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Exploring critical factors of green business failure based on Grey-Decision Making Trial and Evaluation Laboratory (DEMATEL)

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ABSTRACT

Business failure is an important issue for companies in the 21st century, and green business is of global concern. Therefore, it is of vital importance to reveal the critical factors that could lead to green business failure. Nevertheless, existing research has not fully addressed this yet. This study adopts the company life cycle theory to identify such critical factors. The Decision Making Trial and Evaluation Laboratory (DEMATEL) method is applied to convert the expert opinion into quantifiable data, and grey relational analysis is used to take the imprecise information into account in order to improve the validity of the results. Research frameworks constructed from company life cycle is able to reflect the critical factors that lead to green business failure at different development phases. Meanwhile, the adoption of Grey DEMATEL improves the accuracy of assessment, and the result of assessment provides feasible and practical suggestions for decision-making.

1. Introduction

Since the beginning of the twenty-first century, the global economy has experienced not only unparalleled changes, but also unprecedented challenges. Especially with growing societal attention on environmental sustainability, companies are realizing that they should take some actions to meet not just economic but also social and environmental needs. Green business refers to meeting the needs of customers without causing environmental and social problems, is an important way to realise sustainable business (Kanchan, Kumar, & Gupta, 2015). Green business provides an opportunity for companies to respond to the changes and strengthens the sustainable competitive advantage. So the companies can gain a favourable position in the market. Therefore, more and more companies run green businesses. While implementing green business, the organisation needs to manage many internal and external risk factors or difficulties, be they foreseeable or not (Su, Shih, & Hsu, 2014). In order to run green business well, some researchers have investigated drivers of green business growth, and the successful experience has been summarised for company reference (Yi, 2014). Hwang, Zhu, and Tan (2017) suggested that the most feasible solution for green business was "government's co-funding and incentives for training and technologies". Some researchers have noted some influencing factors in green business success, for example, top management support (Dai, Montabon, & Cantor, 2014), employee training (Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010), supply chain collaboration (Dai, Cantor, & Montabon, 2015), and environment dynamism (Chan, Yee, Dai, & Lim, 2016).

Meanwhile, the research aims on business failure is to derive methods that could prevent critical losses incurred by enterprises (Wang & Wu, 2017). As an old Chinese saying goes — "failure is the mother of success", that is, there is some wisdom to be learned from failure. Business failure has been frequently observed and has become one of the most important issues in the business and management domain (Kherrazi & Ahsina, 2016). For example, if emotional problems lead to business failure, emotion-focused coping can be used to deal with negative emotions and promote self-reflection, then improve business condition (Byrne & Shepherd, 2015). Thus, exploring the critical factors of business failure is important for future business success. To summarise from literature review, there are lots of studies that discuss the success factors of green business. There are some studies that consider business failure, but seldom consider "green". In order to fill this gap, this study aims to reveal the critical factors on green business failures, in order to provide a reference framework for company to learn from failure and to avoid failure in the past which would improve the chances of green business success. This study can advance the theory by constructing a framework to avoid green business failure in parallel to the current studies that mainly pay attention to investigating the success factors. As a consequence, it is more convincing in terms of theory to practice green business.

To accurately identify the critical factors of green business failure, it

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is more practical to conduct situational analysis by introducing some theories to present the negative factors of a "declining" green business that must urgently be reconstructed and introduced to new evaluation measures. Constructing a framework for identifying the critical factors is the key. Through the analysis from previous studies, scholars can pay more attention in extracting, analyzing, and evaluating the critical factors. For instance, Büyüközkan and Güleryüz (2016) extracted 21 criteria from five aspects, namely, technical, economic, political, social, and environmental. Jeng (2015) investigated environmental uncertainty, asset specificity, and trust as focus indicators in a causal model of supply chain collaboration. A company itself also has a life cycle, which will go through stages of maturity and predicaments (Al-Hadi, Chatterjee, Yaftian, Taylor, & Monzur Hasan, 2017), a failure can occur at any phase and the reason of failure is diverse. Nevertheless, previous studies do not provide an explanation of this phenomenon. Therefore, this study will adopt life cycle theory as the theoretical basis to build a new framework for evaluating the factors that lead to company failure at all stages of life cycle.

Then, a quantitative analysis was conducted with the help of expert evaluation in order to reveal the importance of each influencing factor. The "Decision-Making and Trial Evaluation Laboratory" (DEMATEL) method is employed in this assessment process. DEMATEL is a well-known methods and a lot of studies have applied this. Therefore, it is very straightforward to apply DEMATEL. That being said, the major shortcoming of DEMATEL is that it relies on experts' evaluation. This may introduce inconsistency. This study compensates this issue by using Grey Set Theory (Xia, Govindan, & Zhu, 2015). Because grey set theory is suitable for dealing with the information that only part of the information is clear, whereas the other part is unclear and uncertain. In this connection, the grey set theory has the ability to compensate for incomplete information (Su et al., 2016). Consequently, in order to assess the relationship between the factors more accurately and practically, grey set theory is blended with the DEMATEL to incorporate uncertainty, imprecise information, and ambiguity into the assessment process.

Therefore, the contributions of this study include: (1) Investigate the influencing factors on green business from a business failure perspective. This will provide a holistic research in green business; (2) Develop a framework to include abovementioned factors based on the company life cycle lens, enriching the building of theoretical framework; (3) Combine grey set theory and DEMATEL to evaluate the factors. Consequently, the accuracy and practicality of the assessment results can be improved. The remainder of this article is structured as follows. Section 2 provides a comprehensive literature review about green business and its critical factors, life cycle theory and application of Grey-DEMATEL to identify the potential influencing factors for green business failure. Section 3 describes the research method, including Grey-DEMATEL (GDEMATEL) and analytical procedures. In Section 4, data processing and analysis are presented. Section 5 discusses the implications of this work, and Section 6 presents conclusions and limitations of this study.

2. Literature review

2.1. Green business and its critical factors

Green business is aiming at introducing products, processes, services and business models with low-car bon, resource efficient or re-manufactured, the green business operates and delivers in a significantly more sustainable way than their closest competitors (Kanchan et al., 2015). Especially in the entrepreneurial environment specific to the 21st century, the development and modernisation require companies to adopt green business strategies (Mioara & Mihai, 2014). Ilinitch and Schaltegger (1995) suggested that green business needs to incorporate an environmental dimension into companies' strategy planning process. Kirchhoff (2000) believed that companies running green business should switch to environmentally sound inputs, reduce waste and pollution in the production process, and increase biodegradability of the final product. Lin, Tseng, Chen, and Chiu (2011) used a hybrid method to analyse the green business innovation capabilities.

