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Identifying Critical Risk Factors in Green Product Certification Using Hybrid Multiple-Criteria Decision-Making

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Abstract: Green product certification (GPC) is an important means of eliminating the asymmetry of information between consumers and manufacturers in the context of sustainable development. This study examined the critical risk factors in GPC and provided relevant suggestions for managers to reduce risk and ensure the correctness of the process. First, 18 risk factors were summarized along four dimensions: the certification institution, the entrusting enterprise, the certification business, and the implementation of the certification. Second, the Delphi method was used to determine the formal research framework, and the decision-making trial and evaluation laboratory (DEMATEL) method was applied to analyze the causal relationships among the risk factors to identify the ones driving risk and those representing the outcomes of GPC. This was used to construct a causality diagram of the risks related to green certification. Finally, the analytic network process (ANP) method was used to calculate the weight of each risk factor, and the weighted prominence of each is calculated to identify the critical factors. The results showed that the working life and experience of the certification institution were the critical driving risk factors in GPC. Corresponding countermeasures were also proposed to mitigate these risk factors.

Keywords: green production certification; critical risk factors; DEMATEL–ANP; risk control; MCDM

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1. Introduction

Social productivity and economic development have improved remarkably rapidly since the Industrial Revolution, and have led to profound changes in society. However, this has also exacerbated environmental contamination, energy exhaustion, resource depletion, a changing climate, and other ecological problems. According to Gurau et al. and Lam et al., green products are products made of non-toxic materials that are manufactured using environmental protection technology and are certified by competent organizations [1,2]. Palevich has claimed that green products were those that comply with the requirements of environmental protection in their design, production, marketing, and use [3]. According to GB/T 33761-2017 [4], green products are products of high quality that cause little or no harm to the ecological environment and human health, consume few energy resources, and meet the requirements of environmental protection in their lifecycle. The green product label is used to prove that the relevant product satisfies the requirements of green products in terms of production, processing, and use. Developed countries have been researching and implementing GPC systems for several decades. The Blue Angel mark, issued in Germany in 1978, was the world's first mark of green product certification [5]. More than 460 green product labels have since been launched in countries around the world. Of them, the Nordic Swan of Northern Europe, the EU Ecolabel, the Korea Ecolabel, the Green Seal of the United States, and the Maple Leaf logo of Canada have wide international influence.

GPC is the activity of a fully trusted third-party certification body to confirm that a product complies with a specific green standard and provides its technical specifications. Once

GPC is complete, the relevant product is awarded the green product label issued by the certification body with the corresponding qualifications. Compared with the certification of organic products, energy-saving products, water-saving products, and low carbon products, GPC has the characteristics of a long certification cycle, more participants, and complex and diverse inspection indicators. As a result, there are many risk factors in the GPC process, the interaction between these factors is complex, and controlling the risk is thus difficult [6]. Therefore, risk control in the process of GPC is important to ensure the effectiveness of the certification authority and improve the social recognition of the product [7]. In the risk control of certification, it is difficult to attend to and control all the risk factors due to limitations of human and material resources. Therefore, it is important to identify the critical risk factors in the process of GPC and propose corresponding countermeasures.

The previous literature has focused on identifying the uncertainty and risk problems of the certification process through statistical analysis. Qualitative analysis, rather than quantitative research, was conducted to analyze the specific risk factors leading to uncertainty. Many scholars have identified the risk factors of certification from different perspectives, including those of the certification process, the certifying body, and the certification business. However, few studies have systematically examined risk factors in certification and identified the critical ones [8].

Multiple-criteria decision-making (MCDM) methods are often used to deal with the problems that are characterized by several non-commensurable and conflicting (competing) criteria, where there may be no solution that satisfies all of the criteria simultaneously [9]. The identification of critical risk factors in GPC is a typical MCDM problem. The risk factors do not exist in isolation but influence one another [10]. Traditionally, there are some classical methods to calculate the weight, which can be used to obtain the importance ranking of the criteria, such as the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP). However, AHP assumes complete independence among aspects, criteria, or alternatives, which may seriously deviate from reality [11]. The ANP can be used to fully consider their complex internal correlations and identify them [12], but a tedious network diagram is needed. Furthermore, as the number of factors increases, the complexity of pairwise comparison significantly increases as well [13] and makes it difficult to achieve consistency. A hybrid MCDM technique consists of the decision-making trial and evaluation laboratory (DEMATEL) and ANP can help solve the problem. In the proposed model, the total influence matrix of DEMATEL is treated as the unweighted supermatrix of ANP, which helps avoid the tedious work of comparing indices and performing a consistency test. Moreover, the final weight of each factor is calculated by comprehensively considering the weights determined by DEMATEL and the ANP [14]. Therefore, we use the proposed model to identify the critical risk factors in GPC.

In this study, we explore the answers to the following research questions: What risk factors should be considered in the GPC process? Which are the critical risk factors and how do they affect each other? Furthermore, which are the critical driving factors and outcome factors? Answering these questions can be beneficial for providing effective suggestions for reducing and even avoiding the risk in GPC.

The remainder of this paper is organized as follows: Section 2 reviews the literature on risk factors in the product certification process, and Section 3 introduces the methodology used. Section 4 uses the Delphi method to establish the formal research structure used here and details the use of the proposed MCDM method to identify the critical risk factors in GPC. Section 5 discusses the various outcomes and related implications for management, and Section 6 summarizes the conclusions of this study.

2. Literature Review

2.1. Uncertainty Analysis in the Certification Process

The product certification industry emerged with the specialization of mass production and the development of the market economy. As a modern production-based service industry, it was developed for hundreds of years in developed Western countries such as Britain and Germany [15]. It is an endorsement of a certain aspect of the product to meet the corresponding standards according to an accredited certification body. It is also an important means to reduce asymmetry in product information, optimize the market environment and establish a trust mechanism [16,17].

However, many risk factors hinder the effectiveness of product certification. The risk of certification is the effect of uncertainty on the goal of certification [18]. Certification risk management is a means of reducing this uncertainty and ensuring the effectiveness of certification activities. Scholars have conducted extensive and in-depth research on uncertainty in the certification business through statistical analyses of certification data. The Clean Clothes Campaign described third-party certification as a cat-and-mouse game between naive and badly trained auditors, and unscrupulous managers, and concluded that social certification practices had suffered a considerable loss of credibility [19]. Anders questioned the trustworthiness of third-party certification (TPC) as a quality signal and addressed the problems of auditor independence and objectiveness [20]. Schulze et al. and Albersmeier et al. studied the reliability of third-party certification in the food chain [21]. Through statistical analyses, they clearly indicated the differences between various certification bodies. The risk factors leading to differences mainly include differences in know-how between auditors and varying intensities of audit as well as economic dependencies.

2.2. Identifying Risk Factors in the Certification Process

Identifying critical risk factors is an important task in risk management that can be carried out from different perspectives. A typical method is 4M1E. That is, the risk factors are summarized as risks related to “man, machine, material, method, and environment” [22]. The 4M1E method is mainly suitable for analyzing the risks in the production process. In essence, certification is a kind of service. In general, the identification of risk factors in the service process differs from the 4M1E method. Risk factors are usually extracted from the participants to the certification and the certification business itself [8].

Researchers have analyzed risk factors in the entire certification process, including the acceptance of certification, document review, planning for the certification scheme, on-site inspection, comprehensive evaluation, and post-certification supervision. The representative achievements are as follows: Wang analyzed risk factors in the stages of certification acceptance, audit planning, and supervision after the certification by using the human–machine loop in the process [23]. Liu conducted a risk analysis of the certification of organic agricultural products and claimed that there were management-related risks in the process, such as the improper arrangement of the certification inspection and ineffective supervision after inspection, personnel-related risks such as incompetent inspectors, and other operational risks such as improper sampling and inspection methods [24].

