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Journal Article

N.B.: When citing this work, cite the original article.

Original Publication:

Huatao Peng and Yang Liu, A comprehensive analysis of cleaner production policies in China, Journal of Cleaner Production, 2016. 135, pp.1138-1149.

<http://dx.doi.org/10.1016/j.jclepro.2016.06.190>

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Postprint available at: Linköping University Electronic Press

<http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-131869>

A comprehensive analysis of cleaner production policies in China

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Abstract

Studies of cleaner production have often focused on two domains: the applications and the effects. An ever-increasing importance of cleaner production is pushing researchers to pay more attention to the formulation and principles of cleaner production policies. However, there is nearly none of the previous research ~~that~~ systematically and comprehensively analyses the development processes of cleaner production policies and exploring their characteristics deeply. The missing study is important in not only contributing to the perfection of cleaner production policies but also influencing the strategic planning of firms. This paper bridges this gap by first presenting a comprehensive study of the development process of cleaner production policies and then exploring their characteristics. We choose China, the biggest developing country and one of the most challenging countries to implement cleaner production, as the main research target and in addition a number of other developed and developing countries for comparisons. To investigate deeper into the characteristics of cleaner production in China, all the major policies and regulations issued by central ministries from 1997 to 2013 have been studied, ensuring the accuracy and reliability of the research. By employing T-LAB software with linguistic and statistical content analysis method, this paper derives following conclusions. (1) “audit”, “implementation” and “environmental” have the highest correlation coefficients with cleaner production; (2) cleaner production policies focus on four themes: “pilot”, “indicator”, “people” and “list”; (3) the formulation and implementation of cleaner production policies are endowed with typical characteristics of collaboration; (4) the characteristics of cleaner production policies are typically constraining types that evidently guide and regulate the behaviours of firms. This paper contributes as a general important reference of cleaner production policies for governments and firms especially in developing countries.

Keywords: Cleaner production; Policies; Content analysis; China

1 Introduction

The positive influence ~~that~~ brought by cleaner production (CP) on the enterprises, countries and the society has been wildly acknowledged by theoretical and practical circles. For example, [Khuriyati and Wagiman \(2015\)](#) suggested that CP can bring economic, technical and environmental benefits for small-scale cracker industry; [Silvestre and Silva Neto \(2014\)](#) put forward that although in developing and emerging countries CP cannot build sustainable mining regions, it is definitively a step in the right direction; ~~Rahim and Abdu~~[Rahim and Raman \(2015\)](#) proposed that CP is a feasible strategy for the production plant to reduce CO2 emission; [Zhang et al. \(2013\)](#) found that after CP was implemented in the sewage treatment system, the environmental performance and the resource efficiency are all improved to a certain degree. Regarded as one of the most efficient methods to reduce industrial contamination ([Kong and White, 2010](#)), CP not only contributes to environmental protection, but also contributes to firms' sustainable development. It can help firms to decrease production cost ([Zhang and Wen, 2008](#); [Hicks and Dietmar, 2007](#)) and increase production flexibility and dynamic capacity, thus enhancing firms' competitive advantages ([Zhang and Wen, 2008](#); [Liu, 2013](#); [Liu and Liang, 2015](#)). Moreover, by efficiently and economically utilizing natural resources, CP can minimize the risks and dangers to human safety and health ([Tseng et al., 2009](#)). It has already been demonstrated that CP contributes to the sustainability ([Bonilla et al., 2010](#); [Glavic and Lukman, 2007](#)), but the implementation of CP is confronted with serious obstacles of consciousness, supervision, finance, technology and organization ([Wang, 1999](#); [Dong et al., 2010](#); [Khalili et al., 2014](#)), which urgently need the support of government's guiding and supporting policies and this phenomenon has already attracted the wide attention of theoretical and practical circles.

Energy and environmental pollution problems are very serious in developing countries, and in order to solve these problems, various and effective policies should be implemented by the governments (Xie and Sidney, 2000). In recent years, a growing number of developing countries start to realize the importance of CP in minimizing the generation of waste and the consumption of energy, water, and raw materials in the process of industrialization (Dong et al., 2010), and therefore, various kind of CP policies have been formulated and implemented by them. However, in spite of all the efforts to promote CP, limited results have been achieved. For example, the majority of Chinese CP policies, characterized by non-compulsory, encouraging enterprise to carry out CP voluntarily. As a result, many Chinese firms cannot feel the urgency to promote CP. Meanwhile, CP cannot bring direct economic benefits in a short period, so firms do not have the motivation and passion to promote CP. In summary, the internal and external impetus for CP is not forceful (Chang et al., 2015). Moreover, the Chinese government neglected the advertisement of CP. Under such circumstance, the management in some enterprises cannot understand the essence of CP. They misunderstood that the key object is to protect the environment rather than improving the resource use efficiency and upgrading enterprises' equipment and key technology (Bai et al., 2015). Furthermore, the process of promoting CP is capital consuming, and some enterprises are confronted with the problems of capital shortage. Therefore, the Chinese government should allocate certain funds or subsidies for those firms that ~~promoting~~ promote CP, construct the information service platform of CP and enhance their cooperation with the foreign environment protection departments (Zhang et al., 2016).