With intense competition in current business world, there are a lot of factors leading to the business failure. For example, manager cognition has been seen as an important failure factor (Cox & Vos, 2005). Other factors such as fluctuation in costs, delays from clients, lack of experience in contracts, a low margin of profit due to competition (Mahamid, 2012) and supplier selection (Bohner & Minner, 2017) can also result in business failure. For green business, green process management and improvement are the key to achieving sustainable development, for example, for real estate companies (Peng & Zhang, 2014), the agri-business (Cui, 2017), and so on. One of the effective approaches to make business operations more environmentally friendly is to undertake business process reengineering with a strategic focus on green perspectives (Lan, 2012). Chen and Wu (2015) explored the influence of companies' perception of green business on the implementation of green business and business performance.

However, many of these studies aimed to find the impact of a single factor on green business, such as green human resources (Ahmad, 2015). The research rarely incorporates multiple factors to evaluate the degree of influence between the factors, and rarely considers the link among green business failure factors. Therefore, in this study, influencing factors of green business failure were identified based on life cycle theory in order to facilitate a comprehensive analysis of green business failure. At the same time, the DEMATEL method is applied to quantify the importance of each factor, and grey set theory is utilised to deal with the semantic uncertainty problem effectively.

2.2. Life cycle theory

Life cycle theory covers a wide range of issues. For example, leadership life cycle theory (Hersey & Blanchard, 1969), company life cycle theory (Mueller, 1972), organizational life cycle theory (Smith & Miner, 1983), product life cycle theory (Windrum & Birchenhall, 1998), and so on. A life cycle represents several stages of an individual or a collective life over time. Life cycle theory is applied in many areas: the construction industry (Buyle, Braet, & Audenaert, 2013), photovoltaic electricity (Zhai & Williams, 2010), plants (Hsieh & Klenow, 2014), the environmental evaluation of product development processes (Cabeza, Rincón, Vilariño, Pérez, & Castell, 2014), corporate finance (Arikan & Stulz, 2016), and corporate social responsibility (Al-Hadi et al., 2017).

The life cycle of a company has diverse definitions, and more importantly they are still vague. For instance, there is no consensus on the number of phrases of different life cycles. To name a few, Smith, Mitchell, and Summer (1985) showed that there are three phases in the life cycle of a company: Inception, High-Growth, and Maturity. Faugère and Shawky (2004) argued that there are four phases in the life cycle of a company, namely, Introduction, Growth, Maturity, and Decline phases. Miller and Friesen (1984) proposed five phases including Birth phase, Growth phase, Maturity Phase, Revival phase, and Decline phase. Nevertheless, company life cycle is a good reference model for research. For example, Bellone, Musso, Nesta, and Quéré (2008) argued that depending on the age of the company, the determinants of business survival are different. Dickinson (2011) developed a company life cycle proxy using cash flow patterns. The patterns provided a parsimonious indicator of life cycle stage that is free from distributional assumptions.

Despite the importance of life cycle theory, few studies made it the basis to build a business failure research framework. If one study does not consider management theory to support the framework, it will seriously affect the accuracy of the evaluation result, and will therefore affects the practical value of research. Hence, this paper builds a green business failure framework based on life cycle theory, which lays a solid theoretical foundation for this research. Therefore, in this study, the

Aspects part of the green business failure is constructed based on the five phases of the company life cycle theory: the Latent Phase (LP), Growth Phase (GP), Maturity Phase (MP), Shaky Phase (SP) and Recession Phase (RP). Then, 16 criteria are selected as the influencing factors of green business failure based on these five aspects.

2.3. Application of Grey-DEMATEL

The DEMATEL is an effective approach for analyzing relationships between factors of concern with respect to the type and severity. It selects the logical relationship among the elements and the direct impact of the matrix in order to calculate the influence and importance of each factor on other factors. The method has been widely used in practice. Bai and Sarkis (2013) employed the DEMATEL approach to visualise the structure of complicated causal relationships between critical success factors and obtained the influence level of business process management factors. Xia et al. (2015) analysed internal barriers encountered by automotive parts remanufacturers and evaluated causal barriers using a proposed model framework. The DEMATEL method can also be used to determine the causal relationships and interactive influence among criteria (Tsai et al., 2016). Sharma, Kumar, and Kumar (2017) employed DEMATEL for the selection of network controllers and relays. Baykasoğlu and Gölcük (2017) developed a new interval type-2 fuzzy multiple-attribute decision making model based on DEMATEL.

Because human judgments are vague and difficult to depict with accurate numerical values (Govindan, Khodaverdi, & Vafadarnikjoo, 2016), the DEMATEL method does not address a hierarchical structure and involves incomplete information within its analytical method. The research object of Grey set theory is an uncertain system with unknown information. The grey set theory can supplement this due to its ability to compensate for incomplete information (Su et al., 2016). Vafadarnikjoo, Mobin, Salmon, and Javadian (2015) determined the most significant categories of project risks based on the GDEMATEL method. The results of the GDEMATEL determined the impact of sludge on the sustainability assessment of energy technologies more accurately (Ren et al., 2017). Many researchers explore success factors using GDEMATEL, such as in medical device development (Kirkire & Rane, 2017), environmental management (Arab, Sahebi, Modarresi, & Ajalli, 2017), and so on.

Although GDEMATEL method is utilised, for example, to explore the decisive attributes of supply chain risks and uncertainties based on big data (Wu et al., 2017) and sustainable consumption and production adoption (Luthra, Govindan, & Mangla, 2017), few studies have explored failure factors of green business using GDEMATEL. Expert opinions focus on critical factors of green business failure are uncertain in our study, hence combining grey set theory and adopt Grey-DEMATEL is feasible and suitable in this study. Therefore, our research can complement this research gap to a certain extent, and provide better theoretical support and practical guidance.

3. Methodology

In this section, the procedure of GDEMATEL analysis for influencing factors of green business failure is outlined as follows.

Step 1: Identify influencing factors and their relationships. According to the investigation and analysis of the literature, the influencing factors of green business failure are summarised. There are five aspects identified from the company life cycle theory, which are Latent Phase (AS_1), Growth Phase (AS_2), Maturity Phase (AS_3), Shaky Phase (AS_4), and Recession Phase (AS_5). Based on these five aspects, sixteen criteria were extracted. Academics and entrepreneurs in this field analyse the direct impact of each factor on other factors, and then a direct-relation matrix can be constructed. Details are discussed in Section 4.1.

Step 2: Construction of the influencing factors of business failure based on grey set theory. The details are as follows.

Table 1
The grey linguistic scale for experts' assessments.

Linguistic terms	Grey numbers	Values
No influence (NI)	[0, 0]	1
Very low influence (VL)	[0, 0.25]	2
Low influence (LI)	[0.25, 0.5]	3
High influence (HI)	[0.5, 0.75]	4
Very high influence (VHI)	[0.75, 1]	5

(1) We use a five-level grey linguistic scale for experts' assessments (Table 1). There are five grades of “No influence”, “Very low influence”, “Low influence”, “High influence” and “Very high influence”.