In the context of the subject and object of certification, researchers have claimed that the risk of certification exists in the implementation of the certification process as well as the characteristics of certification projects and certification bodies. Tanner analyzed independent assessments conducted by third-party certification bodies and concluded that the validity of the certification process is influenced by conflicts of interest in the certification service [25]. Pignatti analyzed risk factors influencing trust in certification bodies by dividing them into modes of external visibility and internal operation [26]. The factors of external visibility included years in the business, suspension of an authorization, size of the certification body, and the accreditation process. The modes of internal operation included the competence of the certification commission, management, and technical operators, the clarity of documents, and the management of procedures. Jahn et al. studied the reliability of certification and revealed the following risk factors: (a) results of audit of the last inspection (detected errors, audit performance), (b) the category of food (e.g., shelf life, considering that fresh products decay quickly), (c) the potential benefits of mislabeling (e.g., the price premium in the respective category), (d) potential fines, (e) organizational structure (e.g., company size, complexity, import quota), and (f) the internal quality management system of the firm [27]. In addition to the above-mentioned risk factors, the potential risk of damage (e.g., loss of reputation or health risk) and the amount of public attention in case of a crisis were used to identify and weigh the risk factors. Du et al. researched the risk of certification of parts of buildings and divided the risk factors into three levels [28]. They also examined the characteristics and lifecycle factors of the certified products. Pang and Sun analyzed risks in the process of GMP certification. In addition to risks in the implementation of certification, they considered the risks to the fairness, accuracy, and credibility of certification institutions as well as the integrity-related risks for pharmaceutical enterprises [29,30]. Zhao analyzed risk factors in the management system of certification and extracted 20 factors from certification institutions, external supervision, and reviewed enterprises [31].

2.3. Analysis of Risk Factors in Product Certification

Detailed analyses of risk factors in product certification have yielded refined and integrated systems for examining them. Tan et al. researched the risk posed by the inspector in on-site inspections at the factory and divided this into risks related to the inspector's basic skills, professional skills, and quality of work [32]. Yin studied the risk of accreditation of certification institutions and divided it into risks in terms of the maturity of the system, risk management, control capability, and risk awareness of the institution [33]. Liu, Liu, and Jiang studied the risks of the on-site inspection in the certification process and subdivided them into risks posed by the factory personnel, environment, equipment, product process, and quality management system of the factory [34–36]. Cheng et al. identified the risks of publicity of information by certification institutions, the qualifications of certification clients and members of the audit team, integrity-related risk of the audit procedures, and the risk of not completing the audit process from the perspective of administrative supervision [37]. Wan et al. studied endogenous risk in the certification of pollution-free agricultural products and claimed that it had three sources: the technical system, certification behavior, and organizational system [38]. They analyzed the subdivided the factors of each source.

Based on the above summary of the literature, we summarize the preliminary aspects and risk factors identified in the area in Table 1.

Table 1. The initial set of risk factors in product certification.

Risk Category	Risk Factor	Risk Description	References
Certification institution	Working life	Years in business	[26,33]
	Certification experience	Number of certification services in the same field in the last three years	[26,29,30]
	Strength	Business scale of certification institution	[26,38]
	Impartiality	① Is there an organizational structure to ensure fairness? ② Is there any interest relationship with the applicant?	[20,21,25,29,30]
	Management standardization	① Formulation and improvement of certification system and rules. ② Are the selection, training, and evaluation of certification personnel scientific and reasonable?	[24,26,33,37]
Entrusting enterprise	Social credit	The entrusting enterprise has user complaints, negative news, etc.	[27,31]
	Nature of enterprise	The nature and type of ownership of the entrusting enterprise	[27,31]
	Scale of enterprise	Enterprise turnover, profit, and other indicators	[27,34–36]
	Satisfaction of enterprise	The soundness of the enterprise management system, progress of process technology, satisfaction of energy conservation, and environmental protection	[27,31,34–36,38]
Certification business	Number of green indexes	Types and quantity of green index of products to be certified	[21,31]
	Difficulty of detection of green indexes	Objectivity and difficulty in identifying the green index of the products to be certified	[21,31]
	Multi-site attribute of business	Multi-site attribute of the production to be certified	[21,31]
Certification implementation	Staffing	Human resources for document inspection, sampling inspection, on-site inspection, and other links of certification implementation	[21,31]
	Professional quality of personnel	The professional ability and quality of the personnel assigned to each link, such as document inspection, sampling inspection, and on-site inspection in the implementation of certification	[21,24,26,32,38]
	Inspection coverage of green indexes	Coverage of products, projects, and green indicators to be reviewed	[24,31]
	Degree of sampling standardization	The number of samples and method of sampling meet the relevant national specifications	[24,31,38]
	Level of subcontractor testing organization	Level of organization of testing by subcontractor or laboratory	[31,37]
	Communication frequency with enterprises	Maintaining frequent communication with certified enterprises	[23,31,38]

2.4. MCDM and Its Application in Risk Management and Green Product

The representative MCDM methods include the conventional ones such as AHP, ANP, DEMATEL, Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS), and the newly proposed ones such as the Stable Preference Ordering Towards Ideal Solution (SPOTIS), Characteristic Objects Method (COMET), and Sequential Interactive Modelling for Urban Systems (SIMUS).

These methods are more frequently applied and improved to find a reliable solution for a specific problem in various fields. Zha et al. employed the ANP and TOPSIS method to rank the optimal facility layout alternatives, and compared the difference between ANP–TOPSIS and AHP–TOPSIS [39]. Wudhikarn et al. improved the ANP method with Monte Carlo analysis and applied it in the new product formula selection decision [40]. Wang et al. used the entropy weight and VIKOR methods to evaluate and optimize the design schemes [41]. Li et al. employed the AHP–DEMATEL method to analyze the institutional barriers to integration innovation [42]. Dezert proposed a new MCDM which is rank reversal free called the SPOTIS method [43]. Baszkiewicz et al. conducted the comparative analysis of solar panels using two newly developed MCDM methods: COMET combined with TOPSIS and SPOTIS resistant to the rank reversal phenomenon [44]. Stoilova applied SIMUS as a tool to assess alternative transport policies for container carriage [45]. Stoilova et al. analyzed the policies of Bulgarian railway operators using SWOT criteria and the SIMUS method. The SIMUS method was applied to rank the alternatives and assess the criteria in the SWOT groups [46]. Kizielewicz et al. used three selected MCDA methods called COMET, TOPSIS, and SPOTIS in order to examine how the obtained rankings vary. It was observed that in the selection of material suppliers, all of the methods provide highly correlated results, and the obtained positional rankings are not significantly different [47].

MCDM has also been widely used in the risk management and green product field. Wu et al. proposed an improved AHP and applied it to the key personnel risk assessment [48]. Zeng et al. combined the AHP and entropy methods to assess the risk of urban gas pipelines [49]. Su et al. employed the AHP and fussy mathematics methods to evaluate the risk level of coal mines [50]. Erol et al. developed a risk assessment process for mega construction projects with an ANP model [51]. Su et al. comprehensively applied the ANP and probabilistic neural network methods to assess the risk of county mining areas [52]. Ge et al. proposed a safety risk assessment method based on Grey–ANP and employed it to evaluate the risk level of drug production [53]. Wang et al. comprehensively used the DEMATEL and interpretative structural model (ISM) to analyze Internet financial risks [54]. Zhang et al. explored the interaction between the key risk factors and analyzed the comprehensive impact on fire risk of large urban public buildings with the adoption of the DEMATEL–ISM method [55]. Lin assessed the risk of maritime accidents, applying balanced scorecard (BSC) concepts integrating DEMATEL with ANP [56]. Wudhikarn et al. applied the ANP approach for the election of green marketable products [57].