Based on these reasons, it is highly important to explore deeper into the reasons and give the corresponding advices for governments in the developing countries to optimize their CP policies. China, the largest developing country in the world, also the most challenging country to implement CP, has endeavoured greatly in promoting CP. In 1990s, the Chinese government has started to introduce CP (Ortolano et al., 1999). Since then a large number of laws and regulations about CP have been formulated and implemented (Ortolano et al., 1999; Wang, 1999). In China, CP has been involved in national strategies (Ortolano et al., 1999). National CP centres have been built, a large number of CP experts have been cultivated, and the tradition of a roundtable conference about CP has been formed, etc. (Wang, 1999). In addition, after years of practices on CP, it has achieved remarkable improvements in social, economic and environmental aspects (Guo et al., 2006), making it one of the most important and successful developing countries in promoting CP around the world. As a result, its CP policies have attracted increasingly more attention from the academic world. Based on the analysis above, this study selects China as the primary research subject.

The CP policies in China have been studied by many researchers, but the vast majority of their research was confined to certain regions, certain industries or to a certain period of time. For example, Geng et al. (2010) studied CP policies in Liaoning, China and put forward that the implementation of CP may still suffer from the ineffective enforcement of relevant regulations; Zhang et al. (2013) conducted an empirical study in Changshu, China, and the research results ~~ef~~ which helped policy-makers to better understand the drivers of firms' willingness to promote CP; Ren (1998) studied the influence of CP project in pulp and paper industry in China, and emphasized the importance of internal and external mechanisms promoting CP. Bai et al. (2015) analysed Chinese CP policies from the perspective of mandatory audit system. Meanwhile, they analysed the regulating policies of CP, and put forward that the mandatory CP audit system can enhance enterprises' conciseness and ability of CP. Luken et al. (2016) illustrated the influence of certain CP policies on CP. For example, they explained the influence that the Laws for Promoting CP of People's Republic of China brought for CP, and they divided these policies into four parts, namely, mandatory policies, audit policies, motivation policies, and punishment policies. The development of China's CP policies system has experienced four stages, namely, the initial stage, the legislation stage, the institutional stage, and the perfecting stage (Chang et al., 2015). It is very important for policy makers and practitioners to continually looking back to evaluate and review the progresses they have achieved in CP, which is essential for the future development of CP (Brown and Stone, 2007). However, none of the researchers mentioned above carry a longitudinal and comprehensive study on CP policies in China, and it is very challenging to comprehensively and systematically analyse them. This paper focuses on all the major CP policies in China and therefore it is comparatively the most comprehensive and systematic analysis for CP policies in China to date. Although countries differ in CP implemental scope, political reality and environmental awareness (Thorpe, 2011), there are also many things in common. Therefore, the contribution of this paper provides an important reference and guidance for the government and firms in not only China but also other developing countries.

The rest of this paper is structured as follows. Section 2 briefly illustrates the theoretical backgrounds. Section 3 explains the research methodology. Section 4 presents the qualitative research findings of the content analysis, including the findings of word associations and the findings of thematic analysis of elementary contexts. Section 5 discusses the findings in details. Section 6 concludes the contributions, research limitation and sheds lights on priorities for future studies.

2 Theoretical backgrounds

CP, originated from waste minimization in the USA, was very popular in Europe in the nineties (Schramm, 1997). Generally, the policies related to CP can be divided into three categories: regulating policies, incentive policies and guiding policies. These policies serve different functions, i.e., regulating policies are adjusting enterprises' production behaviours with mandatory measures; incentive policies are engaging enterprises in CP actively; guiding policies are guiding the modes, methods, and directions of CP.

