191	1.163	1.191	11.464
C1	1.414	1.489	1.405	1.380	1.521	1.468	1.417	1.199	1.344	12.636
C2	1.353	1.430	1.337	1.351	1.450	1.391	1.354	1.245	1.179	12.091
R (influence received)	12.431	13.082	12.274	12.287	13.311	12.868	12.435	11.358	11.683	

Through the above matrix, we calculated the prominences (D + R) and the relations (D − R) of the sum of column values (influence given) D and the sum of row values (influence received) R. The results are shown in Table 4 below.

Table 4. Prominence and Relation of Criteria.

Criteria	D	R	D + R	Ranking	D − R
A1	12.837	12.431	25.268	4	0.406
A2	12.924	13.082	26.006	2	−0.158
A3	11.771	12.274	24.045	6	−0.503
B1	12.068	12.287	24.355	5	−0.219
B2	12.856	13.311	26.167	1	−0.455
B3	13.083	12.868	25.951	3	0.215
B4	11.464	12.435	23.899	8	−0.971
C1	12.636	11.358	23.994	7	1.278
C2	12.091	11.683	23.774	9	0.408

According to the D + R values in Table 4, B2, A2, B3, and A1 are the factors to be considered when evaluating a tenderer's CSR. The criteria as a whole are grouped in the "causes" or "effects" categories as follows:

A. Causes (tending to influence other criteria): criteria A1, B3, C1, and C2.

B. Effects (tending to receive influence from other criteria): criteria A2, A3, B1, B2, and B4.

3.2. DANP Calculation

The weights of DANP are the relative importance of the factors. Thus, the importance of the criteria will be determined by converging the two types of information. First, the DEMATEL total influence matrix (T), as shown in Table 5, was used as the unweighted supermatrix (T*).

Table 5. Unweighted Supermatrix (T*).

Criteria	A1	A2	A3	B1	B2	B3	B4	C1	C2
A1	1.333	1.524	1.425	1.419	1.549	1.478	1.432	1.320	1.358
A2	1.448	1.412	1.434	1.425	1.563	1.511	1.451	1.317	1.363
A3	1.324	1.397	1.207	1.310	1.418	1.371	1.314	1.192	1.240
B1	1.351	1.432	1.328	1.238	1.447	1.392	1.368	1.243	1.268
B2	1.440	1.503	1.432	1.418	1.429	1.509	1.451	1.328	1.346
B3	1.480	1.548	1.439	1.461	1.546	1.405	1.457	1.352	1.395
B4	1.289	1.347	1.266	1.286	1.389	1.343	1.191	1.163	1.191
C1	1.414	1.489	1.405	1.380	1.521	1.468	1.417	1.199	1.344
C2	1.353	1.430	1.337	1.351	1.450	1.391	1.354	1.245	1.179

After normalizing the unweighted supermatrix (T*), the weighted supermatrix (W) was obtained as shown in Table 6 below.

Table 6. Weighted Supermatrix (W).

Factors	A1	A2	A3	B1	B2	B3	B4	C1	C2
A1	0.107	0.117	0.116	0.116	0.116	0.115	0.115	0.116	0.116
A2	0.116	0.108	0.117	0.116	0.117	0.117	0.117	0.115	0.117
A3	0.107	0.107	0.098	0.107	0.107	0.107	0.106	0.105	0.106
B1	0.109	0.110	0.108	0.101	0.109	0.108	0.110	0.109	0.109
B2	0.116	0.115	0.117	0.115	0.107	0.117	0.117	0.116	0.115
B3	0.119	0.118	0.117	0.119	0.116	0.109	0.117	0.120	0.119
B4	0.104	0.103	0.103	0.105	0.104	0.104	0.096	0.102	0.102
C1	0.114	0.114	0.114	0.112	0.114	0.114	0.114	0.106	0.115
C2	0.109	0.109	0.109	0.110	0.109	0.108	0.109	0.110	0.100
SUM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Finally, the weighted supermatrix (W) was multiplied by itself three times to determine that the overall weight values converged consistently and obtain the limit supermatrix (W*), as shown in Table 7 below.

Table 7. Limit Supermatrix (W*).

