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Exploring Green Innovation Practices: Content Analysis of the Fortune Global 500 Companies

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Abstract

Green innovation has been attracting increasing attention due to its contributions to the conservation of resources and environmental protection. However, in the process of exploring green innovation, the allocation of resources and the direction of innovation are often inaccurate, which leads to a low efficiency of green innovation. If we can learn the green innovation practices from successful companies, we can certainly provide reference strategies for those companies that are exploring green innovation. Therefore, taking the Fortune Global 500 companies as the analysis object, this research develops the criteria of green innovation practices and conducts a cluster analysis of these companies by using a content analysis method. Finally, this article summarizes the green innovation practices of the six types of industries and provides corresponding countermeasures and suggestions, which provide a strong reference for relevant companies to carry out green innovation.

Keywords

green innovation, content analysis, cluster analysis, global top 500 companies

Introduction

With the rapid development of the economy, environmental problems have become increasingly prominent. Environmental pollution and degradation have become global problems. Environmental problems, such as global warming, ozone depletion, smog, and water pollution, have largely affected economic development and social progress for the next generations. With the increase in the number of people and the consumption of resource-based companies, coal, oil, natural gas, and other nonrenewable energy sources are gradually decreasing or even being depleted. The use of these nonclean energy sources exacerbates the deterioration of the environment. Firms that do not increase their environmental sensitivity will face the risk of losing their upside opportunities in a market shaped by environmental factors (Esty & Winston, 2006). Thus, firms have begun to pay more attention to the impact of their decision-making and management behaviors on the environment and to promote green innovation (Cui, 2017; Safari et al., 2018). Some firms focus on the green design of products, some focus on raw materials and clean energy, and others are interested in the innovation of production processes.

However, for most firms, green innovation practices are still in the primary stage of exploration. These companies urgently require relevant theoretical research as a guide. Green innovation has also become the focus of academic research. Studies have indicated that green innovation introduces the ecological idea into the development process to eliminate or reduce the harm caused to the environment (Gunasekaran & Spalanzani, 2012). In addition, organizations with green innovation ability can use green resources and gain the ability to respond to customer needs quickly and appropriately so as to gain competitive advantage (Albort-Morant et al., 2018). Some researchers pay greater attention to the study of the influencing factors of green innovation, such as policies and regulations (Stucki et al., 2018), quality management (D. Li et al., 2018), and the impact of green innovation on the economic and social performances of companies (El-Kassar & Singh, 2019; Q. H. Li, 2014), as well as specific practices, such as green technology innovation (Liu et al., 2017), green design of products (Hashemi et al., 2015; W. Y. Li et al., 2016), and the disposal of waste (Y. S. Chen

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et al., 2006). However, due to the different characteristics of the industry and the firm itself, such as business form and resource situation, it is difficult to apply these research conclusions to provide reference models for green innovation for firms, especially emerging firms, to follow. If we can grasp the green innovation practices of some companies, especially representative firms, the firms exploring green innovation channels can obtain useful experience to optimize the utilization of resources, which has significant practical meaning.

For this purpose, we have two questions to answer. One is how do we identify the criteria of green innovation practices? Two is how do we deeply analyze these practices? In the existing studies about green innovation practices, the criteria are obtained mainly from the literature (Cui et al., 2019; Tseng et al., 2013) and may be somewhat inconsistent with the actual situation of the companies' practices of green innovation. In addition, most of the state-of-the-art knowledge about green innovation comes from an organization's case study of environmental issues in management and response (Mele & Russo-Spena, 2015); a small amount of research used a one-time survey, but quantitative research with large samples is seriously lacking (Zhang, 2012). Therefore, to answer these questions and further enrich the theoretical research of green innovation, this article takes the top 500 global companies as the research objects and their relevant data of green innovation practices as the sample, uses a content analysis method to obtain criteria, and then clusters and analyzes the green innovation practices of companies.

The main contributions of this research are as follows: First, we develop criteria of green innovation practices by combining the literature with content analysis, which enriches the criteria framework of green innovation. Second, we conduct cluster analysis for green innovation practices of the top 500 global companies. On one hand, large sample research on green innovation is further enriched; on the other hand, the results have a strong reference value for the practitioners of green innovation. The remainder of this study is organized as follows. "Literature Review" section is the literature review. "Research Method" section describes the research method. "Application Illustration" section is an application illustration. "Theoretical and Managerial Implications" section discusses the theoretical and managerial implications. The last part includes the conclusion and limitation of the study.

Literature Review

This section provides a comprehensive review of the literature on green innovation practices and content analysis.