2.1 Regulating policies

As the Pollutant Release and Transfer Register (PRTR) systems provide the basic data and information about emissions of pollutants, policymakers can continuously track the generation and release of contaminants (Lerche et al., 2004). It is regarded as one of the most commonly used environmental policy tool to regulate facilities' pollutant emissions in the Organization for Economic Co-operation and Development (OECD) countries (Kolominskas and Sullivan, 2004). For example, in Australia, industrial and other facilities are required to report the emissions to the environmental authority if they have triggered the thresholds by Australian PRTR (Kolominskas and Sullivan, 2004). Likewise, in the United States, enterprises and other facilities are regulated by the law to

report on the annual pollutant emissions, and the date derived from the reports would be released in the database known as the Toxics Release Inventory (Jobe, 1999; Hendryx et al., 2014). With the help of the database, industries in the United States can have a more comprehensive and accurate understanding of the chemicals being released during the manufacturing processes, thus better evaluating and modifying the manufacturing processes and better implementing CP (Jobe, 1999). Moreover, enterprises' financial performances are positively correlated with their overall emissions (Konar and Cohen, 1997). The higher the overall emissions enterprises reports, the lower their stock price shall be, and in this context, enterprises would voluntarily reduce emissions (Jobe, 1999). There are also some other regulating policies for CP, for example, in Netherlands, the local governments can force enterprises to integrate CP into practice with their enforcement and licensing mandates (Gombault and Versteeg, 1999). The mandatory CP audit system in China aims at improving the utilization efficiency of energy and resources, minimizing the production of pollutants, and decreasing the usage of harmful substances (Bai et al., 2015). In fact, China is the first country in the world to issue the Cleaner Production Promotion Law to force enterprises and other organizations to carry out CP.

2.2 Incentive policies

Through changing the behaviour of producers, incentive policies like subsidies can accelerate the pace of environmental change (Lingard, 2002). The incentive policies of CP have been widely used around the world. For example, in the United States, the federal, state and local county authorities attached great importance to incentive policies of CP. They have incorporated incentives policies in all kinds of conservation programs, like the Nonpoint Source Management Program (NPSMP), the Environmental Quality Incentives Program (EQIP) etc. (Richardson et al., 2008; Nyaupane and Gillespie, 2011). Another typical example is Japan. In Japan, a series of agricultural CP technologies and agricultural environmental codes have been formulated, and in order to integrate the technologies and codes into practice, subsidies and other incentives are given to the practitioners (Jin, 2010). The Chinese government also has formulated various incentive policies for CP, especially economic incentive policies, such as deducting training costs and CP audit tax, awarding CP achievements, reducing or exempting valued added tax for the firms that produce products from the waste, setting special fund for small and medium-sized enterprises (SME) to better integrate CP into practice etc. (Hicks and Dietmar, 2007). In the academic world, the importance of incentive policies of CP has also been confirmed by research like Dong et al. (2010), Luo et al. (2014), etc. In China, most CP policies are based on the principles of motivating enterprises to carry out CP voluntarily. In 2002, the Cleaner Production Promotion Law was issued and it attached great importance to the motivation measures for CP. For example, it provides specific CP funds and reduces or exempts the value-added tax for SMEs (Hicks and Dietmar, 2007).

2.3 Guiding policies

Under the influence that government should change its role from being interventionist to playing an active guiding and supporting role (Frijns and Vliet, 1999), voluntary mechanisms become increasingly more important in implementing environmental policy in developing countries (Blackman, 2006). In other words, governments should encourage stakeholders to take effective measures themselves to promote CP by guiding and facilitating them. A growing number of governments start to realize the importance of guiding policies in promoting CP. For example, The Egyptian government has issued guidelines to help industries to compare the costs of CP with the costs of current production methods by utilizing the accounting principles (Hamed and Mahgary, 2004). The guiding policy of CP is also very important in China, which has been developed a lot in recent years (Wang, 1999). At present, the Chinese government has successfully formulated the policies of guiding firms to introduce advanced environmental protection technologies, advanced energy technologies, and advanced operation technologies (Kong and White, 2010). Under the guidance and influence of State Environmental Protection Administration (SEPA)¹ and United Nations Industrial Development Organization (UNIDO), the Chinese National Cleaner Production Centre (CNCPC) joined the National Cleaner Production Centres (NCPs) programme. Since then, it started to provide the multiple services related to CP for the Chinese enterprises, like information consultation, personnel training and technical support (Luken et al., 2016). In 2004, the National Development and Reform Commission (NDRC) and the Ministry of Environmental Protection (MEP) of China jointly issued the interim measures for CP audit. Moreover, they worked together to promote CP training, and to provide CP audit information and technical support (Bai et al., 2015).