To sum up, the previous literature had analyzed the risk factors in GPC from different perspectives, which was beneficial to establish the initial risk factor set. However, previous studies did not identify the key risk factors in GPC, nor did they explore the interdependent impacts between risk factors. Meanwhile, the integrated MCDM method was suitable to solve the above problems. Therefore, we intended to use the integrated MCDM method to fill the gap.

3. Methodology

3.1. Delphi Method

The Delphi method was pioneered by the RAND Corporation in the United States and is used for prediction and decision-making [58]. It solicits anonymous expert advice and finally reaches a high consensus through several rounds of correspondence. An organizer summarizes the opinions of each expert in each round and then sends them to all the experts as a reference so that they can arrive at new conclusions. After several rounds of correspondence, the experts' opinions gradually converge and can be made available to the decision-makers.

The key to using the Delphi method is, first, to choose experts who are familiar with and proficient in the decision-making problem being considered, second, to ensure that the experts are anonymous, and, third, that they are provided with adequate and accurate information.

The procedure of the Delphi method as explained by Jiang et al. is briefly summarized in Figure 1 [59].

- Step 1: Form a group of experts based on the issues to be decided;
- Step 2: Provide the experts with the problems to be solved and the relevant information;
- Step 3: Collect the experts' opinions;
- Step 4: Perform a consistency test on the expert opinions.

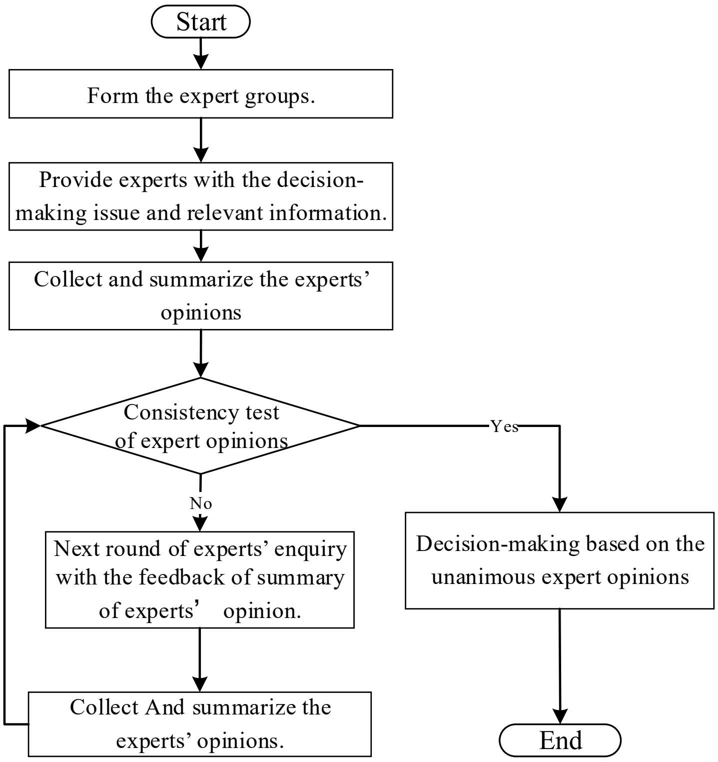

Figure 1. Procedure of the Delphi method.

If consistency is reached, a decision based on the consensus of the experts can be made. Otherwise, another round of inquiry should be conducted until consistency is reached.

3.2. D–ANP

We used the DEMATEL method to analyze the interactional relationship of risk factors in GPC, calculate the relation and prominence of each, construct a causality diagram of the risk factors, and identify the critical ones. We used the ANP to calculate the weight of each risk factor. The weight of all risk factors and their prominence were then integrated into weighted prominence. Following this, the risk factors that needed to be controlled in GPC were identified according to their weighted prominence. The steps of model construction were as follows:

- First, we collected data on interactions among the risk factors in GPC by using a questionnaire. The initial direct influence matrix $\boldsymbol{Z}$ for the risk factors in GPC is shown in Equation (1), where z_{ij} indicates the degree of influence of risk factor i on factor j:

$$Z = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ z_{n1} & z_{n2} & \vdots & z_{nn} \end{bmatrix} \quad (1)$$

- Second, we normalized the matrix $\boldsymbol{Z}$ to obtain the normalized direct influence matrix $\boldsymbol{X}$. The process is shown in Equation (2), where $\lambda = \frac{1}{\max_{1 \le i \le n} \sum_{j=1}^{n} z_{ij}} (i, j = 1, 2, \ldots, n)$.

$$X = \lambda \cdot Z \quad (2)$$

- Third, we calculated the total influence matrix $\boldsymbol{T}$ according to the normalized direct influence matrix X. $T = X(I - X)^{-1}$, and $\boldsymbol{I}$ represents the unit matrix. The total influence matrix $\boldsymbol{T}$ is regarded as an unweighted supermatrix for ANP. The weighted supermatrix, limited supermatrix, and the weights of each risk factor were calculated by the ANP.
- Fourth, we determined the interactional relationships between the risk factors. We assumed that in the total influence matrix $\boldsymbol{T}$, d_i represents the sum of the risk factors in the row, namely, the value of the comprehensive impact of the i-th risk factor on the other factors, and r_i represents the sum of the risk factors in the columns, that is, the total impact on the i-th risk factor by the other factors. The relation of the i-th risk factor can be obtained by $d_i - r_i$. If $d_i - r_i > 0$, it indicates that this risk factor has a significant impact on the other factors, and is called the driving factor. The higher the value is, the greater the influence of the risk factor on the other factors. If the opposite is the case, the factor is called the outcome factor. This was used to construct a diagram of the causal relationships among the risk factors.
- Finally, we determined the ranking of the risk factors and critical ones. The prominence of the i-th risk factor was calculated by $d_i + r_i$, indicating its importance in GPC. At the same time, the weight w_i of each factor was calculated according to the ANP. The weighted prominence of each factor was calculated and was used to rank the risk factors and identify the critical ones.

The framework of the model to identify the critical risk factors in GPC are shown in Figure 2.

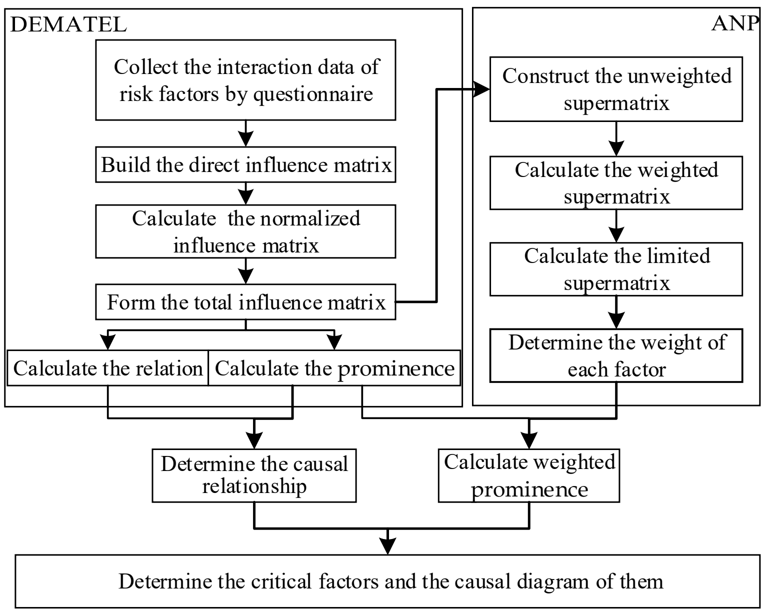

Figure 2. Framework of the DEMATEL–ANP model for analyzing risk factors.