Factors	A1	A2	A3	B1	B2	B3	B4	C1	C2
A1	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115
A2	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116
A3	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
B1	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
B2	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115
B3	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117
B4	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103
C1	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113
C2	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108

Therefore, under the DANP calculation in the table above, we obtained the weight ranking order of the criteria, as shown in Table 8 below.

Table 8. DANP Weight Ranking Order of Criteria.

Criteria	Weights	Ranking
A1	0.115	3 (tied)
A2	0.116	2
A3	0.105	6
B1	0.108	5 (tied)
B2	0.115	3 (tied)
B3	0.117	1
B4	0.103	7
C1	0.113	4
C2	0.108	5 (tied)

The weight ranking results were regrouped into a prominence ranking table. Finally, the DANP weight ranking values and the DEMATEL prominence ranking values were summed and then ranked according to the size of the summed values, with a smaller summed value indicating a higher new ranking, as shown in Table 9.

Table 9. Prominence Ranking.

Criteria	DEMATEL	DANP	Sum of Rankings	Overall Rankings
A1	4	3 (tied)	7	2
A2	2	2	4	1 (tied)
A3	6	6	12	5
B1	5	5 (tied)	10	3
B2	1	3 (tied)	4	1 (tied)
B3	3	1	4	1 (tied)
B4	8	7	15	7
C1	7	4	11	4
C2	9	5 (tied)	14	6

3.3. Drawing Cause-Effect Network Relationship Map

We referred to the total influence matrix (*T*) in Table 3 to draw the causal loop diagram. We reviewed the total influence matrix (T) from top to bottom to find the maximum value. After finding the data of causal influence, we started to draw the cause-effect NRM as shown in Figure 1.

From the nine criteria in the experts' discussion, the first three items with the lowest ranking and summation are regarded as important key criteria. We found that there are three summaries and juxtapositions, so another criterion is used to draw a cause-and-effect diagram. According to the diagram, "flexible working hours (B3)" and "salary (excluding overtime) of at least NTD 30,000 for employees working full-time on the procurement project during the performance period (A2)" were mutually influential, and B3 also directly affects other key criteria. Screening tenderers using CSR indicators may start with "B3" or "A2".
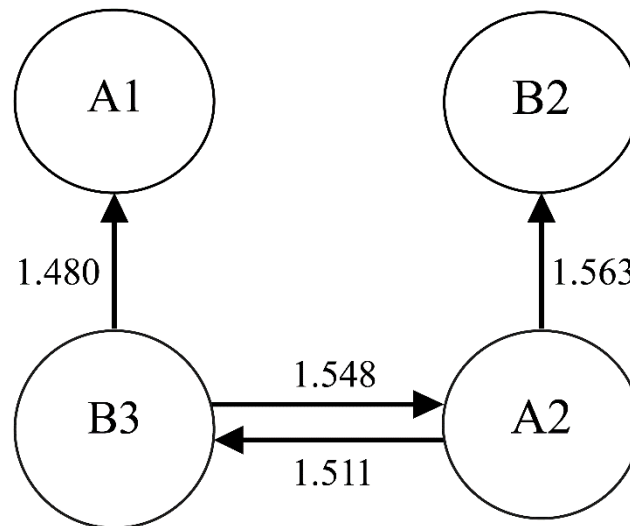

Figure 1. Cause-effect Network Relationship Map (NRM).

4. Research Methodology and Design

4.1. Research Framework

In this study, firstly, we conducted a brainstorming session with six procurement officers from different government entities, and summarized 17 criteria sources (as shown in Table 10) of possible CSR indicators from domestic CSR reports and foreign literature to form a prototype for the study. Then, through interview with experts, we added and adjusted the criteria, or made up for the deficiencies. Finally, we used the Delphi method to confirm the importance of the criteria and form a formal research framework. The experts who participated in the interviews were officers and members of public administrative agencies that we had close business contact with and were responsible for procurement liaison, communication, and management (as shown in Table 11). Meanwhile, we balanced the areas of the three major dimensions of CSR indicators such as employees' compensation, procurement management, employees' work–life balance, and promotion of green products. It was expected that through expert interviews, they could effectively reflect the critical factors of CSR indicators that companies are currently facing. The experts were selected for their complete qualifications and familiarity with internal procurement and employee management, and were representative.

Table 10. Criteria for Prototyping Dimensions and Preliminary Framework.