3 Research methodology

In order to investigate deeper into the process that the Chinese government promotes CP and identify the guiding principles of CP policies, this paper analyses all the related policies, regulations and files. Like most of the other important policies and regulations, all the CP policies have been issued by the principal Chinese government organizations, for example, the Standing Committee of the National People's Congress (NPCSC), NDRC, MEP, Ministry of Science and Technology, Ministry of Finance, Ministry of Construction, etc. Chinese government issued its first major file about CP on April 14, 1997. Since then, many other policies, regulations and files have been issued. All of them are collected from the official website of the issuing organizations as shown in Table 1.

Table 1 Policies, regulations and governing documents of CP in China.					
File name	Issuing organization	Reference number	Issuing date	Background	Policy classification
Notice of Opinions for Promoting CP issued by SEPA	SEPA	No.232	Apr. 14, 1997	In order to realize the overall objectives of promoting CP	Comprehensive policies

				in the 9th Five Year period	
Laws for Promoting CP of People's Republic of China	NPCSC	Decree of the President of the People's Republic of China, No.72	Jun.29, 2002	In order to promote CP, increase resource use efficiency, decrease pollution, protect environment and human health, and realize the sustainable development of economy and society.	Guiding policies
Opinions for Implementing Laws for Promoting CP	SEPA	No.60	Apr.4, 2003	In order to implement Laws for Promoting CP, execute the responsibilities of SEPA and promote firms to carry out CP.	Comprehensive policies
Opinions for Accelerating CP	NDRC, MEP, Ministry of Science and Technology, Ministry of Finance, Ministry of Construction, Ministry of Agriculture, Ministry of Education, Ministry of Land and Resources, State Administration of Taxation, State Quality Inspection Administration	Issued by General Office of the State Council, No.100	Dec. 17, 2003	In order to implement the Laws for Promoting CP of People's Republic of China, accelerate the development of CP, increase resource use efficiency, decrease pollution, protect environment and human health, and realize the sustainable development of economy and society.	Guiding policies
Interim Procedures for Auditing CP	NDRC and SEPA	Issued by SEPA, No.16	Aug.16, 2004	In order to fully implement CP and regulate	Guiding policies

				audit behaviours of CP	
Methods for Utilizing the Exclusive Funds for CP Subsidized by Central Government	Ministry of Finance	No.343	Oct.13, 2004	In order to regulate the utilization and management of the exclusive funds for CP subsidized by Central Government	Incentive policies
Notice of Regulating the Audit Process of CP for Key Firms	SEPA	No.151	Dec. 13, 2005	In order to carry out the CP audit of the key firms normatively and orderly in the whole country.	Regulating policies
Notice of Further Enhancing the CP audit of Key Firms	SEPA	No.60	Jul. 1, 2008	In order to further realize the importance of CP in reducing pollution, and enhance the CP audit of the key firms.	Comprehensive policies
Notice for Further Advancing CP of Key Firms	SEPA	No.54	Apr. 22, 2010	In order to, deeply and firmly, advance CP in key firms	Comprehensive policies
Decision for Modifying the Laws for Promoting CP of People's Republic of China	NPCSC	Decree of the President of the People's Republic of China, No.54	Feb. 29, 2012	In order to further advance CP in China, enhance the construction of audit institution of CP, regulate the audit team of CP, and perfect the management system of CP.	Guiding policies
General Principles for Compiling the Evaluation	NDRC, MEP, Ministry of Industry and Information	Release of NDRC, No.33	Jun. 5, 2013	In order to accelerate the formulation of a systematic and unified	Guiding policies

Indicators of CP (Trial Principles)				supporting system for CP technologies.	

As a widely-used research method in social science to study the content of documentation (Liu et al., 2015; Julien and Fourie, 2015), content analysis can transform the qualitative symbolic contents into the systematic quantitative data (Joubish and Khurram, 2011), and find meaningful patterns from various kinds of information, helping people to find essence from phenomenon (Graneheim and Lundman, 2004; Hsieh and Shannon, 2005). When the objective of the research results is to comment and describe, it has been considered to be one of the most appropriate research methods (Butnaru, 2015). As Zhang et al. (2012) claimed, content analysis specializes in extracting new ideas from the historical information, and it is more applicable to analyse policy contexts comparing with qualitative approach, as it is equipped with foreseeing and guiding ability. Content analysis utilizes the standardized measurements to code, compare, and characterize the content of the text (Lin and Mao, 2015), therefore, it can symmetrically and objectively, refine and derive the logical relations and deep-rooted principles from the text contents of all kinds of documents, including policies.