4. Empirical Study

4.1. Establishing the Formal Decision Structure

The Delphi method was used to screen and optimize the initial set of risk factors in GPC. Five experts, with a rich practical experience and theoretical background in green building materials, green homes, and green textiles, were selected, as shown in Table 2.

Table 2. Professional backgrounds of the selected five experts for the Delphi survey.

Expert	Duties	Gender	Age	Specializes in	Working Area	Seniority (yr)	Experience
I	Senior Engineer	Male	45	Certification	Beijing	16	Since June 2005, he has served at J Certification Authority, and he is currently a senior engineer.
II	Senior Engineer	Male	40	Certification	Beijing	13	Since June 2008, he has served at J Certification Authority, and he is currently a senior engineer.
III	Professor	Male	45	Green development	Beijing	18	Since September 2003, he has served at Beijing Information Science and Technology University, and he is currently a professor.
IV	Professor	Male	36	Quality control	Beijing	10	Since September 2008, he has served at Beijing Information Science and Technology University, and he is currently a professor.
V	Associate Professor	Male	34	Circular economy	Shanghai	9	Since September 2012, he has served at Fudan University, and he is currently an associate professor.

In the first round of the Delphi questionnaire, an initial research framework was provided to experts. Experts judge whether the listed factors are suitable for GPC evaluation according to their experience, and check whether the definition of the criteria is clear.

In the second round of the Delphi questionnaire, the experts scored the risk factors on a scale of 0~10. A score of 0 denoted that the risk factor was absolutely unnecessary and one of 10 indicated that it was absolutely necessary. The consensus deviation index (CDI) was used to calculate the consensus degree of the expert panel. Taking 0.2 as the threshold of CDI, if it was greater than 0.2, it indicated a significant divergence in the experts' opinions, and the next round of expert scoring is required until all the CDI values were lower than 0.2 [60]. As shown in Table 3, the CDI values of 12 risk factors were lower than 0.2, indicating that the expert panel reached a consensus on 12 risk factors. Therefore, to prompt the experts to reach a consensus on the left six risk factors, the third round of the Delphi questionnaire was conducted.

Table 3. Necessity scores of risk factors in the second round of the Delphi questionnaire.

Risk Category	Risk Factor	Necessity Scoring I	II	III	IV	V	Mean Value	Standard Deviation	CDI
Certification institution	Working life	6	6	8	6	8	6.8	1.095	0.161
	Certification experience	8	8	7	8	10	8.2	1.095	0.134
	Strength	3	6	6	5	8	5.6	1.817	0.324
	Impartiality	10	10	8	7	10	9.0	1.414	0.157
	Management standardization	8	9	8	7	9	8.2	0.837	0.102
Entrusting enterprise	Social credit	3	3	7	5	6	4.8	1.789	0.373
	Nature of enterprise	2	6	6	6	6	5.2	1.789	0.344
	Scale of enterprise	8	8	8	7	9	8.0	0.707	0.088
	Satisfaction of enterprise	7	8	7	6	9	7.4	1.140	0.154
Certification business	Number of green indexes	7	6	8	8	10	7.8	1.483	0.190
	Difficulty of detection of green indexes	6	7	8	9	10	8.0	1.581	0.198
	Multi-site attribute of business	8	7	7	8	10	8.0	1.225	0.153
Certification Implementation	Staffing	10	8	9	6	9	8.4	1.517	0.181
	Professional quality of personnel	7	6	8	5	9	7.0	1.581	0.226
	Inspection coverage of green indexes	7	9	7	7	10	8.0	1.414	0.177
	Degree of sampling standardization	9	9	10	6	10	8.8	1.643	0.187
	Level of subcontractor testing organization	3	6	7	5	9	6.0	2.236	0.373
	Communication frequency with enterprises	5	9	8	6	10	7.6	2.074	0.273

In the third round of the Delphi questionnaire, the mean value and standard deviation of the second-round questionnaire filled out by all experts were presented. The experts whose scores exceeded the mean value plus or minus a standard deviation in the second round were asked to explain their reasons before they filled in the new scores. After the third round of the Delphi survey, the CDIs of all 18 factors were lower than 0.2, which showed that all experts had reached a consensus on all criteria. After the discussion of the experts, the experts agreed to take the average score of 6 as the critical value. As a result, risk factors whose mean values were less than 6 were judged to be unnecessary and discarded from further consideration. The discarded risk factors included the strength of the certification institution, social credit of the entrusting enterprise and its nature, professional quality of personnel in the implementation of certification, and level of subcontractor testing organization. Therefore, 12 risk factors were included in the formal decision structure (Table 4).

Table 4. Necessity scores of risk factors in the third round of the Delphi questionnaire.

Risk Category	Risk Factor	Necessity Scoring					Mean Value	Standard Deviation	CDI	Variable Number
		I	II	III	IV	V				
Certification institution	Working life	6	6	8	6	8	6.8	1.095	0.161	A1
	Certification experience	8	8	7	8	10	8.2	1.095	0.134	A2
	Strength	5	6	6	5	6	5.6	0.548	0.098	discarded
	Impartiality	10	10	8	7	10	9.0	1.414	0.157	A3
	Management standardization	8	9	8	7	9	8.2	0.837	0.102	A4
Entrusting enterprise	Social credit	4	4	5	4	5	4.4	0.548	0.125	discarded
	Nature of enterprise	4	5	6	5	5	5.0	0.707	0.141	discarded
	Scale of enterprise	8	8	8	7	9	8.0	0.707	0.088	B1
	Satisfaction of enterprise	7	8	7	6	9	7.4	1.140	0.154	B2
Certification business	Number of green indexes	7	6	8	8	10	7.8	1.483	0.190	C1
	Difficulty of detection of green indexes	6	7	8	9	10	8.0	1.581	0.198	C2
	Multi-site attribute of business	8	7	7	8	10	8.0	1.225	0.153	C3
Certification Implementation	Staffing	10	8	9	6	9	8.4	1.517	0.181	D1
	Professional quality of personnel	5	5	7	5	7	5.8	1.095	0.189	discarded
	Inspection coverage of green indexes	7	9	7	7	10	8.0	1.414	0.177	D2
	Degree of sampling standardization	9	9	10	6	10	8.8	1.643	0.187	D3
	Level of subcontractor testing organization	4	5	6	5	6	5.2	0.837	0.161	discarded
	Communication frequency with enterprises	5	7	6	5	6	5.8	0.837	0.144	discarded

4.2. Identification and Analysis of the Critical Risk Factors

We obtained the interdependent impacts data between risk factors through a questionnaire survey. There were 132 pairwise comparison questions in the questionnaire and the question was "How is the impact of the working life of the certification institution on its certification experience". Part of the questionnaire is shown in Table A1 in Appendix A.

We used the three-level scoring method of 0~2. A score of 0 represented no impact, 1 represented a general impact, and 2 represented a significant impact. The questionnaire survey was filled out by eight experts in GPC. We treated the weights of all experts equally and calculated the simple average value of the eight experts. The final summarized results were obtained to determine the initial direct influence matrix for risk factors in GPC, as shown in Table 5.

Table 5. The initial direct influence matrix for risk factors in GPC.

