

Research on the Practice Structure of Green Supply Chain Management in County Enterprises of China

Mengting Li*, Yujie She

School of Wuxi Institute of Technology, Wuxi, Jiangsu, China

**Corresponding author*

Keywords: Low carbon economy, Green supply chain management, Green development of county economy

Abstract: Optimizing the green supply chain management practice (GSCM) structure of county enterprises is an important step for county's green economic development. By quantifying carbon emission reduction practices of 65 enterprises' GSCM in South Jiangsu of China, a causal relationship model between practices was constructed. The results show that: the degree of cooperation with suppliers and promotion of shared value creation (CSV) is low; Organizational system innovation and environmentally friendly design promote the promotion of corporate social responsibility (CSR) and CSV, cooperation with suppliers and customers, and promotion of CSV promotes cooperation with suppliers and customers. It is suggested that enterprises strengthen cooperation with suppliers and promote CSV, and explore ways of cooperation based on the premise of promoting the strategy of CSR and CSV and realizing common interests.

1. Introduction

As the issue of climate warming has become a global concern, all walks of life have come to realize the limitations of the way enterprises only implement environmental management internally, and the key to solve the problem of global warming is to cooperate with suppliers and customers to implement green supply chain management (hereinafter referred to as "GSCM") throughout the supply chain [1]. The "high carbon" characteristics of some county economies in China are still obvious, and the low-carbon development of county economy is a practical problem to be solved urgently. Focusing on carbon emission reduction measures to discuss the practice structure of county enterprises' GSCM has important guiding significance for the establishment of enterprise GSCM model suitable for the development of county low carbon economy.

2. Theoretical Review and Research Hypothesis

GSCM practices refer to the environmental management activities implemented at all links in the supply chain of enterprises, from suppliers to producers and consumers. Some studies have pointed out that the internal practices include organizational system innovation[2], environmentally friendly design[3] And Corporate Social Responsibility (CSR)[4] Etc. External practices include cooperation

with suppliers and collaboration with customers[5]Etc., this paper includes their carbon emission reduction practices into the research scope. Moreover, in recent years, more and more Chinese enterprises are Creating Shared Value (CSV) into low-carbon business strategies and putting it into practice[6]. Domestic and foreign research has not paid enough attention to this new environmental management practice, especially the research on its formation path, performance impact and development trend has not been based on statistical analysis of the literature. Therefore, the carbon reduction practice incorporated into CSV concept is also included into the research horizon as a form of internal practice in this paper.

The research hypothesis of the relationship between GSCM practices is based on the development of internal environmental management practices in Chinese enterprises. Organizational system innovations such as the top-level design of top management and interdepartmental cooperation originated in the early "environmental correspondence" era[7] and have always played an important role in corporate environmental management. Environmentally-friendly design came into being[8] under the guidance of the scientific outlook on development and the advocacy of energy-saving product design. At present, it plays an important role in coping with the increasingly strict environmental regulations overseas. CSR and CSV, especially the latter, are internal environmental management measures implemented under the guidance of the "Five development concepts"[9-10]. In recent years, amid frequent corporate scandals, there has been a growing awareness that "environmental management is related to corporate interests". In order to build a competitive corporate image, CSR measures such as the release of environmental reports and the introduction of environmental accounting have been introduced into Chinese enterprises[11]. While CSR tends to be a simple environmental contribution, CSV emphasizes solving environmental problems and obtaining economic benefits at the same time. It can be seen that the promotion of CSR and CSV is indeed a form of practice after organizational system innovation and environmentally friendly design[12]. In addition to the time dimension, whether there is a cause-and-effect relationship between them, and to explore the correlation between the degree of integration into the practice of CSR and CSV concept and the degree of early organizational system innovation and environmentally friendly design is the main content of this paper to explore the relationship between internal practices.

In addition, as mentioned above, the way of environmental management in some enterprises in China is gradually expanding to external practices such as cooperation with suppliers and customers. Therefore, this paper includes external practices related to carbon emission reduction into the category of discussion, exploring the causal relationship between internal and external practices, mainly exploring whether the degree of external practices depends on the degree of internal practices, and whether the promotion of external practices can force enterprises to improve the implementation of internal practices. To sum up, the following two research hypotheses are proposed:

H1: In the internal carbon reduction practice, enterprises innovate organizational system and carry out environmentally friendly design to promote the promotion of CSR and CSV.

H2: Internal and external carbon abatement practices in GSCM promote each other.