Context analysis of government policies helps the policies formulator and implementer to clarify the essence of these policies, thus assuring the right direction of these policies (Haapanen and Tapio, 2016; Antoine et al., 2016). At present, content analysis has already been widely utilized to analyse the content of various kinds of policies (Ju-Pak, 1999; Singh et al., 2003; Liao, 2016), which cover the policies in various industries, including energy (D'Agostino et al., 2011), chemical engineering (Klueh et al., 2009), medical treatment (Lemiengre et al., 2008), environmental protection (Tosun, 2011; Zhang et al., 2012), transportation (Vonk Noordegraaf et al., 2014). The prior research also cover many countries and cities in the world. For example, Lemiengre et al. (2008) utilized it to analyse the euthanasia policies in Flanders; Baynham and Stevens (2014) applied it to compare official community plans in British Columbia etc. Therefore, it also can be used to refine and derive the statistical principles about CP in related regulations and policies.

According to content analysis literature (e.g. Williams and Plouffe, 2007; Vallet-Bellmont et al., 2011; Wickens et al., 2013), content analysis is normally undertaken with the following procedures.

- Step 1: Select samples.
- Step 2: Specify the analysis unit.
- Step 3: Determine the category scheme.
- Step 4: Judge and record.
- Step 5: Assess reliability.

In our research, all these steps are involved. The pre-processing stage includes text segmentation, automatic lemmatization and key-term selection and processing stage includes co-occurrence analysis and thematic analysis.

In this paper, we employ T-LAB 9.1 software to analyse the CP policies. It is a set of international linguistic and statistical tools for content analysis and text mining. It can be utilized to analyse various kinds of texts, speeches, newspapers, recording contexts, interview transcriptions, company documents, academic works, policies etc. Currently, it is used by a large number of professionals and researchers in various fields, including anthropologists, psychologists, marketing consultants, historians, psychiatrists, public administration managers etc. For instance, Papaleo et al. (2013) used it to analyse the content of the interviews; Sengers et al. (2010) employed it to examine the content of the media texts about biofuels etc. Through the text-driven automatic approach, like co-occurrence analysis, thematic analysis and comparative analysis, T-LAB can, automatically and quantitatively, extracts the meaningful patterns of words from the context. For example, it automatically identifies a cluster after the word with the highest Chi-square test value within it (Sengers et al., 2010). In addition, it ensures the objectivity and systematicness of analysis, since it derives the logical relations from the text contents without being influenced by personal opinions. Meanwhile, tables and charts resulted from the software can be easily browsed and interpreted, increasing the accuracy and reliability of the results.

4 Research findings

We employ two functions of T-LAB software for content analysis, which are word associations and thematic analysis of elementary contexts, to derive the insights of CP policies.

4.1 Word associations

The steps to achieve the results of word associations are as follows. Firstly, import the texts into T-LAB 9.1, and then apply “Word Association”. Secondly, apply “Analysis Context” and choose the option of “Corpus”. Thirdly, apply “Advanced Options” and choose the option of “Co-occurrence Threshold”, and set the “Frequency” to more than 10. Fourthly, apply “Go”, and the results of the word associations presented automatically. The software automatically extracts 280 co-occurrence words and achieves 166 available items. Furthermore, we choose CP as lemma to obtain the word associations. Fig. 1 shows the word associations of CP with 20 highest correlation coefficients. The complete correlation coefficients between CP and other words sorted from high to low are presented in Appendix 1.

Fig. 1 Word associations of CP with 20 highest correlation coefficients (the cosine values).

According to Fig. 1 and Appendix 1, we can see the three items that have the highest correlation coefficients with CP are “audit”, “implementation” and “environmental”. In the following parts, we explore further the reasons why they are closely related.

4.1.1 Audit

It is a tradition for the Chinese government to stress the importance of CP audit. In April 1997, the Chinese government issued a file ~~that~~ demanding almost all levels of administration departments of environment protection to carry out CP audit. CP audit quantifies the total waste generation and resources consumption in the production process (Rahim and Raman, 2015), so the reports of CP audit can provide recommendations and guidelines for CP (Hong and Li, 2013), thus accelerating the implementation of CP. However, it is believed that CP increases firms' costs. Therefore, firms are not active in promoting CP. Under this circumstance, it is very essential for government to carry out CP audit. In practice, it has already been proved to be an efficient and unique method to advance CP. For example, in the metal finishing industry of South African, CP audit has been widely conducted (Telukdarie et al., 2006). When CP first caught the Chinese government's attention, the principal work it has done was just to issue the license for pollution according to the evaluation reports of CP. After that, a series of policies related to CP audit have been issued. In September 2001, SEPA issued the Notice for Carrying out Pilot Work of Audit Institutions of CP. It initiated the comprehensive pilot work of CP audit institutions in China. Since then, the pilot working programs and the working scope of the audit institutions have been implemented in succession. In the working programs, the government details on the purposes and progress of the pilot work, certifications and work content of pilot institutions etc. In August 2004, China's NDRC and SEPA formulated the Interim Procedures for Auditing CP (Number 16); in December 2005, SEPA issued the Notice of Regulating the Audit Process of CP for Key Firms (Number 151), and in July 2008, it issued the Notice of Further Enhancing the CP audit of Key Firms (Number 60). All of these three files focus on the scope, the implementation, the organization, the management, the rewarding and punishment of CP audit. Great importance was attached to the audit progress of CP for key firms, especially in the Notice of Further Enhancing the CP audit of Key Firms (Number 60). In this notice, the responsibilities that the SEPA carries and the role it plays in CP audit has been specified. It not only integrates the CP audit with existing environment management system, but also proposes the standardized management measures for audit institutions of CP.