(2) Normalise the grey number on the lower bound by the following equations, where K is the number of experts.

$$\underline{\otimes}\bar{x}_{ij}^{k} = (\underline{\otimes}x_{ij}^{k} - \min\underline{\otimes}x_{ij}^{k})/\Delta_{\min}^{\max}$$

$$\overline{\otimes}\bar{x}_{ij}^{k} = (\overline{\otimes}x_{ij}^{k} - \min\overline{\otimes}x_{ij}^{k})/\Delta_{\min}^{\max}$$

Among them,

$$\Delta_{\min}^{\max} = \max\overline{\otimes}x_{ij}^{k} - \min\underline{\otimes}x_{ij}^{k} \tag{1}$$

(3) Calculate the total normalised crisp value using Eq. (2) after the grey number is normalised:

$$Y_{ij}^{k} = \frac{\underline{\otimes}\bar{x}_{ij}^{k}(1 - \underline{\otimes}\bar{x}_{ij}^{k}) + \overline{\otimes}\bar{x}_{ij}^{k} \times \overline{\otimes}\bar{x}_{ij}^{k}}{1 - \underline{\otimes}\bar{x}_{ij}^{k} + \overline{\otimes}\bar{x}_{ij}^{k}} \tag{2}$$

(4) Calculate the final crisp values by Eq. (3):

$$Z_{ij}^{k} = \min_{j} \underline{\otimes}\ x_{ij}^{k} + Y_{ij}^{k}\Delta_{\min}^{\max} \tag{3}$$

Step 3: Define number weight for experts.

Step 4: The matrix is normalised to obtain a normalised matrix X.

$$K = \frac{1}{\max\limits_{1\le i\le n}\sum_{j=1}^{n} a_{ij}} \tag{4}$$

$$X = K*A \tag{5}$$

Step 5: Using the Eq. (6) to get the total relation matrix M.

$$M = X(1 - X)^{-1} \tag{6}$$

Step 6: Use Eqs. (7) and (8) to calculate the sum of rows (D) and the sum of columns (R) respectively.

$$D = \left[\sum_{j=1}^{n} m_{ij}\right]_{n\times 1} \tag{7}$$

$$R = \left[\sum_{i=1}^{n} m_{ij}\right]_{1\times n} \tag{8}$$

Step 7: Create a Cartesian coordinate system according to the dataset consisting of $(R + D, R - D)$. The influencing factors can then be plotted in the coordinate system (the causal relationship diagram). At the same time, according to the mean and standard deviation of the total relation matrix M, relationships between each other can be indicated on the diagram.

4. Data collection and analysis

4.1. Proposed factors

In this study, the Aspects part of the green business failure is constructed based on the five phases of the company life cycle: the Latent

Table 2
Proposed evaluation aspects and criteria.

Aspects	Criteria
AS_1 (LP)	The conflict of interest between stockholders and operators (C_1)
Latent phase	The lack of industry policy of green business (C_2)
	Lack of green technical knowledge (C_3)
	The lack of partners and limited access to finance, or the imperfect financial structure (C_4)
AS_2 (GP)	A short-term investor mind-set and less investment (C_5)
Growth phase	Negative opinion and evaluation from experts and social media (C_6)
	The company's business capacity cannot adapt to the company's development (C_7)
AS_3 (MP)	Anti-environmental attitudes (C_8)
Maturity phase	Lack of external pressure (C_9)
	Profit-oriented business models and a lack of environmental awareness (C_{10})
AS_4 (SP)	Failure to effectively update the power allocation (C_{11})
Shaky phase	Risk assessment mechanisms including public opinion assessment are invalid (C_{12})
	Changes in the external environment are not conducive to the development of companies, such as seasonal and political (annual summary) factors (C_{13})
AS_5 (RP)	The results of online comments and public opinion polls are not ideal (C_{14})
Recession phase	Invalid business decisions and failure to learn from failure (C_{15})
	The constraints on public finances during the financial crisis (C_{16})

Phase (LP), Growth Phase (GP), Maturity Phase (MP), Shaky Phase (SP) and Recession Phase (RP). Then, 16 criteria are selected as the influencing factors of green business failure based on these five aspects. Details are discussed below.

In the latent phase (AS_1), communication with the relevant subject has an impact on project development (Huang, Faysse, & Ren, 2017). Customer satisfaction is related to the motivation of corporate social responsibility (Gao & Mattila, 2014). Therefore, “The conflict of interest between Stockholders and operators” (C_1) is one criterion of the aspect of the latent phase. Ge, Jiang, Gao, and Tsai (2016) researched the influence of legitimacy on proactive green orientation and green performance. Failure to realise systemic features of modern business may lead to business failure (Boda & Zsolnai, 2016). Strategic green industry policy promotes environmental sales (Fischer, 2017). Therefore “The lack of industry policy of green business” (C_2) is an important criterion. The “Lack of green technology” (C_3) hinders green business (Heinrich, Schulz, & Geis, 2016; Mathur & Tandon, 2016; O'Keeffe, Gilmour, & Simpson, 2016). Through an empirical investigation in Sri Lanka (Lussier, Bandara, & Marom, 2016), the study of sustainable development of small and medium-sized business companies (Halme & Korpela, 2014), the assessment of value proposition drivers for a micro company (Pillai & Dam, 2017) and the study of sustainable venture capital (Bocken, 2015), “The lack of partners and limited access to finance, or the financial structure is not perfect” (C_4) is identified as the 4th criterion of the aspect of the latent phase.

In the growth phase (AS2), uninterrupted venture capital is likely to lead to a sustainable business failure (Bocken, 2015; Davidson, 2016). The insufficient green infrastructure investment leads to the failure of green business (Kaminker, Kawanishi, Stewart, Caldecott, & Howarth, 2013). Therefore, “A short-term investor mind-set and less investment” (C_5) is a criterion of this period. In addition, public opinion formation affects business failure (Zaptcioglu Celikdemir, Gunay, Katrinli, & Penbek Alpbaz, 2017), which is impacted by the media plurality to democratic discourse, freedom of speech and control over public opinion formation (Tambini & Labo, 2016). Negative views and negative evaluation in public opinion can lead to business failure (Nip & Fu, 2016; Rosenkranz & Pollach, 2016). Therefore, “Negative opinion and evaluation from experts and social media” (C_6) is another criterion. Moreover, personnel appointment and entrepreneurial heterogeneity (C_7) are very important to the growth and development of companies (Uyarra, Shapira, & Harding, 2016). Low entrepreneurial capacity hinders green development (Dewald & Achternbosch, 2016) because entrepreneur innovation ability promotes a company's green development (Kim, 2016).

In the maturity phase (AS_3), anti-environmental attitudes toward companies (C_8) have a significant impact on green business (Lee, Kim, & Lee, 2016; Sapci & Considine, 2014). Customer pressure (C_9) played an important role in sustainable supply chain management (Gualandris & Kalchschmidt, 2014), the same as environmental pressure (Kronenberg, 2015). Al-Tawil (2016) studied the major issues that need to be addressed by effective corporate governance (C_{10}) in the 21st century (Upward & Jones, 2016).