Factor	A1	A2	A3	A4	B1	B2	C1	C2	C3	D1	D2	D3
A1	0.000	1.750	1.750	1.875	0.375	0.375	0.625	1.250	0.625	1.500	1.500	2.000
A2	0.375	0.000	1.500	1.750	0.625	0.625	1.000	1.625	0.750	1.375	1.875	2.000
A3	0.625	0.500	0.000	1.500	0.625	0.500	0.500	0.500	0.625	1.375	1.625	1.875
A4	0.500	0.875	1.625	0.000	0.625	0.375	0.750	1.125	0.875	1.750	1.625	2.000
B1	0.250	0.500	0.625	0.750	0.000	1.875	1.125	1.000	1.375	1.375	1.250	1.000
B2	0.000	0.250	0.750	0.875	1.500	0.000	1.375	1.250	1.250	1.375	1.250	0.750
C1	0.375	0.625	1.125	0.750	0.625	1.125	0.000	1.125	1.125	1.875	1.500	1.000
C2	0.500	0.750	1.000	0.625	0.125	0.875	0.500	0.000	0.500	1.625	1.375	1.250
C3	0.125	0.625	0.625	0.500	0.875	1.250	0.875	1.500	0.000	1.750	1.625	1.375
D1	0.375	0.625	1.000	0.750	0.500	0.125	0.500	0.875	0.750	0.000	1.500	1.500
D2	0.250	0.875	1.250	1.125	0.375	0.750	0.875	1.000	0.750	1.625	0.000	1.250
D3	0.375	0.625	1.625	1.750	0.000	0.750	0.625	1.125	0.750	1.375	1.750	0.000

We used Equation (2) to standardize the initial direct influence matrix and obtain the normalized direct influence matrix $\boldsymbol{X}$, as shown in Table 6.

Table 6. The normalized direct influence matrix for risk factors in GPC.

Factor	A1	A2	A3	A4	B1	B2	C1	C2	C3	D1	D2	D3
A1	0.000	0.128	0.128	0.138	0.028	0.028	0.046	0.092	0.046	0.110	0.110	0.147
A2	0.028	0.000	0.110	0.128	0.046	0.046	0.073	0.119	0.055	0.101	0.138	0.147
A3	0.046	0.037	0.000	0.110	0.046	0.037	0.037	0.037	0.046	0.101	0.119	0.138
A4	0.037	0.064	0.119	0.000	0.046	0.028	0.055	0.083	0.064	0.128	0.119	0.147
B1	0.018	0.037	0.046	0.055	0.000	0.138	0.083	0.073	0.101	0.101	0.092	0.073
B2	0.000	0.018	0.055	0.064	0.110	0.000	0.101	0.092	0.092	0.101	0.092	0.055
C1	0.028	0.046	0.083	0.055	0.046	0.083	0.000	0.083	0.083	0.138	0.110	0.073
C2	0.037	0.055	0.073	0.046	0.009	0.064	0.037	0.000	0.037	0.119	0.101	0.092
C3	0.009	0.046	0.046	0.037	0.064	0.092	0.064	0.110	0.000	0.128	0.119	0.101
D1	0.028	0.046	0.073	0.055	0.037	0.009	0.037	0.064	0.055	0.000	0.110	0.110
D2	0.018	0.064	0.092	0.083	0.028	0.055	0.064	0.073	0.055	0.119	0.000	0.092
D3	0.028	0.046	0.119	0.128	0.000	0.055	0.046	0.083	0.055	0.101	0.128	0.000

The total influence matrix $\boldsymbol{T}$ was calculated by the formula $T = X(I - X)^{-1}$, as shown in Table 7.

Table 7. The total influence matrix for risk factors in GPC.

Factor	A1	A2	A3	A4	B1	B2	C1	C2	C3	D1	D2	D3
A1	0.122	0.345	0.495	0.480	0.192	0.252	0.282	0.423	0.3008	0.571	0.576	0.587
A2	0.144	0.217	0.463	0.454	0.205	0.266	0.301	0.435	0.3034	0.550	0.583	0.567
A3	0.134	0.206	0.284	0.365	0.169	0.207	0.217	0.291	0.2402	0.448	0.465	0.463
A4	0.140	0.256	0.434	0.306	0.188	0.227	0.260	0.370	0.2855	0.526	0.521	0.523
B1	0.110	0.211	0.334	0.322	0.143	0.317	0.275	0.342	0.3065	0.471	0.460	0.418
B2	0.090	0.186	0.326	0.314	0.234	0.185	0.280	0.342	0.2877	0.453	0.441	0.385
C1	0.121	0.222	0.371	0.327	0.183	0.263	0.195	0.349	0.2874	0.503	0.479	0.426
C2	0.114	0.201	0.317	0.277	0.123	0.210	0.196	0.225	0.2081	0.421	0.407	0.383
C3	0.102	0.218	0.333	0.305	0.196	0.271	0.253	0.368	0.2078	0.488	0.479	0.439
D1	0.102	0.186	0.304	0.273	0.138	0.157	0.186	0.273	0.2145	0.297	0.398	0.383
D2	0.107	0.224	0.358	0.332	0.152	0.220	0.237	0.317	0.2439	0.455	0.350	0.415
D3	0.121	0.219	0.400	0.387	0.135	0.227	0.230	0.338	0.2532	0.461	0.485	0.353

We obtained the prominence and relation of each risk factor and then determined the type according to their relation. The results are shown in Table 8.

Table 8. Prominence and relation of each risk factor in GPC.

Factor	d	r	d + r	d − r	Type
A1	4.626	1.406	6.032	3.220	Driving factors
A2	4.488	2.691	7.178	1.797	Driving factors
A3	3.488	4.417	7.904	−0.929	Outcome factors
A4	4.036	4.142	8.178	−0.106	Outcome factors
B1	3.708	2.057	5.764	1.651	Driving factors
B2	3.521	2.801	6.322	0.721	Driving factors
C1	3.728	2.912	6.640	0.815	Driving factors
C2	3.082	4.074	7.155	−0.992	Outcome factors
C3	3.658	3.139	6.797	0.519	Driving factors
D1	2.912	5.644	8.556	−2.731	Outcome factors
D2	3.411	5.643	9.054	−2.233	Outcome factors
D3	3.609	5.340	8.949	−1.731	Outcome factors

The results showed that the risk factors in GPC were divided into two categories. The driving factors were the working life of the certification institution (A1), the experience of the certification institution (A2), the scale of the entrusting enterprise (B1), the satisfaction of the entrusting enterprise (B2), the number of green indexes in the certification business (C1), and the multi-site attributes of business in the certification business (C3). These factors formed a direct source of risk in GPC. The outcome factors were the impartiality of the certification institution (A3), its management standardization (A4), the difficulty of inspection of green indexes in the certification business (C2), staffing in the certification implementation (D1), inspection coverage of green indexes in the certification implementation (D2), and the degree of sampling standardization in the implementation (D3). These risk factors were the indirect sources of risk in GPC, and the risk posed by them can be reduced by controlling the driving factors.

The total influence matrix, shown in Table 7, was taken as the unweighted supermatrix of the ANP model. The weighted supermatrix and limited supermatrix were calculated, and the weight coefficients of each risk factor are shown in Table 9.

Table 9. The limited supermatrix for risk factors in GPC.

Factor	A1	A2	A3	A4	B1	B2	C1	C2	C3	D1	D2	D3
A1	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103
A2	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
A3	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
A4	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091
B1	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084
B2	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
C1	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084
C2	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070
C3	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082
D1	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
D2	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078
D3	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081

The weighted prominence of each risk factor was calculated by combining its prominence in Table 8 with its weight coefficient in Table 9. The factors were then sorted according to this measure and the results are shown in Table 10.

Table 10. Comprehensive ranking of GPC risk factors.