4.1.2 Implementation

The earliest file promoting the implementation of CP was called Notice of Opinions for Promoting CP issued by SEPA, in which policies and regulations about implementing CP were issued in large numbers, including Laws for Promoting CP of People's Republic of China (Number 72), Opinions for Implementing Laws for Promoting CP (2003, Number 60), Opinions for Accelerating CP (2003, Number 100), etc. From the perspective of departments implementing CP, China's NDRC, MEP, Ministry of Science and Technology, Ministry of Finance, Ministry of Construction, Ministry of Agriculture, Ministry of Education, Ministry of Land and Resources, State Administration of Taxation, State Quality Inspection Administration are all involved. For example, with cooperation of these organizations, Comprehensive Coordination Department of CP regularly releases the catalogue of CP technologies, crafts, equipment, and products. As a result, it is believed that the process of promoting CP is the process of communication and coordination as multiple departments working together. In addition, various kinds of policies are involved in implementing CP, including the fiscal and taxation policies (like setting exclusive funds for CP and guiding social capital to support key CP projects), education policies (like incorporating the curriculums of CP technologies and management into higher education, vocational education and technical training), rewarding and punishing policies (like establishing the system of commendation and reward of CP), government procurement policies (like giving priority to the products of CP) etc.

4.1.3 Environmental

As the world's second largest economy, China has made great progresses in economy, but these progresses also brought serious environmental problems (Zhang et al., 2013). In order to achieve high economic growth rate as well as good environment, the Chinese government has made CP an important part of its development plan as CP is closely related with environmental protection (Hicks and Dietmar, 2007). In recent years, CP has become one of the most important methods that the Chinese government

utilized to solve the environmental problems (Shi and Qian, 2002). The SEPA firstly issued CP strategy in 1993. Since then, the environment protection departments started to pass the related laws and regulations to promote the implementation of CP, like “Cleaner Production Promotion Law of People’s Republic of China” in 2002. Meanwhile, the environment protection departments attached great importance to the supervision of the implementation of CP (Dong et al., 2010). Moreover, the Chinese government included CP in the environmental protection act, which further demonstrated that Chinese government put a high value on CP.

This study details on the reasons why CP has the highest correlation coefficients with “audit”, “implementation” and “environmental”. More profoundly, these three words reflect the key points that Chinese CP policies are involved. The word “Environmental” reflect the starting and standing point of CP. CP policies involve in many aspects, like helping enterprises to improve resources utilization efficiency, but the ultimate goal is to protect the environment. As to the words “audit”, and “implementation”, they reveal the focuses of Chinese CP policies. Mandatory CP audit is regarded as one of the most practical regulations to prevent pollutions (Bai et al., 2015; Liu et al., 2015). CP audit helps enterprises to be aware of the CP potential, and increases their possibility of becoming greener (Luken et al., 2016). Meanwhile, CP audit helps government to quantify the total waste generation and resources consumption during the production processes by achieving the quantitative and qualitative information (Rahim, Aziz and Raman, 2015; Rahim and Raman, 2015). In China, the system of the mandatory CP audit has been formed and the system includes five steps (Bai et al., 2015). Firstly, the local governments publish the list of the enterprises that been required to conduct the CP audit. Secondly, the enterprises reveal the information about the emission and the energy consumption. Thirdly, the enterprises conduct the CP audit. Fourthly, the enterprises reveal the CP audit results. Lastly, the local governments assess and accept the results of the CP audit. In summary, the mandatory CP audit has become the key point for promoting CP. The effective measures cannot be separated with implementation. Both the national government and the local government attach great importance to policy implementation. As Yusup et al. (2015) stated, the proactive implementation of CP brought many benefits, like minimizing material waste, improving the efficiency of energy usage, bringing environmentally friendly practices etc. Without the effective implementation, the CP policies mean nothing but words. From the above analysis, it is easy to understand that the Chinese government treats environment protection and policy implementation as the keys of its CP policies. As the Chinese government specifically highlights the importance of the mandatory CP audit, it is reasonable to assume that CP policies in China give specific priority to constraint and regulating policies.