Green Innovation Practices

"Green innovation" is a hot topic that has attracted much attention in recent years. When scholars describe innovation that is helpful in reducing the impact on the natural environment, the following terms still exist: ecological innovation, environment innovation, and sustainable innovation. The former two terms and green innovation are synonyms, while the concept of the latter is extended to the social level (Schiederig et al., 2012). Because of the different disciplines, academic opinions, and preferences of researchers, there is still some argument about the expression and understanding of the concept of "green innovation." Blättel-Mink (1998) noted that green innovation introduces ecological ideas into the development of new products, markets and systems, or even economic strategies. Beise and Rennings (2005) proposed that green innovation is a series of applications in newly developed or improved processes about technologies, practices, systems, and products. The purpose is to avoid or reduce environmental hazards. Kemp and Pearson (2007) defined green innovation as the production, assimilation, or exploitation of a product, production process, service, or management method that is novel to the organizations developing or adopting them. This method runs through the whole life cycle of the product and reduces environmental risks, pollution, and other negative effects on the utilization of resources. Halila and Rundquist (2011) indicated that green innovation is a general term for a series of innovative activities. It helps improve the quality of the ecological environment and contributes to sustainable development. Through comprehensive comparison of these concepts, different scholars have formed a consensus of ideas on the definition of green innovation, including the following: (a) the whole life cycle of products; (b) innovative objects are products, processes, services and methods; and (c) the purpose of innovation is to reduce or eliminate the impact on the environment.

The academic research on green innovation is increasingly deepening. Studies on how to reduce the negative impact on the environment began in the early 1990s (Schiederig et al., 2012). As early as 1997, some scholars noted that the improvement of the environment needs to be integrated into all aspects of business. They studied how to carry out green innovation from raw materials to reduce environmental hazards in the clothing industry (Chouinard & Brown, 1997). In addition, many scholars have focused on the practice of internal and external green supply chains (Zhu et al., 2013) as well as green innovative technologies such as energy-saving technology and sewage treatment technology (Costantini et al., 2016; Ociepa-Kubicka & Pachura, 2017). The ideas of these researchers reflect the green innovation characteristics of different companies. They also indicate that there are some differences between different companies in selecting a green innovation strategy. However, few studies explore these different characteristics at present.

The characteristics of green innovation in companies are the concentrated reflection of enterprise green innovation strategy. If these characteristics are grasped and summarized, firms in different industries with different characteristics can refer to the corresponding green ideas to implement green innovation practices; save time, resources, and capital; and improve the efficiency of green innovation. However,

through the research presented in the literature, we find that the current research is mostly based on case analysis or small sample surveys. The research contents are mainly focused on the influential factors of green innovation, the dynamic mechanism, and the utility evaluation. There are few studies on green innovation characteristics, and the representation and reference value are not strong. Thus, companies have difficulty in finding their own position and have to learn and draw experience from current studies. To better reflect the overall characteristics of green innovation and improve feasibility and operability, research on green innovation for large sample company data is necessary. The data mining method can obtain potential valuable information from a large number of complex data, so it can meet the demand of large sample data research.

Content Analysis

As a commonly used analytical method in the research of social sciences, content analysis is a technique of gathering and organizing diverse data, involving coding information into various groups or categories based on selected criteria (Soldatenko & Backer, 2019). By examining and interpreting the particular body of research systematically, content analysis is able to identify its themes, patterns, and limitations and then provide new insights into the essential ideas and further guide practical actions (Hagen, 2018). Content analysis can be seen as a phase of information processing, which can variously use qualitative and quantitative research techniques to clearly analyze the text content of relevant topics (Miah et al., 2017). In general terms, a high-quality content analysis can provide a replicable methodology for future studies, especially when publications include a wider description of criteria used to conduct the research (Camprubí & Coromina, 2016). In addition, content analysis has great analytical flexibility, and scholars often used it to analyze the essential facts or related trends of some research contents (Duriau et al., 2007; Liao, 2018).

Due to the versatility of content analysis, its application is considerably extensive (Camprubí & Coromina, 2016). On one hand, it can be used to induce or deduce realities (Elo & Kyngäs, 2008). Moldavska and Welo (2017) selected an inductive content analysis method to analyze the definitions of sustainable manufacturing published from 1990 to 2016 in a variety of academic journals to identify the current understanding of what researchers mean by the concept. On the other hand, it can use qualitative or quantitative approaches to carry out different levels of analysis, such as assessing changes or detecting trends and exploring the relationship between variables (Kondracki et al., 2002; Liao, 2018). Soldatenko and Backer (2019) conducted content analysis of previous studies on cross-cultural tourist motivation comparison to reveal gaps in the literature and to indicate future research trends. Xie et al. (2019) adopted the content analysis method to capture the data of listed firms in China and found that green process innovation has a positive impact on green product innovation. In short, content analysis is an effective method to objectively and systematically describe or analyze the relevant content of research topics.

By reviewing the relevant literature of content analysis, it can be seen that this method can analyze the change of attention by determining the frequency of vocabulary and can explore the potential association of content by mining the common appearance of keywords to explore features, trends, and cognition (Duriau et al., 2007). Therefore, the use of content analysis to analyze green firm data and explore green innovation practices has strong applicability. However, although content analysis has been widely used in managerial research, few studies use content analysis to explore the practice of green innovation in firms, which leads to the lack of theoretical guidance in the process of seeking green innovation practice. To explore the green innovation laws of different industry firms and to determine the overall characteristics of green innovation practice, this article analyzes the specific measures of green innovation adopted by Fortune Global 500 companies using the content analysis method, summarizes the internal links and the differences between them, and provides valuable and feasible suggestions for other firms to develop green innovation practices.