Dimensions	Criteria	Literature Sources
A. Salary increase for employees	A1. General salary increase (for employees in the most recent year) A2. On-the-job training for employees (self-education) A3. Principle of equal pay for equal work A4. Salary (excluding overtime) of at least NTD 30,000 for employees working full-time on the procurement project during the performance period A5. Results of annual performance appraisal will be used for salary adjustment A6. Work performance	(ASRock Corporation 2020; Formosa Plastics Corporation 2020; EMIS 2020)
B. Measures to support "work–life balance" for employees	B1. Employee assistance program B2. Community involvement and philanthropy B3. Workplace safety (prevention of occupational disasters) B4. Employee health B5. Gender friendly (including gender diversity) B6. Flexible working hours B7. Family-friendly measures (such as parental leave or family leave)	(ASRock Corporation 2020; Formosa Plastics Corporation 2020; Lee et al. 2012; Gao and Yang 2016; EMIS 2020)
C. Handling green procurement	C1. Green procurement declaration amounting to NTD 400,000 or more in the most current year C2. Providing sustainable products that facilitate material recycling, reuse, and energy-saving technology development C3. Strengthening green procurement and green management, so that products and services and outsourcing tenderers can conform to the international green trend C4. Tenderers procure green products and complete the green procurement declaration on the Green Procurement Reporting Platform for Private Enterprises and Organizations of the Environmental Protection Administration	(Ma 2021; Avotra et al. 2021; ASRock Corporation 2020; Formosa Plastics Corporation 2020; EMIS 2020; AcBel Polytech Inc. 2020)

Table 11. Expert Background.

Experts	Nature of Service	Job Title	Years of Service	Experts	Nature of Service	Job Title	Years of Service
1	Construction	President	26	9	Printing	Manager	12
2	Computer Information Services	President	24	10	Printing	Manager	11
3	Computer Information Services	Assistant Vice President	18	11	Public Sector	Supervisor	16
4	Computer Information Services	Assistant Vice President	16	12	Public Sector	Supervisor	15
5	Manufacturing	Manager	14	13	Public Sector	Supervisor	15
6	Manufacturing	Manager	14	14	Public Sector	Coordinator	16
7	Catering	Manager	14	15	Public Sector	Coordinator	15
8	General merchandise retails	Manager	12	16	Public Sector	Coordinator	16

4.2. Delphi Method

The Delphi method is a research method that combines the advantages of conference and questionnaire surveys. It uses continuous anonymous questionnaires to gradually reach consistent opinions and consensus on a specific issue among a group of experts (Rowe et al. 1991). The basic implementation steps include developing expert selection criteria and forming a panel of experts; designing a questionnaire and conducting a repeated survey; and analyzing qualitative and quantitative data as feedback information for the next round.

In this study, the experts selected for the Delphi method were mainly senior personnel from the purchasing departments of the tendering companies. In order to avoid disclosing company names to cause peer pressure and influence evaluators' judgment, the questionnaires were distributed anonymously and later were returned in a consistent manner to give credibility to the survey. The implementation of the Delphi method first requires the

formation of an expert group of 10–15 people to conduct research on a specific issue (Teng 2012). The group size of at least 10 people is effective in reducing errors and increasing the reliability (Dalkey and Helmer 1963). The number of repetitions of the questionnaire survey should not be too many. Hwang and Lin (2012) pointed out that the response rate decreases with the number of surveys. Green et al. (1990) suggested that two–three repetitions of the survey are sufficient.

In order to confirm whether the expert opinions reached a consensus, this study used the consensus deviation index (CDI) as the evaluation index. A smaller CDI value indicates more consistent opinions among experts and higher degree of consensus (Teng 2012). In this study, the CDI threshold value was set to 0.1 as the basis for judgment, i.e., a CDI value greater than 0.1 indicated that the expert group did not reach consensus; conversely, CDI $\leqq$ 0.1 indicated that the expert group reached consensus and their opinions successfully converged to obtain a formal research framework. This study went through two rounds of questionnaire rating before reaching expert consensus. Following (Johnson et al. 2021) and (Olson and Wu 2010), we used the Delphi method to design the questionnaire and distinguished the necessity of the evaluation criteria as follows: extremely unnecessary = 0 points, very unnecessary = 10 points, moderately unnecessary = 30 points, necessary = 50 points, moderately necessary = 70 points, very necessary = 90 points, and extremely necessary = 100 points. The expert group in Table 11 rated the criteria according to their necessity. In addition, the maximum average rating method proposed by (Teng 2012) was applied to adjust the CDI to avoid the subjectivity of the experts' determination of the necessity.