Risk Factors	Prominence	Weight	Weighted Prominence	Sorting
Working life of certification institution A1	6.032	0.103	0.623	6
Experience of certification institution A2	7.178	0.100	0.719	3
Impartiality of certification institution A3	7.904	0.080	0.63	5
Management standardization of certification institution A4	8.178	0.091	0.746	1
Scale of entrusting enterprise B1	5.764	0.084	0.484	12
Satisfaction of entrusting enterprises B2	6.322	0.08	0.505	10
Number of green indexes of certification business C1	6.64	0.084	0.559	8
Difficulty of detection of green indexes of certification business C2	7.155	0.070	0.501	11
Multi-site attribute of business C3	6.797	0.082	0.558	9
Staffing in certification implementation D1	8.556	0.067	0.569	7
Inspection coverage of green indexes in certification implementation D2	9.054	0.078	0.703	4
Degree of sampling standardization in certification implementation D3	8.949	0.081	0.728	2

According to Table 10, the six most critical risk factors in GPC were the management standardization of the certification institution (A4), degree of sampling standardization in the implementation of certification (D3), the experience of the certification institution (A2), inspection coverage of green indexes in the implementation (D2), the impartiality of the certification institution (A3), and working life of the certification institution (A1).

The causality diagram of critical risk factors in GPC was created by combining the relation in Table 8 with their weighted prominence in Table 10 and is shown in Figure 3. Six risk factors shaded in black were the critical risk factors. Furthermore, the working life of the certification institution (A1) and experience of the certification institution (A2) were the critical driving ones.

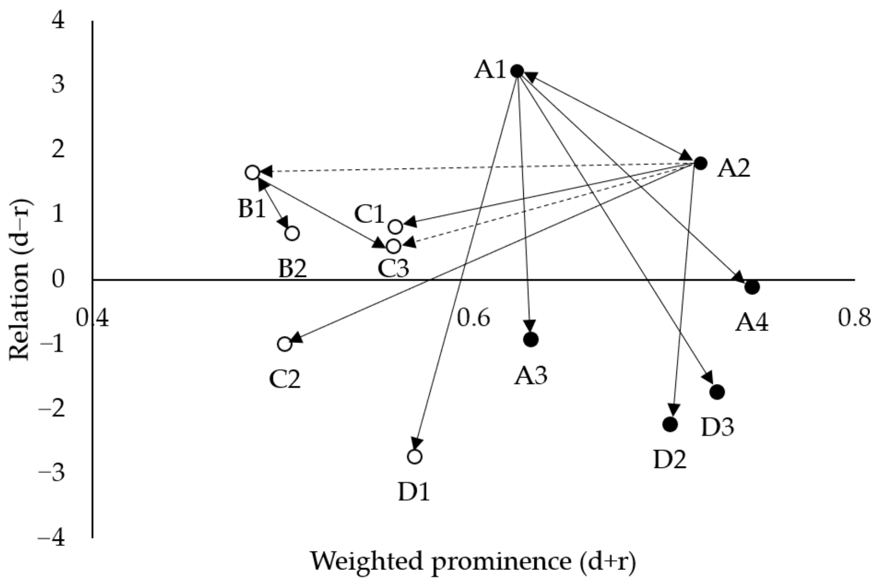

Figure 3. Causality diagram of critical risk factors in GPC.

5. Discussion and Implications

This study constructed a hybrid MCDM model integrating the DEMATEL and the ANP to identify the critical risk factors in GPC. Compared with the previous literature, previous studies have found some risk factors in GPC, such as risk factors related to certification institution, entrusting enterprise, certification business, and certification implementation [20–38]. However, they did not distinguish the importance of risk factors nor did they consider the influence relationship between the risk factors. According to the empirical results, the certification institutions and the implementation of the certification process are important sources of risk in GPC. Specifically, the working life of the certification institution (A1), the experience of the certification institution (A2), its impartiality (A3), standardization of management (A4), coverage of inspection of green indices in implementation (D2), and degree of standardization of sampling (D3) are critical risk factors. We also distinguish the driving risk factors and the outcome ones. Due to limitations of human and material resources, the results of this study are critical for risk management in GPC.

Accordingly, we proposed the following control measures for them:

(1) The standardization of management of certification institutions is the most important risk factor. The effectiveness of GPC is affected by whether the certification body earnestly implements the rules of certification, and whether the selection, training, continuing education, and performance evaluation of the personnel are scientific and reasonable. Therefore, certification institutions should strengthen their measure of standardization. Only in this way can they deal with all kinds of certification-related risks. However, the standardization of the management-related risks of certification institutions is a resulting factor that is mainly affected by the working life of these institutions, which shows that they need to continually improve their specifications in the long term.

(2) The working life and experience of the certification institution are the critical factors driving the risk in certification. The former has a decisive impact on the experience, impartiality, and standardization of management of the organization. It also significantly affects the allocation of human resources and the standardization of sampling operations in the process of certification. Therefore, organizations that have carried out certification for a long time have rich certification experience and a more standardized management system to ensure the impartiality of the process. In this way, the institutions can allocate the necessary number of competent personnel to carry out the relevant business operations. The experience of certification institutions has a decisive impact on the difficulty of testing green indicators, the coverage of inspection

of green indices, and the number of green indices. Certification institutions with rich experience can improve their coverage of the green indices of certification businesses to reduce the risk caused by a large number of indices and the difficulty of testing them. Regulatory authorities should also strengthen the inspections and supervision of certification businesses with little experience.

(3) The impartiality of certification institutions has an important impact on the overall risk in GPC. If there is no guarantee of impartiality, the green certificate issued by the institution has no authority. The impartiality of the certification institution is mainly reflected in whether it aims to make a profit, has established an adequate committee to maintain impartiality, its operation and management are independent, it has an interest-based relationship with the entrusting enterprise, has issued a declaration of impartiality and implemented it, has established a code of conduct to regulate the behavior of the certification personnel, and whether there is discrimination against the applicant. Certification institutions should test their own impartiality based on the above and regulatory authorities need to supervise them as well.

(4) If the certification institution reduces the number of green indicators for inspection or does not appropriately inspect green indicators to save on labor and material resources during the inspection, the certification-related risks increase. Rules for the implementation of GPC must be strictly implemented in the process of certification, and the standard of coverage of green indicators stipulated by the state should not be meddled with. The regulatory authorities should conduct spot-checks on the human and material resources used, as well as the green indicators inspected, to ensure the quality of the certification work.

(5) The degree of standardization of sampling in the implementation of GPC has an important impact on the overall risk in GPC. Standardization is mainly manifested in whether different categories of products of the same certification unit were sampled, whether the number of sampling products to be inspected meets the requirements of the certification specifications, whether the sampling method is scientific and reasonable, and whether the laboratory for sampling has the corresponding qualifications. If the sampling inspection is not standardized, the risk of certification increases. Therefore, the relevant management should be strengthened in the implementation of certification. In addition, as shown in Figure 2, the degree of normalization of sampling is a resulting factor that is mainly affected by the age of the certification body. That is, the sampling operation of certification bodies with more experience is more standardized, which means that supervision departments should strengthen the inspection of sampling operations in newly established certification institutions.

(6) The risk factors pertaining to the entrusting enterprise and the certification business are also sources of risk to GPC. However, the results here showed that these two types of risks were not critical. The scale of the entrusting enterprise, the satisfaction of the technical management, and the difficulty of the certification business did not play a decisive role in the risk to certification because the entrusting enterprise and the authentication business were only the objects of authentication, which is an external cause of the system of risk. However, external causes could permeate the system through internal causes. If the certification institution has the corresponding professional experience and standardized certification management, strictly implements the norms of implementation of certification, fairly carries out the certification business, and is equipped with the necessary material and human resources, potential risks associated with the object of certification can be avoided.