Research Method

This section mainly elaborates the procedures of using content analysis to study the green innovation practices of companies. First, we obtain the dimensions/themes of green innovation practices from the literature (see Table 1). Second, we collect the related data of the top 500 global companies and obtain the criteria according to the dimensions. Then, cluster analysis is conducted to classify the companies. Finally, the analysis of green innovation practices for companies in different groups is conducted. The detailed procedures are as follows.

Step 1: Determine the Dimensions of Green Innovation Practices

The dimensions of green innovation practices are obtained from the literature. The literature research method is not limited by time and space. We can summarize and draw lessons from previous research results. Through collecting, sorting, and reading relevant literature on corporate green innovation, the important dimensions reflecting the research content are determined. The details of the dimensions are shown in Table 1.

Step 2: Extract the Criteria of Green Innovation Practices

Based on the dimensions, the corresponding criteria are obtained from the green innovation data of companies by

Table 1. Dimensions and Corresponding References of Green Innovation Practices.

Dimensions	References
Green technology (D1)	Nieminen et al. (2007); Liu et al. (2017)
Materials (D2)	Chouinard and Brown (1997); Y. S. Chen et al. (2006); Hashemi et al. (2015)
Energy (D3)	Yi (2013); Yuan et al. (2017)
Water (D4)	Willard (2005)
Environmental management system (D5)	Winter and Lasch (2016)
Cooperation (D6)	J. Wang (2010)
Waste (D7)	Willard (2005); Y. S. Chen et al. (2006)
Product (D8)	Willard (2005); Hashemi et al. (2015); W. Y. Li et al. (2016)
Green finance (D9)	Bal et al. (2013)
Green office (D10)	Gou et al. (2012)
Supply chain (D11)	Laari et al. (2017); Aziz et al. (2016); Knez et al. (2011); Mina et al. (2014)
Green activities (D12)	Axon (2016); D. Li et al. (2017)

using word frequency statistics. There are three substeps: research object screening, data acquisition, and data encoding.

Substep 1: Select the research object. As the global top 500 companies as research objects come from all over the world, there are great differences in language, mode, and other aspects, which is inconvenient when obtaining the research data. At the same time, there are also differences in time and the expression of green innovation data published by different companies. Therefore, it is necessary to select the research object according to certain rules. To ensure the smooth development of the research, the selection conditions are as follows:

a. The company has its own website and allows access through the researcher's network environment;
b. The content of the company's official website is presented in Chinese or English;
c. The company's official website has separate modules, such as "CSR (Corporate Social Responsibility)," "sustainable development," "green," and "sustainability."

Substep 2: Extract data. The main source of data is the company report published on the website, including annual reports, sustainable development reports, and social responsibility reports. The annual report is a comprehensive summary reflecting the development of the company. Sustainable development reports include the actions of managing and improving economic, environmental, and social performances by companies, the results of these actions, and future improvements (Zhong & Gan, 2006). The content of social responsibility reports usually involves various aspects of economic responsibility, environmental responsibility, and social responsibility (Xu & Xu, 2011). The green development strategy we focus on is the important part of the company reports. Due to the different published time of the reports belonging to different companies, the time range is 2015 to 2017, so we use the latest published reports to obtain data. For the companies without reports, we use "environment," "sustainability," and "green innovation" as keywords (Chinese website with the corresponding Chinese vocabulary as keywords) to collect materials related to the research content.

Substep 3: Code data. This study uses NVivo10 software to encode and analyze the company data. NVivo10 can address many types of content, summarize a large number of scattered data related to the research topic, and mine hidden information so that researchers can quickly capture the information in the data. In addition, the exploration function of NVivo10 can help researchers perform correlation analysis and clustering analysis, which are needed in this study. The nodes in different levels encoded by NVivo have subordinate relationships. According to the purpose of this study, the company data are imported into software for coding with the dimensions as the first-level nodes. We adopt the method of manual coding and automatic coding to obtain the second-level nodes as the criteria of green innovation practices. The coding process mainly includes open coding and axial coding.

Open coding. Open coding belongs to the stage of meaning formation. In this stage, manual coding is adopted. While browsing each company's information, we select a part of the information with practical meaning and use the core keywords or phrases in this part as the criteria. The reference points with the same meaning are integrated into the same criterion. At this stage, multiple indicators are allowed to encode the same part of the information.

Axial coding. Axial coding belongs to the stage of concept formation. The criteria that have been formed are further inducted and generalized. The criteria with the same or similar meaning are merged. After all the criteria are determined, the remaining company data are encoded in the form

of automatic coding, and the corresponding coding matrix is formed to facilitate the verification of the automatic coding and improve the accuracy and credibility of the coding. Because the data cannot be encoded, we create a memo link for them.