The rating results by the 16 experts along with the mean, standard deviation (SD), and CDI values in the first-round rating on the necessity of criteria are shown in Table 12. According to the rating results on the necessity of including the Delphi criteria in the study, the CDI values of 8 evaluation criteria out of 17 were >0.1, indicating that most of the experts failed to reach a consensus on the necessity of evaluation criteria.

Regarding the reasons for the divergent opinions of experts, Experts 5, 6, 12, and 13 thought that criterion A2, self-education, was less important for tenderers, and Experts 15 and 16 thought that criterion A3, principle of equal pay for equal work, was more difficult to compare because it involved individual work efficiency. In addition, Expert 11 thought that for criterion B2, the community involvement was not high; Expert 4 thought that for criterion B5, gender friendly, although it was difficult to achieve gender equality, the ratio of men and women would be controlled; and Experts 10 and 12 thought that criterion C2, the identification of recycled materials, and criterion C3, the planning management of strengthening green procurement, were too idealistic. Therefore, the expert group was invited to conduct a second-round questionnaire survey to rate the necessity of including the criteria in the study. The rating results along with the mean, SD, and CDI values are shown in Table 13. The formal research framework of this study is shown in Figure 2.

Table 12. First-round Rating on the Necessity of Criteria.

Dimensions	Criteria	Experts																Average	SD	CDI
---	---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
A	A1	80	90	80	100	80	80	80	80	90	80	90	80	90	90	80	80	84.38	6.29	0.075
	A2	80	80	60	70	60	60	70	70	60	80	60	50	50	60	60	60	64.38	9.64	0.150
	A3	90	90	80	70	70	70	80	60	60	50	70	60	50	60	50	50	66.25	13.60	0.205
	A4	80	80	90	80	70	80	70	70	80	80	80	90	90	80	80	80	80.00	6.32	0.079
	A5	90	90	70	80	70	80	70	70	60	60	60	50	50	50	60	50	66.25	13.60	0.205
	A6	90	90	80	80	70	70	80	80	70	70	70	80	80	70	70	80	76.88	7.04	0.091
B	B1	80	90	80	80	70	80	80	70	80	80	70	80	90	80	80	80	79.38	5.74	0.072
	B2	80	80	70	70	60	60	60	70	80	60	50	50	50	50	60	50	62.50	11.25	0.18
	B3	90	90	80	80	70	70	80	70	80	80	90	70	80	80	80	70	78.75	7.19	0.091
	B4	80	80	60	60	60	50	60	60	70	70	60	60	60	60	60	50	62.50	8.56	0.137
	B5	80	90	60	50	60	70	60	70	80	70	60	60	70	60	50	50	65.00	11.55	0.178
	B6	80	80	80	70	70	80	80	80	70	90	70	70	80	80	80	70	76.88	6.02	0.078
	B7	80	80	70	80	80	80	70	70	80	90	70	90	70	80	70	80	77.50	6.83	0.088
C	C1	80	80	80	80	90	70	70	70	80	80	90	90	90	80	80	80	80.63	6.80	0.084
	C2	80	90	80	70	60	60	70	60	80	70	60	60	70	50	60	60	67.50	10.65	0.158
	C3	80	90	70	60	70	60	70	70	60	70	80	70	60	60	60	60	68.13	9.11	0.134
	C4	90	90	80	70	70	80	80	80	80	70	70	70	80	70	80	90	78.13	7.50	0.096

Table 13. Second-round Rating on the Necessity of Criteria.