3. Summary of Questionnaire Survey

The data used in this paper are from a sample survey of manufacturing enterprises in provinces and counties in Southern Jiangsu Province conducted by our research group from September 2022 to December 2022. The county economy of South Jiangsu is the development highland of China's manufacturing industry. According to the level of economic development, the research group selected 8 counties (cities) under the jurisdiction of Suzhou, Wuxi and Changzhou in South Jiangsu as the survey area, and sent questionnaires to the middle and senior managers of 82 manufacturing enterprises in the survey area. Finally, 65 valid questionnaires were collected. The industry categories

of the enterprises from which the valid questionnaires originated are shown in Table 1.

Table 1: Shows the industry categories of the enterprises that answered the valid questionnaires.

Industry category	Number of businesses	Percentage (%)
Food manufacturing	5	7.7
Textile industry	8	12.3
Paper and paper products industry	2	3.0
Manufacturing of chemical raw materials and chemical products	4	6.15
Manufacturing of rubber Products	1	1.5
Beverage Manufacturing	2	3.1
Agricultural and sideline food processing industry	2	3.1
Non-metallic mineral products industry	3	4.6
Metal products industry	2	3.1
General purpose and special purpose equipment manufacturing	10	15.4
Electrical Machinery and Equipment manufacturing	12	18.5
Transportation Machinery Manufacturing	8	12.3
Others	6	9.2
Total	65	100

The questionnaire is divided into three parts: (I) the basic information of enterprises in 2022 (industry type, number of employees, etc.), and (ii) the degree of implementation of various practices. In (II), practices are divided into six types according to H1 and H2, and 28 specific practice forms are set up based on the actual situation of GSCM of survey objects known from previous interviews (see Table 2). Among them, the practice form identified as "CSV advancement" is based on the theory of Porter and Kramer[6] Three ways to practice CSV are proposed (new product development incorporating CSV concepts, CSV practices in value chains, and CSV ventures in business regions). The answers to the questions about the degree of practice were rated on a scale of 5 from high to low: "1. Not considered" and "2." It has been discussed, but has not been implemented, 3. It has been decided to implement, but the details are still being discussed, and 4. Try to implement "and" 5. Formally implement".

4. Analyze the Results

In this paper, SPSS is used to analyze the relationship between GSCM practices and covariance structure analysis (structural equation model). Prior to the factor analysis, items that have little impact on the results should be removed first. The steps are as follows: (1) Calculate the descriptive statistics to get the mean and standard deviation for each item in Table 2; (2) Check ceiling effect ($\text{Mean} + \text{SD} > 5$) and floor effect ($\text{Mean} - \text{SD} < 1$); (3) Analyze the distribution and importance of the items with these two effects, excluding the items marked and underlined in the table.

Table 2: Descriptive statistics of item (II) in the questionnaire.

Classification	Project name	N	Mean	SD
Organizational system innovation	1. Cooperation between departments to reduce carbon emissions	65	4.25↑	1.3
	2. Different departments have different carbon reduction measures	65	4.47↑	1.17
	3. Subsidiaries and associated companies have carbon emission reduction measures	65	3.96↑	1.39
	4. Corporate senior management commits to carbon reduction	65	4.33↑	1.31
	5. Corporate middle management commits to carbon reduction	64	3.91↑	1.26
Environmentally friendly design	6. Take carbon reduction into account in the design of the production process	65	3.96↑	1.43
	7. Design your products with carbon emissions from the use phase in mind	65	3.52↑	1.53
	8. Design products with transportation efficiency in mind	62	3.42↑	1.68
	9. Design products with reduced packaging materials in mind	63	3.55↑	1.63
	10. Obtain environmental label certification	65	2.88	1.65
Advancing CSR	11. Set up a dedicated CSR department	65	3.49↑	1.58
	12. Appoint full-time CSR practitioners	65	3.53↑	1.53
	13. Publicly disclose carbon emissions information	63	2.98	1.55
	14. Subsidiaries and affiliates perform CSR	62	3.39	1.6
	15. Release CSR reports, environmental reports and sustainable development reports	62	3.95↑	1.52
Advancing CSV	16. Provide products and services that help reduce carbon emissions	63	2.86	1.77
	17. Improve energy efficiency throughout the supply chain through the introduction of new technologies, such as cogeneration projects	63	2.41	1.57
	18. Improve logistics efficiency of the entire supply chain by shortening transportation distance and optimizing distribution routes	63	3.41↑	1.63
	19. Improve the efficiency of resource use through the reduction, reuse and recycling of water, raw materials, containers and packaging	62	4.28↑	1.19
Cooperation with Vendors	20. Have carbon reduction requirements for suppliers	65	3.57↑	1.56
	21. Use carbon reduction ability as one of the criteria for supplier selection	65	2.63	1.46
	22. Require suppliers to obtain ISO14001 or other environmental management system certification	65	3.12	1.63
	23. Conduct environmental supervision of suppliers' production processes	65	2.91	1.61
	24. Require secondary suppliers to have carbon abatement measures	65	1.74↓	1.12
Collaboration with customers	25. Collaborate with customers on environmentally friendly design	65	3.61↑	1.61
	26. Collaborate with customers to reduce carbon emissions in shipping	65	3.03	1.67
	27. Collaborate with customers to carry out environmental protection packaging research and development	63	3.31	1.59
	28. Apply for environmental mark certification to meet the green consumption needs of customers	65	2.65	1.64