Step 3: Cluster companies according to the criteria of green innovation practices. After encoding, we use NVivo10 software to perform correlation analysis and cluster analysis based on the criteria of green innovation practices. Correlation analysis is used to quantify the degree of correlation between variables by introducing certain statistical criteria. This helps us to predict and analyze the regularity of the relationships between things or phenomena (Liang et al., 2016). Cluster analysis classifies the data samples according to the similarity or dissimilarity of the pattern features so that the data in the same set are as similar as possible, and the data between different groups are different as much as possible (M. Wang, 2008; J. Wang, 2010). Through the cluster analysis, we can discover the similarities and differences between the research objects. These similarities and differences can reflect the characteristics of the research objects clearly. In this study, the Pearson correlation coefficient of NVivo software is used to analyze the material source. On the basis of correlation analysis, cluster analysis for the companies is completed according to the similarity of criteria coding.

Step 4: Analyze the green innovation practices of companies. According to the clustering results of companies, the green innovation practices of companies in the same group as well as between the groups are analyzed by the comparative analysis method.

Application Illustration

Data Sources

The "Fortune" global top 500 list is the most famous and authoritative list used to measure the world's largest companies, known as the "ultimate list," and is published by the "Fortune" magazine once a year. The list ranking is mainly based on sale revenue. The scale of the company is also considered. The research objects of this study are the top 500 global companies published by fortune Chinese websites on July 20, 2016. These companies come from more than 30 countries, of which 134 are in the United States, 110 in China, and 52 in Japan. Their numbers rank in the top three on the list. In addition, the companies cover all walks of life, of which the real estate industry, finance and insurance industry, energy industry, and communication industry are the major industries. The reasons for choosing the top 500 global companies are as follows. First, through the selection criteria of the top 500 global companies, the companies in the list are the strongest companies in the world, with relatively high sales revenue and large scales. Larger companies are more likely to take environmental actions initiatively, such as green innovation, than smaller ones (Darnall et al., 2010). Larger companies also have greater social influence and can satisfy the stakeholders' demands for more aggressive environmental measures (Etzion, 2007). Second, the top 500 global companies involved in all walks of life in many countries can reflect the green innovation characteristics of companies in different industries, so the research results have a more extensive application value.

Determination of Dimensions and Criteria

First, we select 12 dimensions from the literature. The details are as follows.

Clean technology (D1) is a sustainable technology that can minimize the use of natural resources in the production process and achieve zero emissions (Nieminen et al., 2007). In small and medium companies, the promotion of clean technology is highly valued by stakeholders (Liu et al., 2017). Starting with raw materials (D2), exploring how to reduce the impact on the environment from the early stages of the product life cycle is also an important aspect of corporate green innovation (Y. S. Chen et al., 2006; Chouinard & Brown, 1997; Hashemi et al., 2015). In addition, the energy (D3) problem has also been emphasized by the state and company. The U.S. national and local governments actively promote the use of renewable energy and focus on improving energy efficiency (Yi, 2013). Companies should not only pay attention to energy issues but also the saving and recycling of water resources (D4) (Willard, 2005). To promote green development, some companies try to build an environmental management system (D5) (Winter & Lasch, 2016) and some focus on cooperation (D6) with scientific research institutions and suppliers (Irena, 2015). The disposal of waste (D7) (Y. S. Chen et al., 2006; Willard, 2005) and the green design of products (D8) are also challenges for many companies in the process of green innovation (Hashemi et al., 2015; W. Y. Li et al., 2016; Willard, 2005). The development of green finance (D9) has become an important factor for banks and other financial companies to improve their competitiveness (Bal et al., 2013). Promotion of a green office (D10) (Gou et al., 2012) and green supply chain (D11) management can result in competitive advantages for companies (Aziz et al., 2016; Knez et al., 2011; Laari et al., 2017; Mina et al., 2014).

In addition, carrying out various green activities (D12) (Axon, 2016; W. Y. Li et al., 2016) can enhance firms' green development level. The dimensions of green innovation practices of companies are shown in Table 1.

Then, according to the selection rules in "Research Method" section, we finally obtain 284 available data points from the top 500 global companies, including 202 English and 82 Chinese data points for encoding. To ensure consistency in data formats, all Chinese data are translated into the corresponding English data. Then, we randomly select some data from the 284 company data to encode manually based

on primary indicators. When 132 company data are encoded, the secondary indicators formed by axial encoding have already been well identified by the software and can meet the demand of automatic coding afterward. Examples of manual coding are as follows:

The following data from Apple's official website are used as an example to introduce the encoding process:

> Partnering with suppliers for clean energy. The electricity we use in our supply chain to process raw materials, make parts, and assemble our products is the single biggest source of our carbon footprint. So in 2015, we created a program to help our partners around the world reduce their energy use, power their facilities with clean energy, and build high-quality renewable energy projects.

1. Energy ——— "power their facilities with clean energy," "build high-quality renewable energy projects." — Use clean renewable energy
2. Cooperation ——— "partnering with suppliers." — Cooperate with suppliers

First, according to the keywords "energy" and "partnering with," we determine that this paragraph is related to the "Energy" and "Cooperation" of the dimensions. Then, the specific content "power their facilities with clean energy" and "build high-quality renewable energy projects" about "Energy" is encoded as the corresponding criterion "Use lean renewable energy," and "Partnering with suppliers" about "Cooperation" is encoded as the corresponding secondary criterion "Cooperate with suppliers." In the same way, a total of 43 criteria are obtained that meet the needs of the research and have a hierarchical relationship with the dimensions; see Table 2.