6. Conclusions

This study constructed a system of risk factors in GPC to meet the demands of risk control in the process. Critical risk factors were identified based on the DEMATEL–ANP multi-criteria decision-making model and the corresponding countermeasures were proposed. The conclusions of this study were as follows:

- First, we formed the initial set of risk factors for certification by combining the insights of past studies in the area. The set contained 18 risk factors pertaining to the certification institution, entrusting enterprise, certification business, and the implementation of certification. Expert scoring was used to screen and optimize this initial set. Six risk factors below the threshold were eliminated by calculating the mean value of their necessity scores and dispersion coefficients. A set of risk factors in GPC containing 12 risk factors was thus obtained;
- Second, we used the DEMATEL method to analyze the interactional relationship among the risk factors. A questionnaire survey was filled out by experts in the field of GPC, and the data were used to construct a direct influence matrix of the risk factors. A total influence matrix was then obtained from it. The risk factors are divided into driving factors and resulting factors according to their relations. Driving factors were the fundamental sources of risk in GPC and included the working life of the certification institution, its certification experience, the scale of the entrusting enterprise, satisfaction with the technical management of the entrusting enterprise, the number of green indicators involved in the certification business, and the multi-site attribute of the certification business;
- Third, the DEMATEL–ANP model was used to identify the critical risk factors in GPC. The weighted prominence of each risk factor was then calculated by combining its prominence from the DEMATEL model with its weight coefficient from the ANP model. It was used to identify the critical risk factors in GPC;
- Finally, countermeasures for risk prevention and to ensure control over GPC were proposed.

In future studies, some limitations of the study and additional considerations should be taken into account. First, although 18 risk factors were defined in four categories based on an exhaustive literature review, in future studies, the source of risk factors should be further expanded with the increasing actual certification business volume and the publication of relevant studies. Second, in this study, experts' weights are treated equally. The level of experience of each expert will be taken into account in the future study.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of the School of Economics and Management, Beijing Information Science and Technology University (7 March 2022).

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Appendix A

Table A1. Part of the questionnaire.

1. What do you think about the impact of the working life of the certification institution on its certification experience? - no impact (0) - a general impact (1) - a significant impact (2)
2. What do you think about the impact of the working life of the certification institution on its strength? - no impact (0) - a general impact (1) - a significant impact (2)
3. What do you think about the impact of the working life of the certification institution on its impartiality? - no impact (0) - a general impact (1) - a significant impact (2)
4. What do you think about the impact of the working life of the certification institution on its management standardization? - no impact (0) - a general impact (1) - a significant impact (2)

References

1. Gurau, C.; Ranchhod, A. International green marketing: A comparative study of British and Romanian firms. *Mark. Rev.* **2005**, *2*, 547–561. [CrossRef]
2. Lam, A.Y.C.; Lau, M.M.; Cheung, R. Modelling the relationship among green perceived value, green trust, satisfaction, and repurchase intention of green products. *Contemp. Manag. Res.* **2016**, *12*, 47–60. [CrossRef]
3. Palevich, R. *Lean Sustainable Supply Chain: How to Create a Green Infrastructure with Lean Technologies*; Pearson Education: London, UK, 2011.
4. *General Rules for Green Product Evaluation*; GB/T 33761-2017; China Standards Press: Beijing, China, 2018.
5. Hemmelskamp, J.; Brockmann, K.L. Environmental labels—The German 'Blue Angel'. *Futures* **1997**, *29*, 67–76. [CrossRef]
6. Zhang, C.L.; Zhang, J.; Tian, X.F. Identification and evaluation of key risk points of green product certification based on combination weighting. *J. Stat. Inf.* **2019**, *34*, 83–91.
7. Murphy, B.; Martini, M.; Fedi, A. Consumer trust in organic food and organic certifications in four European countries. *Food Control* **2021**, *133*, 108–148. [CrossRef]
8. Zhang, C.L.; Zhang, J.; Jiang, P. Assessing the risk of green building materials certification using the back-propagation neural network. *Environ. Dev. Sustain.* **2021**. Early Access. [CrossRef]
9. Ouyang, Y.P.; Shieh, H.M.; Tzeng, G.H. A VIKOR technique based on DEMATEL and ANP for information security risk control assessment. *Inf. Sci.* **2013**, *232*, 482–500. [CrossRef]
10. Bao, C.; Wu, D.; Li, J. Measuring systemic importance of banks considering risk interactions: An ANOVA-like decomposition method. *J. Manag. Sci. Eng.* **2020**, *5*, 23–42. [CrossRef]
11. Saaty, T.L. *Fundamentals of Decision Making and Priority Theory with the AHP*; RWS Publications: Pittsburgh, PA, USA, 1994.
12. Tian, B.; Liu, P.Y.; Zheng, Y.S. Research on risk identification and evaluation of Internet of vehicles information platform based on ANP Method. *Inf. Sci.* **2018**, *36*, 100–104.
13. Liu, C.; Li, K.; Jiang, P.; Li, D.; Su, L.; Lu, S.; Li, A. A hybrid multiple criteria decision-making technique to evaluate regional intellectual capital: Evidence from China. *Mathematics* **2021**, *9*, 1676. [CrossRef]
14. Jiang, P.; Wang, Y.; Liu, C.; Hu, Y.-C.; Xie, J. Evaluating Critical Factors Influencing the Reliability of Emergency Logistics Systems Using Multiple-Attribute Decision Making. *Symmetry* **2020**, *12*, 1115. [CrossRef]
15. Gao, G.J. *Innovation and Perfection of Compulsory Product Certification System*; Southwest University of Political Science & Law: Chongqing, China, 2016.
16. Albersmeier, F.; Schulze, H.; Jahn, G.; Spiller, A. The reliability of third-party certification in the food chain: From checklists to risk-oriented auditing. *Food Control* **2009**, *20*, 927–935. [CrossRef]
17. Deaton, B.J. A theoretical framework for examining the role of third-party certifiers. *Food Control* **2004**, *15*, 615–619. [CrossRef]
18. Bao, C.B.; Wu, D.S.; Wan, J. Comparison of Different Methods to Design Risk Matrices from The Perspective of Applicability. *Procedia Comput. Sci.* **2017**, *122*, 455–462. [CrossRef]