Furthermore, in the shaky phase (AS_4), failure of power allocation leads to business failure (Wang & Chen, 2012). Powell and Tilt (2017) exposed the details of an organisation that tried but failed, and highlighted the role of power and politics in its demise. “Failure to effectively update the power allocation” (C_{11}) does have an impact on business failure. On the other hand, Chung and Chu (2015) conducted a risk analysis of the aerospace technology industry when conducting green supply chain management research. Invalid risk assessment (C_{12}) affects green business (Cho, Michelon, Patten, & Roberts, 2015). Seasonal factors (C_{13}) also affect business failures (Jiang, Qiang, & Lin, 2016).

Finally, in the recession phase (AS_5), Lee and Chun (2016) considered that online comments and public opinion polls are social judgment. Negative online commentary and poll results (C_{14}) can lead to green business failure (Mzembe & Meaton, 2014). Terjesen, Guedes, and Patel (2016) researched survival strategies of ventures founded during recessions. Similarly, Danforth, Weidman, and Farnsworth (2017) researched strategies employed and lessons learned by commercial construction companies during economic recessions and recovery periods. Therefore, “Invalid business decisions and failure to learn from failure” (C_{15}) is a relevant criterion. Through reflection on the Great Depression, Hodges and Lapsley (2016) found that private sector failures were affected by the public sector crisis. Public finance plays an important role in green business failure (Caprotti, 2017; Rodrik, 2014). Therefore, “The constraints on public finances during the financial crisis” (C_{16}) plays an important role in the recession phase. All the criteria discussed are listed in Table 2.

4.2. Results and analysis

Identifying the factors in Table 2 is not sufficient to accomplish the objective of this study. In this study, Xia et al. (2015), Ouyang, Chen, and Zhao (2016) and Pajer et al. (2017)'s study on the selection of experts are referenced and four experts were invited to analyse the direct impact of each factor on other factors (Tables A.1–A.4 in the Appendix). The group of experts consists of a university academic expert, a government official, a green food company manager and a green agricultural products company manager. They studied and/or worked in the field for more than five years. The experts' views are equally important for the in-depth exploration of the factors. Therefore, an equal weight is assigned to the four experts, which is 0.25 (a sensitivity analysis on this variable will be presented later). Establishing the

Table 3
Normalised direct-relation matrix *X*.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1	0.0000	0.0470	0.0384	0.0726	0.0826	0.0655	0.0384	0.0384	0.0299	0.0655	0.0408	0.0693	0.0299	0.0816	0.0308	0.0541
C2	0.0664	0.0000	0.0527	0.0740	0.0740	0.0740	0.0484	0.0570	0.0645	0.0655	0.0494	0.0517	0.0271	0.0527	0.0484	0.0688
C3	0.0579	0.0494	0.0000	0.0655	0.0740	0.0555	0.0655	0.0826	0.0726	0.0570	0.0698	0.0432	0.0560	0.0987	0.0793	0.0342
C4	0.0579	0.0726	0.0527	0.0000	0.0655	0.0641	0.0399	0.0484	0.0384	0.0484	0.0470	0.0332	0.0342	0.0408	0.0655	0.0688
C5	0.0902	0.0641	0.0816	0.0655	0.0000	0.0570	0.0555	0.0399	0.0285	0.0740	0.0816	0.0418	0.0427	0.0698	0.0655	0.0603
C6	0.0987	0.0555	0.0541	0.0812	0.0655	0.0000	0.0555	0.0484	0.0555	0.0470	0.0128	0.0199	0.0394	0.0987	0.0688	0.0546
C7	0.0902	0.0812	0.0726	0.0740	0.0655	0.0655	0.0000	0.0384	0.0726	0.0655	0.0641	0.0641	0.0698	0.0783	0.0555	0.0427
C8	0.0394	0.0717	0.0731	0.0399	0.0399	0.0826	0.0484	0.0000	0.0494	0.0555	0.0299	0.0384	0.0645	0.0987	0.0674	0.0546
C9	0.0384	0.0816	0.0731	0.0641	0.0555	0.0740	0.0384	0.0740	0.0000	0.0655	0.0731	0.0384	0.0408	0.0731	0.0451	0.0536
C10	0.0731	0.0645	0.0475	0.0740	0.0740	0.0655	0.0570	0.0655	0.0494	0.0000	0.0384	0.0470	0.0750	0.0645	0.0233	0.0342
C11	0.0731	0.0323	0.0323	0.0570	0.0484	0.0655	0.0826	0.0470	0.0555	0.0285	0.0000	0.0384	0.0494	0.0441	0.0570	0.0451
C12	0.0494	0.0384	0.0470	0.0399	0.0484	0.0570	0.0484	0.0299	0.0384	0.0555	0.0698	0.0000	0.0698	0.0612	0.0484	0.0570
C13	0.0816	0.0641	0.0555	0.0655	0.0399	0.0570	0.0655	0.0484	0.0384	0.0285	0.0731	0.0332	0.0000	0.0645	0.0570	0.0451
C14	0.0612	0.0014	0.0014	0.0313	0.0484	0.0655	0.0043	0.0043	0.0114	0.0128	0.0138	0.0437	0.0237	0.0000	0.0247	0.0418
C15	0.0902	0.0214	0.0199	0.0570	0.0740	0.0655	0.0740	0.0299	0.0323	0.0214	0.0408	0.0555	0.0664	0.0664	0.0000	0.0460
C16	0.0527	0.0308	0.0479	0.0726	0.0726	0.0484	0.0313	0.0313	0.0555	0.0484	0.0408	0.0517	0.0408	0.0494	0.0536	0.0000