Dimensions	Criteria	Experts																Average	SD	CDI
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
A	A1	90	90	80	100	80	80	80	90	90	80	90	80	90	90	80	90	86.25	6.19	0.072
	A2	80	80	80	80	80	70	70	80	70	80	70	70	75	70	75	70	75.00	4.83	0.056
	A3	90	90	80	70	80	70	80	70	80	70	70	70	70	70	70	70	75.00	7.30	0.085
	A4	85	80	90	85	80	80	80	80	80	85	80	90	90	80	85	80	83.13	4.03	0.047
	A5	90	90	80	80	80	80	70	70	70	75	80	80	70	70	70	70	76.56	7.00	0.081
	A6	90	90	85	80	75	80	80	80	70	80	75	80	80	90	70	80	80.31	6.18	0.072
B	B1	80	90	80	80	70	80	80	75	80	85	75	80	90	80	80	80	80.31	4.99	0.058
	B2	90	80	80	85	70	70	80	70	80	70	75	70	75	70	80	70	75.94	6.38	0.074
	B3	90	90	80	80	90	70	80	70	80	80	90	70	80	80	80	70	80.00	7.30	0.085
	B4	80	80	80	80	70	70	70	70	70	75	70	70	70	75	80	70	73.75	4.65	0.054
	B5	80	90	80	80	75	70	75	70	80	70	70	80	75	70	70	70	75.31	5.91	0.069
	B6	90	80	85	80	80	80	80	85	90	90	80	80	80	80	85	80	82.81	4.07	0.047
	B7	90	80	75	85	80	80	75	75	80	85	80	90	80	80	80	80	80.94	4.55	0.053
C	C1	90	90	80	80	90	80	70	80	80	80	90	90	90	80	80	80	83.13	6.02	0.069
	C2	80	90	85	80	75	75	80	75	80	70	70	75	75	80	70	70	76.88	5.74	0.067
	C3	80	90	80	80	70	80	70	75	80	70	85	70	70	75	70	70	75.94	6.38	0.074
	C4	90	90	85	85	85	80	80	85	80	80	80	85	80	80	80	90	83.44	3.97	0.046

The results of the second-round questionnaire survey showed a CDI value of 0.1 for all 17 criteria, indicating that the 16 experts reached a consensus on the necessity of the evaluation criteria. An average score of 80 was calculated based on the experts' ratings. After discussing with the expert group, it was agreed that the average score of 80 should be used as the screening threshold, i.e., the criteria below 80 would be removed due to insufficient necessity. Finally, according to the table, there were 9 evaluation criteria with mean values greater than 80. Thus, these nine criteria were retained and included in the formal research framework, as shown in Figure 2.
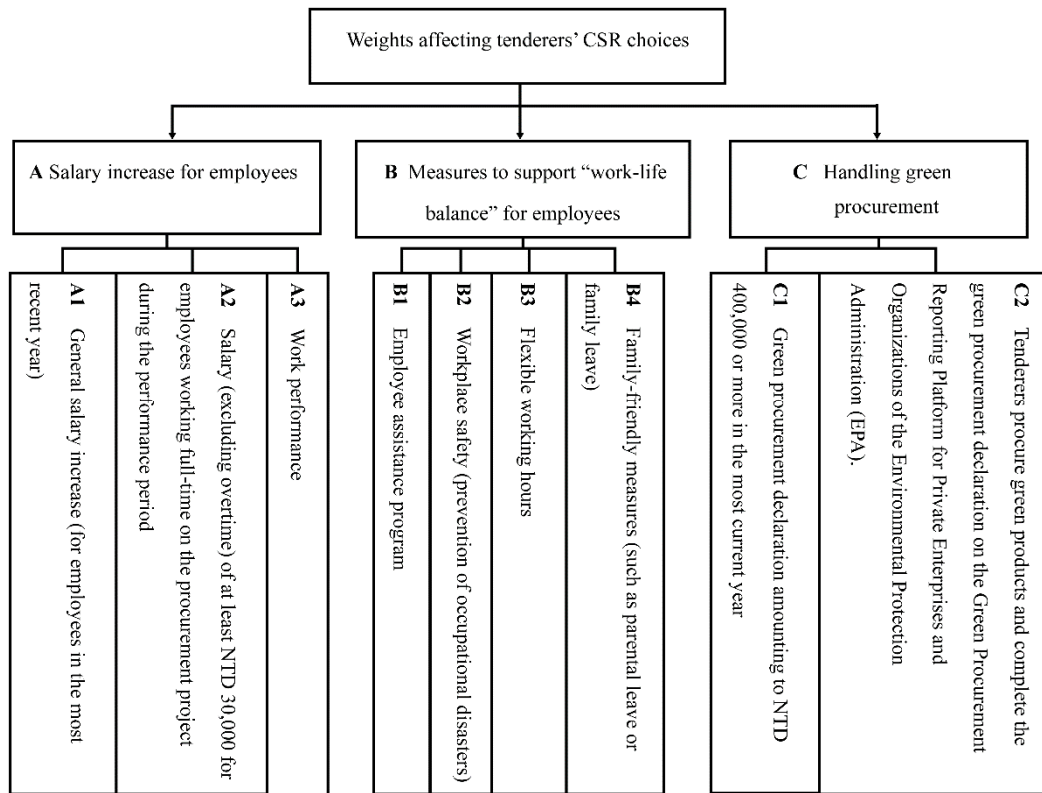
Figure 2. Research Framework of Weights Influencing Tenderers' CSR Choices.