4.2 Thematic analysis of elementary contexts

The steps to achieve the results of thematic analysis of elementary contexts are as follows. Firstly, import the texts into T-LAB 9.1, and then apply “Thematic Analysis” and choose “Thematic Analysis of Elementary Contexts” and apply “Advanced Options”. Secondly, apply “Thematic Clusters to be Obtained” and choose “10” (the highest value of thematic clusters), meanwhile, apply “Co-occurrence within the Context Units” and choose “5” (the lowest value of occurrences within the context unites). Lastly, apply “Go”, and the results of the thematic analysis of elementary contexts presented automatically, shown in Fig. 2. Appendices 2–5 present the key items of every main subject.

Fig. 2 Results of thematic analysis of the CP policies.

As seen from Fig. 2, 4 clusters have been achieved from the thematic analysis of the contents of CP policies. These four clusters explain the whole text contents by the proportion of 18.90%, 39.00%, 17.70% and 24.40% respectively. These proportions show the importance of the main lemma of all of these CP policies texts, i.e. they report the four topics that can be classified from those thematic words. The T-LAB 9.1 software treats the key item with the highest chi square in every cluster as the theme. Therefore, the four themes of CP policies in China are “Pilot”, “Indicator”, “People” and “List”, presented in Appendices 2–5. The explanations for all the four themes are given in the following.

4.2.1 Pilot

The Chinese government has realized the importance of CP since the early 21st century. However, as the perception of CP was not totally implanted in firms and their implementation standards, and the supervision mechanisms and the incentive measures were not fully formed, the development of CP mainly started from the pilot work. The Chinese government started to promote CP in 1993, following by the step of staff training, team building, pilot demonstration, and summarization and popularization. At

this stage, the promotion of CP to a large extent laid on the basis of mandatory and restrictive audit work, impeding its further development. In order to enhance the construction of CP audit institutions, regulate the behaviours of members of the CP audit team and perfect the management mechanism of CP, the Chinese government started to carry out pilot work of CP audit institutions all over the country. It expected that the pilot work would encourage local environmental departments' CP initiative and improve ecological and environmental quality, therefore accelerating the implementation of sustainable development strategy. In the results of the cluster analysis, the words “training”, “establishing”, “activity”, “work”, “system” basically reflect the work program on the pilot work of CP. To be specific, entrusted by the SEPA, the CNCPC organizes the “training” activities for the audit staff of the pilot institutions, thus “establishing” the CP audit team. Then, the government publishes the acceptance requirements of CP pilot institutions, which carry out the CP “activities” correspondingly. Finally, the SEPA publishes the list of qualified pilot institutions, holds the review meeting, and constructs and perfects the assessment index “system” of CP. The words “publicity”, “engage”, “awareness”, “support”, “incentive” reflect the main aims of the CP pilot work, for example, increasing CP “awareness” and “incentive”, “winning public support” for CP, and getting firms to be “engaged” in CP.

4.2.42 List (This should be section 4.2.4.)

The Chinese government has stressed the importance of CP audit since 1992. The first file about CP explicitly pointed out that all levels of administration departments of environment protection should actively and steadily carry out the audit work. As the list of firms that carrying out CP laid the basis for the audit work, the government highly valued the importance of its formulation, auditing and utilization. In the Notice of Further Enhancing the CP audit of Key Firms, the importance of the list has been clearly elaborated. The list of the key firms facilitates firms to carry out CP audit on time and to achieve the target of pollution reduction. It even facilitates local government to incorporate firms' CP audit work in its annual appraisal system. As a result, formulating and issuing the list of firms to be undertaken CP audit becomes one of the important parts of CP policies. In the results of the cluster analysis, the words “administration”, “region”, “municipality”, “province”, “environmental”, “Xinjiang” basically reflect the main government departments that formulate and audit the list of the key firms. In particular, local competent administrative departments formulate and submit the primary list, and then the “provinces”, autonomous “regions” and “municipalities”, the competent administrative departments of “Xinjiang” production and construction corps for “environmental” protection etc., audit the list and confirm the final edition. The words “publish”, “audit”, “report”, “submit”, “notice” reveal the working procedure for firms after the list beenbeing issued. Within the first month the list being issued, firms should “publish” the information about the discharge of major pollutants; within the second month, firms start the “audit” work; within the first year, firms should “submit” the “report” of audit results to the competent administrative departments. (This paragraph under List should be moved to 4.2.4.)