Table 4
Total-relation matrix *M*.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1	0.2540	0.2342	0.2206	0.2986	0.3084	0.2979	0.2196	0.2031	0.1972	0.2458	0.2202	0.2331	0.2061	0.3314	0.2250	0.2430
C2	0.3489	0.2163	0.2592	0.3314	0.3319	0.3372	0.2540	0.2442	0.2526	0.2711	0.2522	0.2395	0.2273	0.3402	0.2675	0.2814
C3	0.3642	0.2788	0.2236	0.3419	0.3503	0.3426	0.2860	0.2807	0.2734	0.2769	0.2865	0.2467	0.2696	0.4044	0.3121	0.2661
C4	0.3125	0.2606	0.2367	0.2354	0.2974	0.3002	0.2257	0.2163	0.2094	0.2332	0.2285	0.2033	0.2126	0.2991	0.2603	0.2588
C5	0.3822	0.2821	0.2901	0.3337	0.2734	0.3318	0.2697	0.2354	0.2274	0.2847	0.2888	0.2389	0.2492	0.3659	0.2905	0.2806
C6	0.3663	0.2581	0.2494	0.3263	0.3142	0.2573	0.2493	0.2264	0.2341	0.2444	0.2093	0.2042	0.2281	0.3698	0.2752	0.2595
C7	0.4075	0.3189	0.3024	0.3649	0.3577	0.3643	0.2352	0.2521	0.2842	0.2969	0.2933	0.2758	0.2911	0.4000	0.3015	0.2854
C8	0.3140	0.2717	0.2661	0.2890	0.2896	0.3339	0.2448	0.1813	0.2306	0.2503	0.2244	0.2192	0.2525	0.3706	0.2750	0.2583
C9	0.3264	0.2934	0.2784	0.3241	0.3167	0.3404	0.2478	0.2622	0.1946	0.2714	0.2746	0.2283	0.2414	0.3614	0.2671	0.2692
C10	0.3484	0.2730	0.2500	0.3247	0.3242	0.3235	0.2565	0.2471	0.2337	0.2042	0.2382	0.2303	0.2651	0.3443	0.2394	0.2451
C11	0.3200	0.2208	0.2140	0.2830	0.2750	0.2958	0.2593	0.2098	0.2202	0.2102	0.1796	0.2041	0.2224	0.2963	0.2473	0.2321
C12	0.2956	0.2216	0.2232	0.2642	0.2715	0.2844	0.2267	0.1923	0.2022	0.2306	0.2431	0.1641	0.2389	0.3070	0.2365	0.2396
C13	0.3432	0.2597	0.2448	0.3048	0.2823	0.3032	0.2555	0.2218	0.2155	0.2209	0.2588	0.2101	0.1854	0.3300	0.2595	0.2443
C14	0.1871	0.0973	0.0948	0.1476	0.1635	0.1802	0.0973	0.0876	0.0951	0.1061	0.1047	0.1266	0.1115	0.1295	0.1225	0.1374
C15	0.3335	0.2070	0.1996	0.2798	0.2951	0.2921	0.2484	0.1899	0.1948	0.2010	0.2170	0.2179	0.2349	0.3127	0.1903	0.2310
C16	0.2895	0.2101	0.2196	0.2862	0.2868	0.2694	0.2046	0.1889	0.2115	0.2201	0.2119	0.2079	0.2066	0.2884	0.2357	0.1808

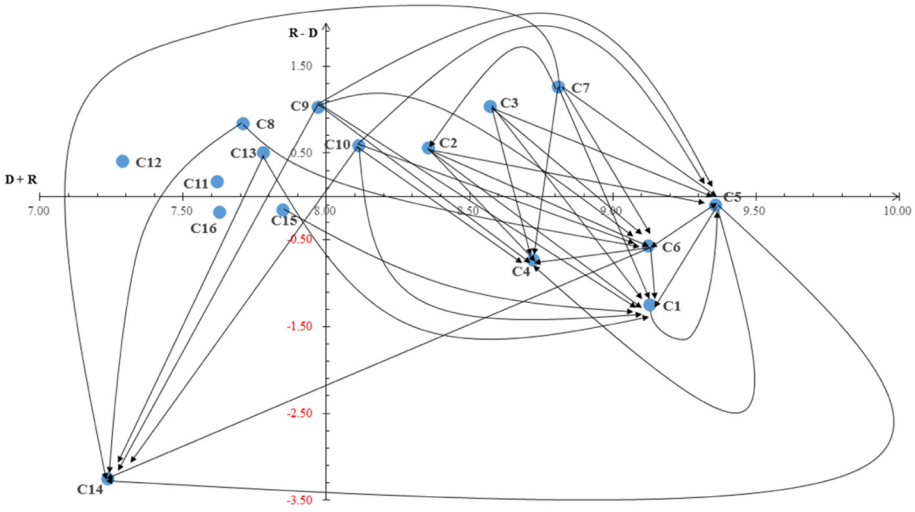

Fig. 1. Causal relationship diagram.

matrix of 16 criteria composed of linguistic variables, a 16 × 16 grey direct-relation matrix can be calculated. According to the steps 4 and 5 in Section 3, normalised direct-relation matrix X can be obtained (Table 3), as well as total relation matrix M (Table 4). Then, the dataset $(R + D, R - D)$ are calculated and a Cartesian coordinate system was created according to steps 6 and 7 in Section 3. Here we take θ = mean + standard deviation for the initial value (i.e., the effect of M less than this value is negligible), so $\theta = 0.2565 + 0.0589 = 0.3154$. Then, the causal relationship diagram is depicted in Fig. 1.

According to Table 5 and Fig. 1, the casual factors, effect factors and the correlation between the factors affecting green business failure can be found. Specific explanations are given below.

Table 5
Degree of prominence and net cause/effect values for green business failure.

Criteria	R sum	D sum	R + D	R-D
C1	3.9382	5.1935	9.1317	−1.2553
C2	4.4550	3.9037	8.3586	0.5513
C3	4.8037	3.7726	8.5763	1.0312
C4	3.9901	4.7356	8.7257	−0.7455
C5	4.6244	4.7381	9.3625	−0.1137
C6	4.2721	4.8542	9.1263	−0.5822
C7	5.0314	3.7804	8.8118	1.2511
C8	4.2717	3.4392	7.7109	0.8325
C9	4.4974	3.4766	7.9740	1.0208
C10	4.3475	3.7679	8.1154	0.5796
C11	3.8898	3.7309	7.6207	0.1589
C12	3.8415	3.4501	7.2916	0.3914
C13	4.1399	3.6426	7.7825	0.4973
C14	1.9890	5.2510	7.2400	−3.2620
C15	3.8450	4.0055	7.8505	−0.1605
C16	3.7180	3.9128	7.6309	−0.1948

4.2.1. Causal/effect factors

According to Fig. 1, the value $R - D$ means the higher the value, the stronger the influence on green business failure. Furthermore, factors with positive values are called causal factors. They are the most affecting factors that lead to green business failure directly. Causal factors are sorted by the prominence for the influence of green business failure as: C_7, C_3, C_9, C_8, C_{10}, C_2, C_{13}, C_{12}, C_{11}. They can be used to develop long-term measures. Factors with negative values are called effect factors. They are sorted as: C_5, C_{15}, C_{16}, C_6, C_4, C_1 and C_{14}. Effect factors are influenced by causal factors, which lead to the green business failure.

Among the causal factors of concern, “The company's business capacity cannot adapt to the company's development” (C_7) is on the top of the cause group which indicates that C_7 is the primary causal factor for business failure, followed by “Lack of green technical knowledge” (C_3), and so on. The results show a positive relationship. Leadership ability becomes more conducive to technological innovation (Jiao, Yang, Gao, Xie, & Wu, 2016), and the joint impact of perceived company capacity and high actual capacity affect business failures (Bayon & Vaillant, 2016), especially for the sustainable development of green companies. The improvement of company capacity is beneficial to company development (Leffler & Näsström, 2014). In most cases, the promotion of green technology can effectively prevent bottlenecks in green business operations (Govindan, Kaliyan, Kannan, & Haq, 2014). Awareness of external pressure and enhanced social responsibility contribute to the green business of companies (Klettner, Clarke, & Boersma, 2014). Therefore, enhancing a company's capacity to adapt to the company's green business, seeking long-term investment and enhancing technical levels are the fundamental measures to take to avoid green business failure.