4.3. DEMATEL-Based Analytic Network Process

This method is based on direct or indirect interrelations to observe the degree of influence in between, and uses matrix calculus and analysis to identify the influence given and influence received. Using a cause-effect network relationship map (NRM) can clearly present the influence and cause-effect relationships between important factors. Through a cause-effect NRM and quantification of the degree of influence between them, the core problems can be identified, thereby providing decision makers with a reference basis for problem solving. DEMATEL can be used to tackle complicated problems that involve structural relationships in a wide range of areas, such as resource planning decisions, environmental assessment management, conditions for environmental improvement, and business complexity.

DEMATEL can be applied in many fields. There are three characteristics for the application of DEMATEL: (1) the subject matter explored is complicated; (2) the factors to be evaluated are all causally dependent; and (3) the intention is to analyze which is the most influential factor.

Tzeng and Huang (2011) proposed the decision-making trial and evaluation laboratory-based analytic network process (DANP). When the respondents are internal stakeholders, the questionnaire of ANP pairwise comparisons can be exempted, and the total influence

matrix (*T*) generated by DEMATEL can be used directly as the unweighted supermatrix (T*) of the ANP to calculate the limit supermatrix (W*) and find the prominence ranking.

In recent years, there has been much related literature abroad on the application of DANP. For example, Yen and Tsao (2020) applied DANP to explore consumers' perceptions and evaluations of CSR. Wang et al. (2020) used a refined CSR model to mitigate information asymmetry and assess performance. Rao (2021) improved the measurement of enterprise sustainable development indicators based on the DEMATEL-ANP-based multiple criteria decision making (MCDM) model through a case study on Taiwan's high-speed rail.

4.4. DANP Questionnaire Design

The criteria influencing tenderers' CSR choices were determined according to the experts' opinions, and then the weights of each criterion were determined by the DANP questionnaire constructed in this study and used as the calculation model for procurement rankings.

The DANP questionnaire for experts was administered as shown in Figure 2. The importance of "evaluation criteria" and "evaluation items" were compared in pairs according to the goal "weights influencing tenderers' CSR choices". Different importance levels from 0 to 4 were entered in the questionnaire, with higher numbers representing higher importance. The questionnaire was distributed to the experts and scholars listed in the table above. A total of 16 copies were recovered, of which 6 were from government entities and 10 from tendering companies. The DEMATEL calculation was performed in the following steps:

(1) Using DEMATEL to assess the scale

The dimensions were designed according to the research theme and purpose. Then, different scales were established according to the different degrees of influence between the dimensions to facilitate the comparison between the relationship of each two dimensions. Five scales were established in total, namely, "0 no influence," "1 low influence," "2 medium influence," "3 high influence," and "4 extremely high influence".

(2) Establishing the direct-relation matrix (Z)

The direct-relation matrix was calculated in the following way. Each respondent compared the relationship between each two dimensions according to the content of the questionnaire. Different combinations of matrices could be obtained according to the corresponding scale filled in by the respondents. The diagonal line from the top left to the bottom right of the matrix were 0s (indicating that the degree of influence of dimension A on dimension A was 0). The results of each respondents' answers were finally integrated to obtain the direct-relation matrix.

$$Z = \begin{bmatrix} 0 & Z12 & \cdots & Z1n \\ Z21 & 0 & \cdots & Z2n \\ \vdots & & \ddots & \vdots \\ Zn1 & Zn2 & \cdots & 0 \end{bmatrix} \quad (1)$$

(3) Normalized direct-relation matrix X

$$\lambda = \frac{1}{\max\limits_{1 \leq i \leq n} \left(\sum_{j=1}^{n} Zij \right)} \quad (2)$$

Furthermore, by multiplying the result of the direct-relation matrix by λ, i.e., X = λ·Z, we could obtain a normalized direct-relation matrix.