Note: ↑ indicates items with ceiling effects. ↓ indicates the item with floor effect.

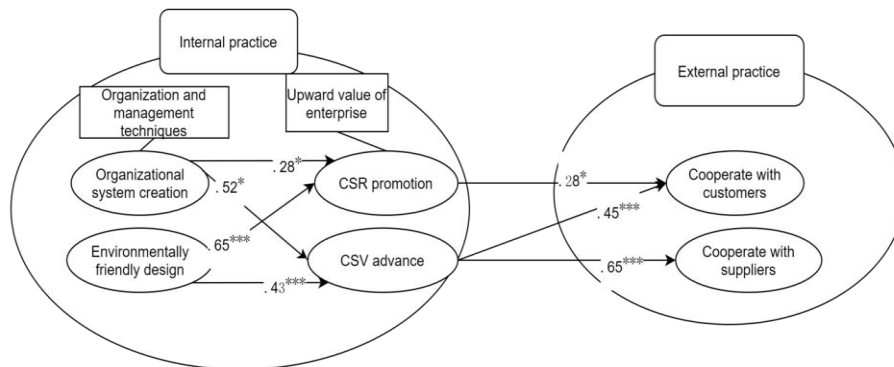
4.1. Factor Extraction

Using questionnaire data, factor analysis (principal component analysis, Kaiser standardized orthogonal rotation method) was conducted for carbon reduction practices and corporate performance in GSCM. The KMO (Kaiser-Meyer-Olkin) sample fitness measure is 0.90 and 0.92, respectively, which can determine suitability for factor analysis. In order to ensure a close correlation between each

item, factor analysis was performed repeatedly after the items were deleted until there were no more items with absolute factor load less than 0.50, and the factor load matrix was obtained (see Table 3). In the carbon emission reduction management practice in Table 3, the cumulative contribution rate of the six factors of "organizational system innovation", "environmentally friendly design", "promoting CSR", "promoting CSV", "cooperating with suppliers" and "cooperating with customers" is 82.6%. In addition, in order to ensure the internal consistency of each factor, the Cronbach coefficient was calculated, and the 10 factors were all higher than 0.70 (generally more than 0.7 is acceptable). The degree of carbon emission reduction practice in enterprise GSCM is shown in Table 4.

4.2. Causality Model

The factors extracted above (see Table 4) were used for covariance structure analysis to build a causal model among various practices of carbon reduction in GSCM (see Figure 1). The adaptability of the model is CFI = 0.879 and RMSEA=0.057. Considering the number of observed variables, it can be considered that the model can cope with the changes of practical situations to a certain extent. The arrow indicates the causal relationship between variables, the path coefficient marked horizontally indicates its influence, and the number of asterisks marked at the top right of the value is used to indicate significance.



Note: CFI=.879, RMSEA=.057; *<0.1, **<0.05, ***<0.01.

Figure 1: Causal relationship model between carbon emission reduction practices in GSCM.

4.3. Hypothesis Testing

The analysis of the causality model in Figure 1 is as follows:

The impact of "organizational system innovation" and "environmentally friendly design" on "advancing CSR" (.28*) (.65***) and "Advancing CSV" (.52*) (.43***) has a significant promoting effect. Therefore, hypothesis 1 is supported.

"Advancing CSR" in internal practice promotes "collaboration with customers" (.28*), "Advancing CSV" promotes "collaboration with customers" (.45***) and "cooperation with suppliers" (.65***). In addition, "organizational system innovation" and "environmentally friendly design" had no significant direct impact on the implementation of GSCM with suppliers and customers, but their facilitating effects on the promotion of CSR and the promotion of CSV could indirectly promote the implementation of GSCM with customers and suppliers. Therefore, part of hypothesis 2 is supported.

Table 3: Results of carbon emission reduction practice factor analysis.