19. Clean Clothes Campaign. Looking for a Quick Fix: How Weak Social Auditing is Keeping Workers in Sweatshops, Amsterdam. 2005. Available online: http://www.cleanclothes.org/ftp/05-quick_fix.pdf (accessed on 1 December 2021).
20. Anders, S.; Souza Monteiro, D.M.; Rouviere, E. Objectiveness in the market for third-party certification: What can we learn from market structure? In Proceedings of the 105th EAAE Seminar 'International Marketing and International Trade of Quality Food Products', Bologna, Italy, 8–10 March 2007.
21. Schulze, H.; Albersmeier, F.; Jahn, G.; Spiller, A. Checklist governance: Risk oriented audits to improve the quality of certification standards in the food sector. In Proceedings of the 16th Annual World Food and Agribusiness Forum, Symposium and Case Conference of the IAMA, Buenos Aires, Argentina, 10–13 June 2006.
22. Wu, D.S.; Zhu, X.Q.; Wan, J. A Multi objective Optimization Approach for Selecting Risk Response Strategies of Software Project: From the Perspective of Risk Correlations. *Int. J. Inf. Technol. Decis. Mak.* **2019**, *18*, 339–364. [CrossRef]
23. Wang, W. Risk control in certification project management. *China Certif. Accredit.* **2010**, *3*, 46–47.
24. Liu, Z.A. Risk analysis and control of organic agricultural product certification. *Trop. Agric. Sci. Technol.* **2011**, *34*, 40–42.
25. Tanner, B. Independent assessment by third-party certification bodies. *Food Control* **2000**, *11*, 415–417. [CrossRef]
26. Pignatti, E.; Spadoni, R. Trust within the Organic Food Supply Chain: The Role of the Certification Bodies. In Proceedings of the 99th EAAE Seminar 'Trust and Risk in Business Networks', Bonn, Germany, 8–10 February 2006.
27. Jahn, G.; Schramm, M.; Spiller, A. The Reliability of Certification: Quality Labels as a Consumer Policy Tool. *J. Consum. Policy* **2006**, *28*, 53–73. [CrossRef]
28. Du, Q.T.; Chang, Y.C.; Ma, X.W. Research on risk assessment of certification of fabricated building parts and components. *J. Eng. Manag.* **2019**, *33*, 32–37.
29. Pang, R. Risk analysis in the process of GMP certification based on the new version. *Discov. Value* **2014**, *4*, 112.
30. Sun, Y.; Chen, D.D. Quality risk analysis and control of on-site inspection for GMP certification. *Merch. Qual.* **2018**, *3*, 252.
31. Zhao, M. Preliminary study on risk management mode of management system certification. *Stand. Sci.* **2010**, *9*, 82–86.
32. Tan, F.M.; Xu, X.X.; Wang, F.F. Risk identification of inspectors in factory on-site inspection. *China Qual. Certif.* **2017**, *9*, 50–52.
33. Yin, X.M. Preliminary study on risk management mode recognized by certification bodies. *Stand. Sci.* **2013**, *10*, 84–87.
34. Liu, C.F.; Xu, X.X.; Wang, F.F. Risk identification of factory in factory on-site inspection. *China Qual. Certif.* **2017**, *9*, 53–54.
35. Liu, H. Quality risk analysis and control of on-site inspection of GMP certification. *Heilongjiang Med. J.* **2015**, *28*, 1243–1244.
36. Jiang, Y.Z.; Zou, Y. Quality risk analysis and control of on-site inspection of GMP certification. *J. Guangdong Pharm. Univ.* **2010**, *26*, 302–304.
37. Cheng, Z.W.; Yao, D.M.; Shi, W. Risk analysis of common administrative regulations of system certification Institutions. *China Certif. Accredit.* **2014**, *6*, 23–24.
38. Wan, L.J.; Zhu, Y.; Liu, J.H. Research on endogenous risk management of agricultural product quality and safety certification—Taking pollution-free agricultural product certification as an example. *Food Nutr. China* **2016**, *22*, 9–12.
39. Zha, S.S.; Guo, Y.; Huang, S.H.; Tang, P.Z. A hybrid MCDM approach based on ANP and TOPSIS for facility layout selection. *Trans. Nanjing Univ. Aeronaut. Astronaut.* **2018**, *35*, 1027–1037.
40. Wudhikarn, R.; Chakpitak, N.; Neubert, G. Use of an Analytic Network Process and Monte Carlo Analysis in New Product Formula Selection Decisions. *Asia-Pac. J. Oper. Res.* **2015**, *32*, 1550007. [CrossRef]
41. Wang, Z.Y.; Yan, L.L.; Deng, Y.Y.; Yang, H.M. Evaluation and optimization of design schemes based on entropy weight and VIKOR method. *J. Mach. Des.* **2022**, *39*, 154–160.
42. Li, S.G.; Ma, Y.H.; Zhu, E.J. Analysis of institutional barriers of integration innovation based on AHP-DEMATEL. *J. Harbin Eng. Univ.* **2022**. Early Access.
43. Dezert, J.; Tchamova, A.; Han, D.Q.; Tacnet, J.M. The SPOTIS rank reversal free method for multi-criteria decision-making support. In Proceedings of the 23rd International Conference on Information Fusion, Rustenburg, South Africa, 6–9 July 2020; pp. 195–202.
44. Bączkiewicz, A.; Kizielewicz, B.; Shekhovtsov, A.; Yelmikheiev, M.; Kozlov, V.; Sałabun, W. Comparative Analysis of Solar Panels with Determination of Local Significance Levels of Criteria Using the MCDM Methods Resistant to the Rank Reversal Phenomenon. *Energies* **2021**, *14*, 5727. [CrossRef]
45. Stoilova, S. Application of SIMUS Method for Assessment Alternative Transport Policies for Container Carriage. In Proceedings of the 18th International Scientific Conference Engineering for Rural Development, Jelgava, Latvia, 22–24 May 2019.
46. 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]
47. Kizielewicz, B.; Więckowski, J.; Shekhovtsov, A.; Wątróbski, J.; Depczyński, R.; Sałabun, W. Study towards the time-based mcda ranking analysis—A supplier selection case study. *Facta Univ. Ser. Mech. Eng.* **2021**, *19*, 381–399. [CrossRef]
48. Wu, R.B.; He, Y.X.; Jia, Y.F. Key personnel risk assessment method based on improved AHP. *China Saf. Sci. J.* **2021**, *31*, 112–118.
49. Zeng, X.K.; Feng, Y.; Lai, W.Q. Risk assessment of urban gas pipeline based on AHP and entropy weight method. *J. Saf. Sci. Technol.* **2021**, *17*, 130–135.
50. Su, Y.S.; Zhang, C.L.; He, Y.H. Regional coal mine safety risk grade evaluation based on AHP and Fuzzy Mathematics. *Coal Technol.* **2019**, *38*, 124–127.
51. Erol, H.; Dikmen, I.; Atasoy, G. An analytic network process model for risk quantification of mega construction projects. *Expert Syst. Appl.* **2022**, *191*, 1–17. [CrossRef]

52. Su, Y.S.; Zhang, C.L.; Liao, M.J. Safety risk assessment of county mining area based on ANP and probabilistic neural network. *Saf. Coal Mines* **2020**, *51*, 251–256.
53. Ge, J.J.; Peng, B.H.; Wei, G.; Wan, A.X. Risk assessment on drug production safety based on Grey-Analytic Network Process. *Kybernetes* **2021**, *12*. Early Access. [CrossRef]
54. Wang, Y.; Sheng, Y.; Xue, X.Q. Blockchain technology and internet financial risk prevention and control route. *Stud. Sci. Sci.* **2022**, *40*, 257–268.
55. Zhang, W.D.; Chen, Y.Z.; Li, Q.; Wu, D. Analysis of degree of influence and risk possibility of fire risk factors in large-scale public buildings in cities. *J. Saf. Environ.* **2021**, *21*, 1434–1439.
56. Lin, W.C. Maritime Environment Assessment and Management Using through Balanced Scorecard by Using DEMATEL and ANP Technique. *Int. J. Environ. Res. Public Health* **2022**, *19*, 2873. [CrossRef] [PubMed]
57. Wudhikarn, R.; Chakpitak, N.; Neubert, G. An analytic network process approach for the election of green marketable products. *Benchmarking Int. J.* **2015**, *22*, 994–1018. [CrossRef]
58. Schmidt, R.C. Managing Delphi surveys using nonparametric statistical techniques. *Decis. Sci.* **1997**, *8*, 763–774. [CrossRef]
59. Jiang, P.; Hu, Y.C.; Yen, G.F.; Tsao, S.J. Green supplier selection for sustainable development of the automotive industry using grey decision-making. *Sustain. Dev.* **2018**, *26*, 890–903. [CrossRef]
60. Deng, Z.Y. *Multi Criteria Decision Analysis Method and Application*; Dingmao Book Publishing Co. Ltd.: Taipei, China, 2012.