Company Clustering

In this section, we use the "explore" function of NVivo10 software to conduct Pearson correlation analysis of various companies in accordance with coding similarity and then select the 209 companies with strong correlation (correlation coefficient $\geq .6$; J. Wang et al., 2014) to perform cluster analysis based on the criteria in Table 2. Because the number of clusters is generally less than the square root of the sample number (Vesanto & Alhoniemi, 2000), we take the integer part of $\sqrt{209}$ as the number of clusters. The companies are classified into 14 groups. See Table 3 for details.

In Table 3, the first column is the 14 groups that were classified; the second column includes the names of each company in different groups; the third column contains the criteria of the green innovation practices corresponding to the companies in each group. Here, only the criteria with the highest frequency are listed as the representative criteria.

Analysis of Green Innovation Practices

As shown in Table 3, the first group of companies is involved in the supply of raw materials, sales, transportation, communications, and finance industries, which are most concerned about cooperation with universities and research institutions, followed by the establishment of green data centers, combined with the community and improvement of the mode of transport. The second group mainly contains financial companies but also includes electronic information technology, infrastructure, and so on; this group pays more attention to cooperation with suppliers and the use of clean renewable energy (Kim & Park, 2018). In addition, the frequency of saving paper is also high, showing the companies in this group promote green offices. The companies in the third group are mainly the energy industry. The key criteria are green patents and green innovation projects, indicating that such companies tend to start with the knowledge level in the process of green innovation. The fourth group, including Samsung Electronics, Yanchang Petroleum, and the two major banks, attaches importance to environmental protection activities, establishes environmental protection targets, and uses energy-saving technologies. In addition, a green credit policy is an important criterion for the banking sector (Chang et al., 2019). Companies in the fifth group are all from China, involving equipment manufacturing, transportation, and power. The concerned criteria are waste disposal, energy conservation reform, new energy, and energy conservation technology development. These companies pay more attention to the energy problem. In the sixth group, the financial industry predominates; this group also includes automotive manufacturing and energy. The most concerned criteria of green innovation practices are the improvement of energy efficiency, use of clean and renewable energy, and the formulation of environmental protection strategies. The seventh group's companies include communications, finance, energy, and retail industries. The criteria of these companies are green information and communication technology, green data centers, engaging with communities, and improvement of water use efficiency. The eighth group involves financial insurance, electric power, energy and chemical industries, medicine and the media, and so on. This group focuses on the use of clean and renewable energy, protection of nature and species diversity, environmental protection strategies, and engagement with communities. The ninth group is involved in many industries, but the main one is the energy industry. The main criteria are to reduce water pollution and waste, improve water use efficiency, and dispose of waste (Shao et al., 2017). The tenth group is mainly the insurance industry and also includes energy, electricity, mining, and automobile machinery manufacturing industries. The common criteria of such companies are waste recycling and the protection of natural and biological diversity. The eleventh group is mainly engaged in steel automobile manufacturing and the construction industry. This group pays more attention

Table 2. The Dimensions and Criteria of Green Innovation Practices.

Dimensions	Criteria
Green technology (D1)	Clean production technology (C1)
	Resource saving technology (C2)
	Waste recycling technology (C3)
	Green information and communication technology (C4)
	Energy-saving technology (C5)
Materials (D2)	Develop and use clean materials (C6)
	Chemical control (C7)
	Reduce material use (C8)
Energy (D3)	Improve energy efficiency (C9)
	Use clean renewable energy (C10)
	Search for new energy (C11)
	Energy-saving reform (C12)
Water (D4)	Reduce water waste (C13)
	Reduce water pollution (C14)
	Improve water use efficiency (C15)
Environmental management system (D5)	Environmental strategy (C16)
	Environmental goals (C17)
	Green patents (C18)
	Monitoring and evaluation system (C19)
	Environmental regulation (C20)
	Provide training courses (C21)
	Green data center (C22)
Cooperation (D6)	Cooperate with suppliers (C23)
	Participate in green organization (C24)
	Cooperate with peers (C25)
	Cooperate with universities and research institutions (C26)
Waste (D7)	Waste recycling (C27)
	Waste disposal (C28)
Product (D8)	Product recovery (C29)
	Green design of products (C30)
Green finance (D9)	Green financial bonds (C31)
	Green-credit policy (C32)
Green office (D10)	Save paper (C33)
	Telecommuting (C34)
	Facilitate green transformation (C35)
Supply chain (D11)	Control producing area (C36)
	Green sales chain (C37)
	Green warehouse (C38)
	Transportation improvement (C39)
Green activities (D12)	Engage with communities (C40)
	Protect nature and species diversity (C41)
	Green innovation programs (C42)
	Environmental activities (C43)

to green technology, including clean production technology, energy-saving and emission-reduction technologies, and low-carbon technologies (Masso & Vahter, 2008). There are numerous green innovation projects in such companies. The companies in the twelfth group are in different types of industries. The criteria include training courses, the use of cleaning materials, chemical control, and green product design. There are a large number of companies in the thirteenth group. They are divided into several types, including energy, finance, medicine, food, information technology, and manufacturing. The criteria in this group are to reduce water pollution and waste, improve water use efficiency, use clean renewable energy, reduce the use of raw materials, and protect nature and biodiversity. The fourteenth group is mainly petrochemical and machinery manufacturing, focusing on green product design, the control of chemicals, and green innovation projects.