	F1	F2	F3	F4	F5	F6
Departments have different carbon reduction measures	0.85	0.08	0.15	0.16	0.11	0.07
Cooperation between departments for carbon reduction	0.86	0.14	0.15	0.15	0.11	0.04
Corporate senior management commits to carbon reduction	0.79	0.08	0.12	0.17	0.17	0.08
Corporate middle management commits to carbon reduction	0.76	0.17	0.11	0.08	0.21	0.26
Help suppliers improve their carbon management capacity through capacity building training and other forms	0.16	0.79	0.03	0.08	0.16	0.28
Share the cost of carbon abatement with suppliers	0.08	0.81	0.17	0.11	0.11	0.05
Communicate with suppliers on carbon abatement	0.14	0.77	0.12	0.16	0.2	0.15
Require secondary suppliers to have carbon reduction measures	0.14	0.77	0.07	0.05	0.22	0.01
Provide carbon reduction technology to suppliers	0.12	0.71	0.19	0.24	0.04	0.36
Use carbon reduction ability as one of the criteria for supplier selection	0.24	0.78	0.12	0.15	0.44	0.14
Set up a dedicated CSR department	0.19	0.17	0.81	0.13	0.18	0.07
Set up full-time CSR practitioners	0.21	0.15	0.66	0.15	0.11	0.04
Issue CSR reports, environmental reports and sustainable development reports	0.27	0.1	0.65	0.14	0.21	0.2
Subsidiaries and affiliates perform CSR	0.25	0.15	0.68	0.32	0.21	0.18
Cooperate with customers to carry out environmental protection packaging research and development	0.16	0.17	0.29	0.79	0.21	0.14
Cooperate with customers on environmentally friendly design	0.26	0.14	0.17	0.71	0.11	0.19
Cooperate with customers to reduce carbon emissions in shipping	0.15	0.3	0.15	0.75	0.3	0.08
Design products with carbon emissions from the use phase in mind	0.27	0.15	0.18	0.13	0.75	0.19
Take transportation efficiency into account in product design	0.23	0.24	0.31	0.3	0.71	0.15
Design products with reduced packaging materials in mind	0.15	0.14	0.34	0.31	0.68	0.14
Cultivate suppliers through education, financial assistance and technical support	0.15	0.42	0.27	0.33	0.04	0.63
Provide products and services that contribute to the reduction of carbon emissions	0.13	0.24	0.15	0.11	0.45	0.65
Carry out activities in the area of operation that can simultaneously achieve social contribution and enhance competitiveness	0.19	0.16	0.21	0.33	0.33	0.61
Reliability coefficient	0.89	0.79	0.91	0.86	0.85	0.82
Factor loading	18.72	16.21	12.55	10.85	10.22	6.77

Note: The factor extraction method is principal component analysis with six rotations using the Kaiser standardized orthogonal rotation method.

Table 4: Descriptive statistics for each factor.

	Project name	N	Mean	SD
F1 Organizational system innovation	6	65	3.9	1.85
F2 Cooperation with Vendors	6	65	1.88	1.11
F3 Advancing CSR	4	64	3.75	1.27
F4 Collaboration with customers	3	65	2.85	1.88
F5 Environmentally friendly design	3	65	2.98	1.95
F6 Advancing CSV	3	63	3.22	1.36

5. Research Results

According to the above results, the following phenomena can be pointed out, and combined with the field investigation to analyze the causes of the phenomena. First, it can be seen from the Mean of carbon emission reduction practices in GSCM in Table 4 that the advancement of CSV as a new form of practice in internal practice is slower than that of organizational system innovation,

environmentally friendly design, and CSR promotion. The reason for this phenomenon may be that some enterprises have begun to promote CSV in recent years. Although there are some carbon emission reduction practices based on CSV concept, they have not yet penetrated into various fields of enterprises. In external practice, the cooperation with suppliers develops slowly, while the cooperation with customers advances faster. The reason for this difference may be that cooperation with suppliers requires joint education and training, financial assistance and technical support to suppliers. These measures cost a lot of labor and production costs, and need to reach consensus with suppliers, so the promotion is slow. However, cooperation with customers is to carry out carbon emission reduction practices in packaging, product design and transportation. It can reduce the cost, so it is more likely to be promoted first.