In the effect factors, “A short-term investor mind-set and less investment” (C_5) is the most obvious factor, followed by “Invalid business decisions and failure to learn from failure” (C_{15}) and so on. As stated in the literature, due to the unique characteristics of green companies, like being young (He & Cai, 2014), modern (Zhao, 2014), ethical (Ha, 2016), and so on, the scale of green investment and the cycle of investment become extremely important. It is desirable to determine the time span of the investment to avoid business failures (Reilly, Souder, & Ranucci, 2016), and to develop appropriate strategies for social investment to promote sustainable development (Hailey & Salway, 2016). Many failures have generated adverse impacts on the employees, which in turn affect business decisions, and not mentioning a longer-term effect if they fail to learn from the failures (Shepherd, Haynie, & Patzelt, 2013). Improper response strategies of negative word-of-mouth will lead to a direct influence on business failure.

4.2.2. Correlation between the factors

The values $R + D$ in Table 5 represent the centre of factors. The higher the value of a criterion (i.e., position toward the right in Fig. 1), the stronger the contribution of that factor to green business failure. The centre of factors can be arranged as follows: C_5, C_1, C_6, C_7, C_4, C_3, C_2, C_{10}, C_9, C_{15}, C_{13}, C_8, C_{16}, C_{11}, C_{12} and C_{14}. Key measures should be developed based on that.

The factor with the strongest contribution leads to green business failure is “A short-term investor mind-set and less investment” (C_5). It affected by C_7, C_3, C_2, C_{10} and so on. Some studies have shown that companies can effectively avoid green business failures if companies create value for their stakeholders (McCaughin & White, 2016). External pressure, including environmental awareness, may result in conflicts of interest between the company and other subjects (Rahman & Anwar, 2016). “The company's business capacity cannot adapt to the company's development” (C_7) is the primary causal factor. It has an impact on C_1, C_2, C_4, C_5, C_6 and C_{14} as indicated by the arrows in Fig. 1. The company's business capacity affects the interests of stakeholders (Agyemang, Aboagye, & Frimpong, 2015). Competent companies can use some policy support effectively (Irwin, 2015). Consumers are concerned with online public opinion and evaluation (Jung, Hur, Jung, & Kim, 2015), and the company's business capacity affects public opinion directly or indirectly. In contrast, “Risk assessment mechanisms including public opinion assessment are invalid” (C_{12}) is the least correlated with other factors.

4.3. Sensitivity analysis

In order to verify the influence of an expert on the conclusion of the cognition, it is necessary to analyse the sensitivity of the sample data. For this purpose, three different weights were assigned to expert 1. The weights are 0.30, 0.35 and 0.40, and the weight of other experts remains the same. The causal relationship diagram of sensitivity analysis are shown in Figs. 2–4.

From Figs. 2–4, it can be observed that the influencing factors of each figure do not vary much. The causal factors are still C_7, C_3, C_9, C_8, C_{10}, C_2, C_{13}, C_{12}, and C_{11}. The effect factors being influenced by causal factors are still C_5, C_{15}, C_{16}, C_6, C_4, C_1, and C_{14}. C_5, C_1, C_6, C_7, and C_4 are still on the top five in the group of centre factors, whereas the last one is C_{14}. In conclusion, the expert evaluations are robust subjective to different weights and hence no particular expert evaluation is heavily biased.

5. Discussions

There are a number of theoretical implications from the results of this study. First, this study, in contrast to existing studies, provides a holistic research in green business by investigating the influencing factors on green business from a business failure perspective. Second, the study takes life cycle theory into account so the criteria are extracted based on a good theoretical foundation. Life cycle theory helps us to analyse problems dynamically (Jian, Cai, & Chen, 2017). Therefore, the framework developed in this study can enrich the scientific value in terms of the building up of theoretical framework. Finally, this study tackle the shortcoming of DEMATEL by using Grey Set theory. Consequently, the uncertainty arouse from the experts' judgment can be minimised. Therefore, the evaluation results from the proposed model are more accurate.

There are important managerial implications generated from this study as well. First, based on the assessment results, “A short-term investor mind-set and less investment” (C_5) has the stronger correlation with other factors, and leads to green business failure directly. The cost of green business involves many aspects that need a lot of financial support. Funds are considered as the basis for business development (Missionaries, 1998). Companies need to take measures to obtain long-term full financial support (Trianni, Cagno, & Farné, 2016). Evidence

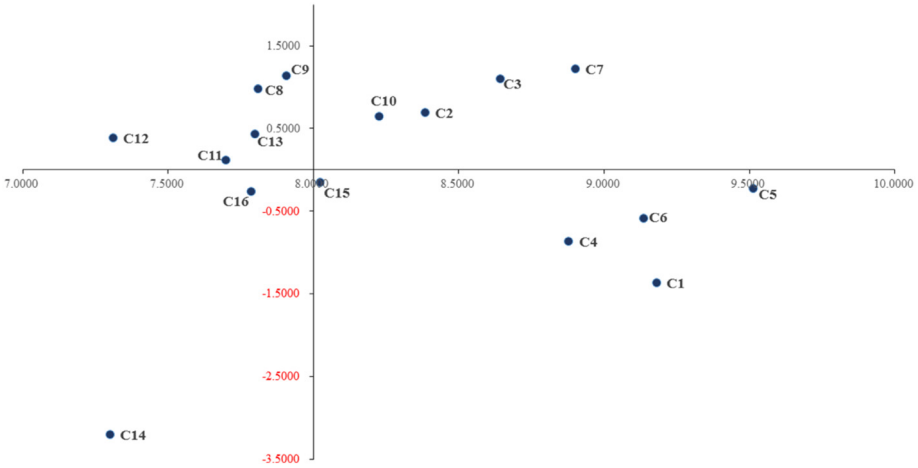

Fig. 2. Sensitivity analysis causal relationship diagram (weight = 0.30).

reveals that the level of investment is critical to the development of the theory (Grimm, Hofstetter, & Sarkis, 2014), but researchers and practitioners should have a better understanding of the most appropriate investment environment for green business.

"The company's business capacity cannot adapt to the company's development" (C_7) also plays a leading role in the failure of green business, which is the most primary factor. Companies' lack of self-knowledge as one of the company capacities leads to business failure (Hsu, Wiklund, & Cotton, 2017). When the company's business capacity cannot adapt to the company's development, the question may be resolved through leadership reorganisation (Thistle & Molinaro, 2016), supervision of the leadership (Dong, Liao, Chuang, Zhou, & Campbell, 2015), and so on. This aspect revealed the most basic elements that need to be met in green business in the evaluation results. Without the right leader, it is difficult for any business to survive in the green business marketplace (Renko, El Tarabishy, Carsrud, & Brännback, 2015). It can be seen that any study of business failure can be carried out from this factor (C_7).