(4)   Establishing the total influence matrix (T)

After obtaining the normalized direct-relation matrix X, the following two equations were derived, respectively.

$$\lim_{k \to \infty} x^k = O$$

$$T = \lim_{k \to \infty} \left(I + X + x^2 + \ldots + x^K \right) = X(I - X)^{-1} \tag{3}$$

The equation yields the total influence matrix T, where 0 denotes the null matrix and 1 the identity matrix.

(5)   Calculating the prominence and relation of each criterion

The prominence (D + R) and relation (D − R) of each criterion can be calculated from the total influence matrix.

T_{ij} (i, j = 1, 2, . . . , n) denotes the element in the total influence matrix T. D_i is the sum of the i-th row, denoting the sum of elements i influencing other elements. R_j is the sum of the j-th column, denoting the sum of elements i influenced by other elements. The D_i and R_j values obtained from the total influence matrix T include both direct and indirect influences.

DANP consists of two main parts. The first is DEMATEL, which uses matrix and mathematical theory to analyze the interactions between elements. The second is the ANP, which uses the NRM to express the complex interdependencies among the elements, and uses the concept of network instead of hierarchical structure to represent the interdependencies and feedbacks. DANP uses the total influence matrix T derived from DEMATEL as the unweighted super matrix T of ANP to calculate the ultimate super matrix W to examine the prominence ranking.

5. Conclusions and Recommendations

According to the results of the three major dimensions, in terms of the weights affecting tenderers' CSR choices, "measures to support 'work–life balance' for employees" is the most important dimension that affects tenderers. Tenderers should focus on evaluating and improving the work environment, because it is the most common environment in which service workers work and is closely related to them. From the results based on DEMATEL and ANP, it was found that the key criteria affecting tenderers' CSR choices were "salary (excluding overtime) of at least NTD 30,000 for employees working full-time on the procurement project during the performance period (A2)", "workplace safety (prevention of occupational disasters) (B2)", and "flexible working hours (B3)". Among them, there were two criteria in the dimension of "measures to support 'work–life balance' for employees", and one criterion in the dimension of "salary increase for employees" ranking as the key criteria. These three items fall under the policy of social responsibility and ethics, which means that tenderers should take more responsibility to improve employee care services and retention. The findings of the study are representative and responsive to corporate social responsibility issues. Although the research results cannot generally identify long-term trends, due to the specificity of this issue, they can serve as a reference for governments if hidden causal relationships and developmental countermeasures can be identified.

The study suggests that more in-depth research and detailed discussions should be conducted on the CSR indicators of tenderers for procurement screening (evaluation) by multiple factors; for example, including special tenderers (welfare groups for the physically and mentally challenged) in the scoring items for the procurement screening to enhance employment opportunities for special people. Taiwan's current policy of incorporating CSR into procurement is to encourage tenderers to raise wages in general. Unfortunately, the CSR indicators are not yet a determinant for government entities to award cases to tenderers being screened (evaluated) for procurement. Companies are an important force in driving the social development of Taiwan, and a key driver in promoting the development of caring and sustainable values of Taiwan's society. Assuredly, the CSR

indicators for tenderers are indeed well-intentioned. It is hoped that in the future, under the co-operation of public and private sectors, we can gradually realize the importance of CSR and have positive interactions. Only through continuous improvement can we make more contributions to the environment and society. In follow-up research, it is worthwhile for the government to explore the aspect of expanding the identification of green products for green procurement, to include the circular economy and pro-environmental behaviors (e.g., purchasing recycled materials) as well as environmentally friendly actions (e.g., purchasing renewable energy, reforestation, etc.) into the CSR indicators for green procurement, and to increase the proportion of the evaluation scores. Moreover, the government can learn from the EU's green procurement practices and implement measures such as tax reduction for environmentally friendly products. If the government can give some incentives (e.g., tax reduction) to companies that insist on green procurement, it can encourage them to implement CSR and create a good image for marketing to the outside world.

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