Table 3. Company Clustering and Corresponding Criteria of Green Innovation Practices.

Group	Companies	Criteria
1	Continental AG; Lowes; Morgan Stanley; Noble Group; Sysco; United Technologies Corporation; Vodafone Group	Cooperate with universities and research institutions (C26) Green data center (C22) Engage with communities (C40) Transportation improvement (C39)
2	Allstate; China Electronics Corporation; China Aerospace Science and Technology Corporation; Compass Group; China Pacific Insurance; HSBC Holdings; JPMorgan Chase & Co; MITSUI & Co., Ltd.; Mitsubishi Chemical Holdings; NEC Corporation; Phoenix_Pharmahandel; Schneider Electric; Zurich Insurance Group	Cooperate with suppliers (C23) Save paper (C33) Use clean renewable energy (C10)
3	China Vanke Co., Ltd.; China Nonferrous Metal Mining (Group) Co., Ltd.; Rosneft Oil; Shenhua Group	Green patents (C18) Green innovation programs (C42)
4	China Merchants Bank; Industrial Bank; Samsung Electronics; Shanxi Yanchang Petroleum	Environmental activities (C43) Environmental goals (C17) Energy-saving technology (C5) Green-credit policy (C32)
5	Aviation Industry Corporation of China; China Metallurgical Corporation Group; China COSCO shipping group; State Grid; Zhejiang Materials Industry Group Corporation	Waste disposal (C28) Energy-saving reform (C12) Search for new energy (C11) Energy-saving technology (C5)
6	Allianz SE; Credit Suisse Group AG; Emerson Electric; General Motors Corporation; Magna International Inc.; National Australia Bank Ltd.; Sumitomo Mitsui Financial Group; Total	Improve energy efficiency (C9) Use clean renewable energy (C10) Environmental strategy (C16)
7	Deutsche Telekom AG; Idemitsu Kosan; Orange Group; Raytheon Company; Soft Bank; Suncor Energy; Scottish Southern Energy; Standard Chartered Bank; TJX Group; Unipol Group	Green information and communication technology (C4) Green data center (C22) Engage with communities (C40) Improve water use efficiency (C15)
8	Aegon; Aviva plc; Chubu Electric Power Company; CHS Group; EDF Group; Metro AG; Marubeni Corporation; Mitsubishi Corporation; Medipal Holdings; Sompo Japan Nipponkoa Holdings; SK Grouo; Time Warner Inc; Tokio Marine & Nichido Fire Insurance Company	Use clean renewable energy (C10) Protect nature and species diversity (C41) Environmental strategy (C16) Engage with communities (C40)
9	Airbus Group N.V.; Air France; Anthem Group; BHP Billiton Ltd.; BAE Systems plc; Bunge Limited; Comcast Corporation; Cigna Insurance Group; CVS Health Group; Danone; Eni energy company; Gazprom; Goldman Sachs; Holland Royal shell oil company; Halliburton Company; International Paper; Indian Oil Corporation; Inditex Group; Johnson&Johnson; Johnson Controls, Inc.; Louis Dreyfus; Lyondell Basell Industries; Mitsubishi Electric Corporation; Petronas; Pfizer,NYSE: PFE; Ray Pschorr company; Robert Bosch Group; Sodexo; Thyssenkrupp; Talanx Group; TIAA-CREF; Wesfarmers Limited; ZF Friedrichshafen AG	Reduce water waste (C13) Improve water use efficiency (C15) Waste disposal (C28) Reduce water pollution (C14)
10	Auchan; China Huadian Corporation; Datong Coal Mine Group Co., Ltd., Japan Post Holdings Co., Ltd.; Jiangxi Copper Corp; JX Holdings; Japan Mizuho Financial Group; MS&AD Insurance Group Holdings; Munich Re Group; Mitsubishi UFJ Financial Group, Inc.; Michelin; National Grid; Petroleos Mexicanos; Panasonic; Power Construction Corporation of China; SINOCHEM GROUP; Tata Motors; Vinci Group; Walgreens Boots Alliance	Protect nature and species diversity (C41) Waste recycling (C27)
11	China Railway Construction Corporation Co., ltd; China National Machinery Industry Corporation; China United Network Communications Limited; Ford Motor Company; HeSteel Group; Jizhong Energy Group; Shougang Group	Clean production technology (C1) Energy-saving technology (C5) Green innovation programs (C42) Resource saving technology (C2)
12	Hyundai Heavy Industries; Lufthansa; Microsoft Corporation; Pepsico; Sanpaolo IMI; Trafigura Beheer BV; Toshiba Corporation	Provide training courses (C21) Develop and use clean materials (C6) Chemical control (C7) Green design of products (C30)