Second, there are different factors in different life cycle phases that affect green business failure. This also justifies why life cycle theory is considered in this study. There is no unchanging factor that companies should pay attention to. In this study, for example, in the latent phase of the company, "Lack of green technical knowledge (C_3)" and "The lack of industry policy of green business (C_2)" easily lead to green business failure. Green technology is the driving force of green business (Kumar, 2016). Negative stakeholders have a negative impact on green business (Wu & Birge, 2016). The government's environmental policy is very important for green management (Yi & Liu, 2015). Therefore, green companies should raise the level of green technology, while paying attention to the learning of green technical knowledge and the industry policy of green business, which can reduce the possibility of green business failure in the latent phase.

In the growth phase of the company, "The company's business capacity cannot adapt to the company's development (C_7)", "A short-term investor mind-set and less investment (C_5)" and "Negative opinion and evaluation from experts and social media (C_6)" are important factors in green business failure. This fact reflects the important role of people in green business failure. Previous studies also show that company competence (Lafuente & Vaillant, 2016), investor quality (Chiaroni et al., 2016) and public opinion (Vezich, Gunter, & Lieberman, 2017) affected the development of a company. In this respect, managers need more attention to the impact of people on green business failure.

In the maturity phase of the company, "Lack of external pressure (C_9)" is most likely factor leading to business failure. External pressure includes system specification (Jia, Guo, & Barnes, 2017), environmental pressure (Yu, Lo, & Li, 2017), policy changes (Antonietti, De Marchi, & Di Maria, 2017) etc., which impose tangible or intangible pressures on a green company. This is the spirit of guidance for avoiding the failure of green business. Enlightenment of the manager in this aspect is that they should give the full power brought by this pressure to green business management, and take the initiative to face the pressure brought by the external environment.

Moreover, in the shaky and recession phases of the company, managers need to pay attention to factors including "Changes in the

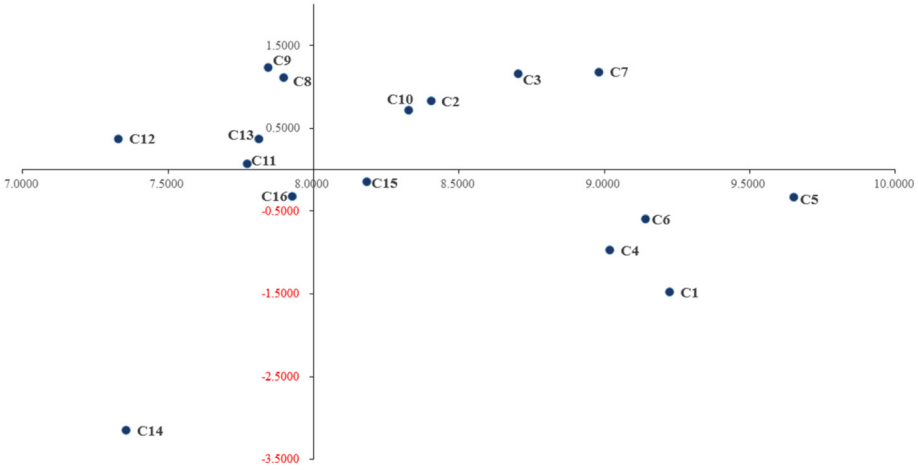

Fig. 3. Sensitivity analysis causal relationship diagram (weight = 0.35).

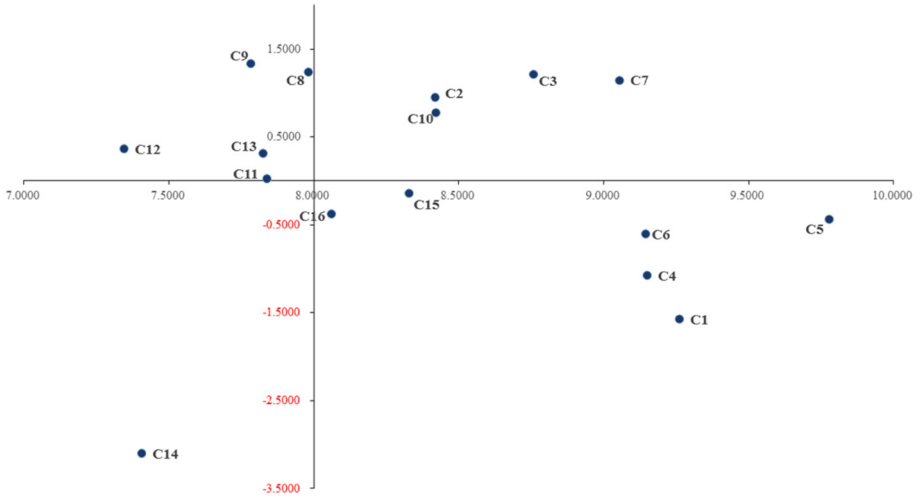

Fig. 4. Sensitivity analysis causal relationship diagram (weight = 0.40).

external environment are not conducive to the development of companies, such as seasonal and political (annual summary)" (C_{13}) and "Invalid business decisions and failure to learn" (C_{15}). It is necessary to learn how to use external factors to increase the opportunities and capabilities of business development (Baranenko, Dudin, Lyasnikov, & Busygin, 2014). Learning experience is also an important way to avoid failures (Essig, 2014). This means that managers should keep an eye on changes in the external environment to adjust their business strategy, while learning to learn from the failure.

6. Conclusions

In this study, 16 criteria as influencing factors in green business failure were successfully extracted from five aspects based on the company life cycle through literature review and expert interviews. Additionally, the DEMATEL method was employed for performance evaluation to quantify the language variables that experts express according to the four experts' scoring, together with the grey set theory that takes uncertainty into consideration. The GDEMATEL translates qualitative information into quantitative assessments, and finds out the most primary and important factors that lead to green business failure, and hence the factors that need to be considered in each company life cycle. This framework can provide a reliable reference and guidance for industrial applications.

Through the multidirectional extraction and analysis of the influencing factors of green business failure, this study enriches research and provides a reference for theory and management. The theoretical implications enhance the understanding of the stage of company development, and put forward the study of company management from the perspective of company life cycle, construct a new theoretical research framework. Meanwhile, the investigation of green business from perspective of failure has contributed to a more holistic view in green business research. Regarding managerial implications, the guiding ideology for the survival and development of companies at different stages was put forward. Therefore, the proposed method can be applied into the green companies in different development periods easily. Managers can use this method to determine the focus of the criteria to achieve sustainability.

The results show that in the green business failure, "The company's business capacity cannot adapt to the company's development (C_7)" is the most primary factor. "A short-term investor mind-set and less investment" (C_5) has the strongest effect on green business failure. These criteria are extremely important for the development of green business. If managers cannot take timely and effective measures, the company will be threatened by business failures. Companies must improve their ability to adapt to business development while attracting long-term, capable investors to invest. Therefore, the company needs to have a clear understanding of what stages of business development and impact criteria are. They need to foster a development strategy that corresponds to criteria to enhance the good image of a green company, and improve business status. Moreover, the analysis of different stages in company life cycles will provide ample suggestions to company to learn from. For instance, in the latent phase, company need to put emphasis on the development of green technology while monitoring the changes in green business policies, in order to minimise the possibility of green business failure. In the growth phase, top management needs to pay more attention to the impact on green business failure to the public. Company will encounter pressures in maturity phase, and hence management should proactively approach risks from external pressures. Lastly, in recession phase, company need to be resilient to company's strategy as external environment keeps changing rapidly, constantly learning from failure helps to shape a feasible company's strategy.