Secondly, the analysis results show that the promotion of CSR promotes cooperation with customers in external practices, and the promotion of CSV promotes cooperation with customers and suppliers in external practices. The reason may be that the simple environmental contribution behavior of promoting CSR is not easy to promote cooperation with suppliers, which needs to pay more expenses, but easy to promote cooperation with customers, which can reduce costs. In addition, another reason may be that in the process of promoting CSR, accompanied by the disclosure of environmental reports and CSR reports, customers' sense of trust towards enterprises will be enhanced, which will make cooperation with customers easier. 2019 China Corporate Social Responsibility Research Report also points out that some consumers, in addition to the media, they also pay attention to the CSR performance of enterprises through environmental reports. About 80% of consumers answered that they would take CSR measures into consideration when purchasing products and services. Furthermore, CSR promotion is a voluntary performance of enterprises to regulate their own behavior, while the regulation of suppliers is generally achieved through mandatory standards such as environmental requirements and supervision of suppliers in procurement guidelines, which may also be the reason why CSR promotion does not promote cooperation with suppliers. The reason why the promotion of CSV has a significant impact may be that the cultivation of suppliers and the provision of low-carbon products to customers under the guidance of CSV concept are in line with the needs of suppliers and customers, so the cooperation with suppliers and customers is promoted under the common interests. For example, measures such as education, financial assistance and technical support in promoting CSV will promote the development of suppliers. Practices such as providing low-carbon products based on CSV concept are consistent with customers' gradually enhanced awareness of low-carbon consumption in recent years.

6. Conclusions

This paper summarizes the implementation of carbon emission reduction practices in GSCM of county manufacturing enterprises in South Jiangsu, China, and makes clear the mutual influence of carbon emission reduction practices. First of all, cooperation with suppliers in external practice and promotion of CSV in internal practice progress slowly compared with other practices. Organizational system innovation and environmentally friendly design in internal practice promote new practices related to enterprise value enhancement (promotion of CSR and CSV) in recent years, and among them, promotion of CSV promotes external measures such as cooperation with customers and suppliers. Therefore, in order to optimize the GSCM practice structure of county manufacturing enterprises in the future, it is necessary to strengthen cooperation with upstream suppliers and promote CSV.

As the object of investigation is green manufacturing demonstration enterprises, environmental management standards are generally high, there are more projects with ceiling effect. It is also a research topic in the future to adjust the questionnaire based on the ceiling effect and floor effect and

gradually improve the data analysis method to deal with the ceiling effect and floor effect.

References

- [1] Zhu Qinghua, Geng Yong. A statistical analysis of the relationship between enterprise green supply chain management practice and performance. *Mathematical Statistics and Management*, 2005, 25(5): 13-19. (in Chinese)
- [2] Arimura TH, Darnall N, and Katayama H. Is ISO14001 a gateway to more advanced voluntary action? The case of green supply chain management. *Journal of Environmental Economics and Management*, 2011, 61:170-182.
- [3] McAuley JW. Global Sustainability and Key Needs in Future Automotive Design. *Environmental Science and Technology*, 2003, 37(23): 5414-5416.
- [4] Sang Shengju, Zhang Qiang. Optimization Decision of Green supply chain Considering Corporate Social Responsibility. *Transactions of Beijing Institute of Technology (Social Sciences)*, 2020, 2:107-116. (in Chinese)
- [5] Vachon S, and Klassen R. Environmental management and manufacturing performance: The role of collaboration in the supply. *Journal of Production Economics*, 2008, 111(2): 299-315.
- [6] Porter ME, and Kramer MR. The Big Idea: Creating Shared Value How to reinvent capitalism-and unleash a wave of *Harvard Business Review*, 2011, 89(1/2): 62-77.
- [7] Hu Meiqin, Luo Shoujian. Research on enterprise green management strategy based on system and technology scenario. *China's Population, Resources and Environment*, 2009 (6): 75-79. (in Chinese)
- [8] Ni Han. Adhere to the scientific concept of development of human text to promote the development of green product design. *Packaging engineering*, 2007 (12): 206-208. (in Chinese)
- [9] Gong Tianping, Li Qian. As the green value concept of economic ethics. *Guangdong Social Science*, 2018 (5): 71-78. (in Chinese)
- [10] Shulan Dong, Anni Zou. Research on corporate Social Responsibility and efficiency under the new development Concept. *Friends of the Accounting*, 2019 (10): 44-52. (in Chinese)
- [11] Du Guoliang, Zhang Zixiao, Ren Junlin. Environmental hotspots and trends in China —— based on CiteSpace knowledge graph analysis. *Accounting communication*, 2020 (13): 20-24. (in Chinese)
- [12] Wang Liping, Li Shuqin, Li Chuang. Research on the influence of environmental information disclosure quality on enterprise value —— Analysis based on market perspective. *Resources and Environment of the Yangtze River Basin*, 2020 (5): 1110-1118. (in Chinese)