(continued)

Table 3. (continued)

Group	Companies	Criteria
13	Amgen; Alcoa; ACS; ABInbev; Aisin Seiki; Aetna; Arcelor Mittal; ANZ Bank; Asea Brown Boveri; Bouygues; Bayer; BP Amoco; Bharat Petroleum; Cardinal Health Group; CK Hutchison Holdings; Coca-Cola; Companhia Vale do Rio Doce; CRH Group; China Minmetals Corporation; Canon; Cisco Systems; Conoco Phillips; DuPont; Enel; EXOR Group; East Japan Railway Company; Enbridge Group; Fujitsu; Gilead Sciences Group; Glaxo Smith Kline; Groupe BPCE; Gas Natural Fenosa; Henri Nestle; Heineken Holding; Kroger; IBM Corporation; Kansai Electric Power; KOC; LG Electronics; Lockheed Martin; LG Display; Marathon Petroleum Corporation; Northrop Grumman; National Union Life and Limb Insurance Company; Nike; OAO Lukoil Holdings; OMV Group; Phillips 66 Group; Procter & Gamble; Rio Tinto Group; Roche Group; RWE Group; Royal Bank of Canada; Veolia Environnement Royal Dutch Philips Electronics Ltd.; Reliance Industries; Siemens; Saudi Basic Industry Corporation; Scotia bank; Sanofi; Sumitomo Electric Industries; Toronto-Dominion Bank; TUI Group; ITOCHU Corporation; TSMC; The Dai-ichi Life Insurance Company; Telstra; Unilever; United Continental Holdings; Wm Morrison Supermarkets; Wilmar International	Improve water use efficiency (C15) Reduce water waste (C13) Protect nature and species diversity (C41) Use clean renewable energy (C10) Reduce water pollution (C14) Reduce material use (C8)
14	Boeing; China National Chemical Corporation; Dow Chemical Company; General Electric Company; Hanwha Group; PKN Orlen; Zhejiang Geely Holdings	Green design of products (C30) Chemical control (C7) Green innovation programs (C42)

In addition to intragroup analysis, an intergroup analysis is also needed. First, the thirteenth group contains 71 companies, accounting for one third of the total number of clusters, indicating that the corresponding criteria of this group are the common concern of most companies when performing green innovation. In addition, there are three criteria, including energy-saving technology, engaging with communities and green innovation programs, which also appear in three groups; the companies are highly concerned with these three criteria. At the same time, the frequency of criteria related to water resources and energy exceeded a value of 7 in all 14 groups, reflecting the importance of water resources and energy in green innovation practice (Gao et al., 2020). Second, there are some criteria that only appear in one group, which reflects the particular characteristics of the companies in this group. For example, the second group focuses on cooperation with suppliers and green offices, the companies in the third group have more green patents, the fourth group of companies focuses on carrying out a series of environmental activities and is good at setting goals, and the eleventh group is primarily concerned with green technology (Fujii & Managi, 2019). The above analysis shows that there are similar green innovation practices between different groups, and there are also differences according to their own actual situations.

In summary, the research result reveals similarities and differences in the green innovation practices. Furthermore, to provide valuable reference for companies' decision-making of green innovation practices, we summarize six categories of industries with obvious characteristics in the above groups and propose corresponding measures, as shown in Table 4.

From Table 4, for those companies exploring or intending to carry out green innovation, they can locate themselves into their own industry and make their own green innovation and development path by referring to the corresponding green innovation measures. For instance, companies in the energy industry can implement green innovation by actively developing green innovation programs, applying green patents and improving water use efficiency. The retail and material supply industry can carry out green innovation through energy-saving reform, improving the transportation mode, establishing a green data center, engaging with communities, and so on. In addition, the industry generally pays attention to water conservation and the protection of nature and species diversity and reflects the social responsibility of the companies and actively generates a good image of consciousness in the process of green innovation. In addition, some companies of an industry are distributed discretely, or the number in a group is small; they cannot present a certain trend, such as the communication industry, mineral industry, and entertainment industry, so we do not give a unified proposal for these types of companies, but we can search for similar business companies as references in the relevant industry.

Theoretical and Managerial Implications

First, we enrich the research on the criteria framework for green innovation practices. Such a criteria framework is

Table 4. Green Innovation Measures for Companies.