There are also several limitations to this study. The first restriction is about the representation of expert opinions. All expert opinions in this study are from one country, which may not provide sufficient information. Based on the analytical steps presented in this study, further studies can be conducted on other countries. Then, the differences in green business failure in different countries can be compared, so as to provide suggestions for the sustainable development of green business. Second, although the number of experts involved in this study is sufficient with reference to the existing literature, more experts can be invited to ensure the results of this work are more scientific and rigorous research, and that to further improve the accuracy of the results.

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Appendix A

Table A.1
Direct-relation matrix for green business failure by expert 1.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1		1	1	5	5	4	2	2	1	2	2	1	3	4	1	1
C2	5		3	4	4	2	4	4	4	4	4	3	2	3	3	4
C3	4	2		4	5	1	4	5	1	5	4	4	2	4	4	3
C4	4	1	3		4	1	3	2	1	5	4	1	2	2	3	4
C5	4	1	4	5		3	3	2	1	4	4	1	1	3	3	4
C6	4	1	1	5	4		4	2	1	1	2	1	3	4	3	4
C7	4	1	1	4	4	4		2	1	2	5	5	5	4	4	3
C8	4	4	4	4	4	4	4		2	5	2	3	3	5	4	4
C9	3	4	4	4	4	2	2	4		4	3	2	3	2	2	2
C10	3	4	4	4	4	4	4	5	2		3	4	4	4	2	3
C11	4	2	2	4	4	3	4	1	1	1		4	4	2	4	2
C12	3	1	1	3	4	3	3	1	1	1	4		4	3	4	3
C13	3	1	1	3	3	4	4	2	1	1	4	2		2	4	2
C14	5	1	1	5	5	4	2	1	1	1	1	1	3		2	4
C15	5	1	1	5	5	5	5	1	2	1	4	4	4	5		4
C16	3	2	2	4	4	3	3	3	1	4	4	4	4	3	3	

Note: 1 represents no influence; 2 represents very low influence; 3 represents low influence; 4 represents high influence; 5 represents very high influence.

Table A.2
Direct-relation matrix for green business failure by expert 2.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1		5	3	4	4	2	1	1	3	4	2	3	2	4	2	1
C2	2		2	4	3	4	2	2	2	3	2	2	2	3	2	2
C3	2	3		2	3	2	3	4	5	2	3	2	3	4	1	1
C4	2	5	2		2	4	2	3	2	2	1	2	1	2	3	2
C5	4	5	4	2		3	1	2	1	3	4	2	2	3	5	2
C6	4	2	1	1	2		1	3	4	5	1	1	1	4	2	1
C7	4	5	4	4	4	2		1	5	5	1	1	2	3	1	1
C8	2	5	5	2	2	4	2		4	1	1	1	2	4	1	1
C9	1	5	5	4	3	5	1	5		3	4	1	2	4	2	2
C10	4	3	2	5	5	3	2	2	4		1	1	5	4	1	1
C11	4	2	2	4	2	4	5	4	4	1		1	3	3	2	2
C12	2	3	2	2	3	2	3	2	4	4	3		4	3	2	2
C13	4	5	4	3	2	2	4	4	3	2	4	2		4	2	2
C14	3	1	1	2	4	4	2	2	2	2	2	3	3		3	2
C15	4	2	1	4	5	2	4	2	3	2	2	1	4	2		1
C16	3	3	4	5	5	2	2	2	4	2	2	2	2	2	3	

Note: 1 represents no influence; 2 represents very low influence; 3 represents low influence; 4 represents high influence; 5 represents very high influence.

Table A.3
Direct-relation matrix for green business failure by expert 3.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1		4	4	5	4	5	5	3	3	4	3	4	4	5	5	5
C2	4		4	5	4	5	4	4	4	3	3	4	3	5	4	4
C3	4	4		5	4	5	4	4	4	3	4	3	4	5	5	4
C4	4	5	4		5	5	4	4	4	3	4	4	4	5	5	4
C5	4	5	4	4		5	4	4	4	4	4	5	5	5	3	4
C6	5	5	5	5	4		4	4	3	4	3	4	5	5	5	5
C7	5	5	5	5	4	5		5	5	5	4	5	5	5	5	5
C8	4	4	4	4	4	5	4		4	4	4	5	5	5	5	5
C9	5	5	4	5	5	5	5	5		5	5	5	5	5	5	5
C10	4	4	4	5	5	5	5	5	5		5	5	5	4	4	4
C11	5	5	5	4	5	5	5	5	5	5		4	4	4	5	5
C12	4	4	5	5	4	5	5	5	4	5	5		4	4	4	5
C13	5	5	5	5	5	5	5	5	5	5	5	5		5	5	5
C14	2	2	1	2	2	3	1	2	1	3	3	3	2		3	1
C15	4	4	4	3	4	4	5	5	4	4	4	4	5	4		4
C16	4	4	5	5	5	4	4	4	5	5	4	4	4	4	5	

Note: 1 represents no influence; 2 represents very low influence; 3 represents low influence; 4 represents high influence; 5 represents very high influence.

Table A.4
Direct-relation matrix for green business failure by expert 4.

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
C1		2	3	1	4	4	3	5	3	5	5	5	1	3	2	5
C2	4		4	3	5	5	3	4	4	5	4	4	3	2	3	3
C3	4	4		4	4	5	4	4	5	4	4	3	4	5	4	2
C4	4	4	4		4	4	3	4	4	3	3	3	3	3	3	3
C5	5	3	4	4		3	5	4	3	5	4	3	3	4	3	2
C6	5	5	5	5	5		4	4	5	2	2	2	2	5	4	2
C7	4	5	5	3	3	4		3	4	3	4	3	3	4	2	2
C8	1	1	2	2	2	4	3		3	3	3	2	4	4	3	2
C9	2	2	2	1	1	4	3	2		3	3	3	2	4	3	3
C10	4	3	2	2	2	3	3	3	2		2	2	2	2	2	2
C11	2	2	2	2	2	3	3	2	3	2		2	2	3	2	2
C12	4	3	4	2	2	4	2	2	2	3	3		3	4	2	2
C13	4	3	3	4	2	3	2	2	2	1	2	1		3	2	2
C14	4	1	2	2	2	4	2	2	3	2	2	3	2		2	2
C15	4	2	2	2	2	4	2	2	2	2	2	4	2	4		2
C16	3	1	1	1	1	4	2	2	3	2	2	3	2	4	2	

Note: 1 represents no influence; 2 represents very low influence; 3 represents low influence; 4 represents high influence; 5 represents very high influence.

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