Category	Industry	Measures
1	Energy-related industries	Carry out green innovation programs, apply for green patents; conserve water, improve the utilization of water resources; address waste and focus on the protection of natural and biological diversity
2	Finance-related industries	Implement green offices, save paper; use clean renewable energy, and develop an environmental strategy; focus on waste recycling as well as the protection of nature and biodiversity
3	Diet and pharmaceutical industries	Cooperate with suppliers; conserve water and increase water use efficiency; use clean renewable energy and recycle waste materials; protect nature and biodiversity
4	Machinery manufacturing industries	Conserve water, increase water use efficiency; carry out green innovation programs and develop or introduce various green technologies; pay attention to the disposal of waste and protect the diversity of nature and biology
5	Electronic information and high-tech industries	Use clean renewable energy; conserve water and increase water use efficiency; cooperate with suppliers and implement green offices; protect the diversity of nature and biology
6	Retail and material supply industries	Engage with communities; establish a green data center; carry out energy-saving reform; improve the transportation mode

basic and important for the study of influencing factors or evaluations. Researchers in the field of green innovation mostly focus on research on driving factors and influential mechanisms, among other factors, whereas the systematic and holistic criteria are lacking (H. J. Chen, 2012). In this study, we not only consider the common dimensions such as "Green technology," "Energy," and "Materials" but also certain distinctive dimensions such as "Cooperation" and "Green finance" to determine corresponding criteria. This new criteria system offers comprehensive insight for the green innovation practices of companies.

Second, we enrich the methodology of green innovation. Specifically, we integrate the methods of literature research and content analysis. The dimensions of green innovation practices are taken from the existing literature. Based on these dimensions, the criteria are obtained from data of Fortune 500 companies by using content analysis. For instance, the corresponding criteria of the dimension "green technology" are energy-saving technology, clean production technology, resource conservation technology, waste recycling technology, and green information and communication technology. The corresponding criteria of the dimension "cooperation" are cooperation with suppliers, participation in green organizations, cooperation with peers, and cooperation with universities and research institutions. The data released by the official websites of companies are scattered and numerous, so it is difficult to apply a homogeneous approach to utilize these data (Chan et al., 2016). Through the integration of literature research and content analysis, the research results of previous scholars can be included; in addition, valuable information contained in a large amount of company data can be mined, which greatly improves the credibility and reference value of the research.

Finally, there are also important managerial implications according to the research results. By exploring the green innovation practices of companies in different industries, we propose suitable measures for green innovation. Other companies can refer to these measures to improve the efficiency of green innovation. According to the criteria of green innovation practices, companies with high correlation are clustered into 14 groups. Each group of companies places special attention on the aspect of green innovation. It can be seen that different green innovation practices of companies are based on their own different business characteristics and business modes. For example, in the first group, there are many companies in the retail and material supply industry, which are keen on energy conservation and improvement of transportation modes, as well as engagement with communities. The companies in the third group are mainly in the energy industry, which concerns green patents and green innovation programs. There are more companies in the financial sector in the eighth group. The use of clean renewable energy and the formulation of environmental strategies are the key strategies for these companies. The eleventh group contains mainly iron and steel industries and automobile manufacturing companies. Green innovation practices focus on green technologies, including clean production technology, energy-saving technology, and resource saving technology.

At the end of this study, we summarize these groups as six industries according to industry characteristics, propose suitable green innovation measures for each industry, and then provide more direct reference to other companies. Specifically, the energy industry can actively carry out green innovation programs, apply for green patents, and focus on the disposal of waste. For the financial industry, the development of specific environmental strategies and green offices is

necessary. The diet and pharmaceutical industry is recommended to work with suppliers to reduce the consumption of raw materials. The mechanical manufacturing industry should improve the importance of green technology, whereas some electronic information and high-tech industries should focus on the use of clean energy. The relevant companies in the retail and material supply industry can try to improve the mode of transportation by rationally optimizing the route and distributing transportation tools. Other companies can also look for industries with similar types and learn from the corresponding green innovation measures to improve the efficiency of green innovation.

Conclusion

With the rapid growth of the economy, the environment is deteriorating daily. Frequent environmental problems have sounded alarm bells for human society. As an important part of society, companies are exploring green innovation to improve their competitiveness and achieve green development. However, it is difficult to provide guidance and reference for relevant companies due to the lack of research on green innovation practices of companies based on a large number of samples. This research takes the world's top 500 companies as the research object and uses a content analysis method to extract data published by companies that reflect the practices of green innovation. Then, with the cluster analysis function of the analysis software NVivo10, 209 companies with higher correlation degrees are classified to explore the green innovation practices of companies in different groups. Finally, corresponding measures and suggestions are proposed.

Based on the criteria of green innovation practices, we divide the companies with high correlation into 14 groups and extract the criteria with higher frequency in each group to reflect the green innovation practices in each group. The results indicate that the green innovation adopted by companies in different industries has different characteristics. Among them, the energy industry, the financial industry, the diet and pharmaceutical industry, machinery manufacturing industry, electronic information and high-tech industries, and retail and materials supply industry show obvious characteristics of the industry. The companies in each industry have their own measures and practices of green innovation. In addition, companies with green innovation pay more attention to the protection of water resources and the use of clean energy. The protection of nature and biodiversity is also a strong concern of companies. This information provides guidance for companies that are going to carry out green innovation or are in the green innovation exploration stage.

Although the entire process of research is as rigorous as possible, there are still some limitations. First, the research data are obtained from a company's official website. Due to restrictions on the network environment or other special reasons, some companies' data cannot be obtained. Second, the data obtained in this study only cover Chinese and English languages. Some of the company data published in other languages are not analyzed. In the future, we can attempt to obtain data from other third-party platforms and involve more samples with different languages.

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