4.2.3 People

The word “people” indicates the leading position of people's government in promoting CP in China. Like all the other policies, the formulation, promotion and implementation of CP policies are also intimately connected with all levels of people's government. Generally speaking, firms are not active in CP since it increases their costs. Under this circumstance, it is very essential for people's government and related institutions to take the guidance, adjusting, even compulsory measures to promote CP. In the results of the cluster analysis, the words “government”, “county”, “state”, “council”, “department”, “administrative” and “republic” basically reflect the main subjects that formulating and implementing CP policies. To be specific, in the Laws for Promoting CP of People's Republic of China, their responsibilities have been detailed. The “state”, “council” and the local people's “governments” at or above the “county” level should incorporate the promotion of CP into the national economy and social development plans, industry development plans, regional development plans, etc. “State”, “council” and the people's “governments” of provinces, autonomous regions and municipalities should build the technical service support system of CP and compile the CP guidelines for key industries or regions. The words “promotion”, “formulate”, “responsibility”, “responsible” and “fine” reveal the main behaviours of the government, like formulating CP audit policies, promoting the collaboration between different departments in CP etc.

4.2.24 Indicator (This should be section 4.2.2.)

The indicator not only forms the basic principles for firms' behaviours, but also builds the key standards and basis for the CP audit work. Therefore, the importance of the indicator has never been neglected by the government. In April 1997, when the first file about CP, called the Notice of Opinion for Promoting CP issued by SEPA was issued, the importance of indicator has already been stressed. Shortly afterwards, the government issued the Laws for Promoting CP of People's Republic of China, in which the functions of indicator were clearly elaborated. Concretely speaking, the environment protection departments of the government of province, autonomous regions and municipalities should strictly follow the indicators to carry out the CP audit work, meanwhile, publish the list of firms that do not meet the integrated energy consumption indicators. Firms should adopt the pollution prevention technique that reaches national and local control indicators for waste emission. In 2003, when the Opinion for Accelerating CP was issued, the importance of the indicator was further highlighted. The file specifically points out that the NDRC and SEPA should collaborate with related departments to formulate the evaluateevaluation indicator system for the key industries of CP. In the Notice of Further Enhancing the CP audit of Key Firms, indicators became the standards whether the firms should be implemented with the compulsory CP audit. If the amount of waste emission exceeded the control indicators of total emission that local government stated, the answer would be yes, otherwise no. In the results of the cluster analysis, the words “waste”, “pollution”, “energy”, “utilization”, “resource”, “equipment”, and “material” reflect the key method to complete the control indicators of waste emission in CP. CP aims at reducing “waste” and “pollution”, saving “energy”, “resource”, and “material”, and increasing the “utilization ratio” of “equipment”. Only by achieving these aims can firms be fully engaged with CP. (This paragraph under Indicator should be moved to 4.2.2.)

This study explains the reasons why the results of thematic analysis of CP policies can be classified into four factors, namely, “Pilot”, “Indicator”, “People” and “List”. These four words reflect the concrete methods that the Chinese government utilizes to promote CP. More profoundly, “Pilot”, “List” and “Indicator” show that the Chinese government not only pays attention to the constraint and regulating policies, but also to the guiding and demonstrating policies in the process of promoting CP. To be specific, the pilot“Pilot” work of CP promotes CP initiative from the government to the enterprises, guiding them to carry out CP voluntarily. “Indicator” forms the basic principles for firms' behaviours. As to the “List”, the government publishes the list of key firms to be undertaken CP audit, and this list constrainconstrains and regulates pilot firms' behaviours as well as guides their behaviours. The word “peoplePeople” reflect that CP policies in China are endowed with the typical characteristic of collaboration. To be specificallyspecific, all levels of people's government in China intimately work together to formulate, to promote and to implement the CP policies.

5 Discussions

China ~~has~~is becoming increasingly more important in the world economy, and it is possible that China ~~becomes~~will become the world's greatest economic power (Edward et al., 2014). During the economy transformation process, one of the biggest challenges that China faced is how to realize the sustainable development of economy and environment (Hicks and Dietmar, 2007). As the biggest developing country, China has made great ~~economy~~economic progress~~es~~ in recent years, but ~~the economy progresses are~~also accompanied by serious environment problems (Zhang et al., 2013).

At present, the Chinese CP policies give specific priority to constraint and regulating policies, echoing the opinion of Mol and Liu (2005) and Geng et al. (2007). The constraint and regulating policies are outstandingly embodied in the CP audit work. To be specific, the constraint policies include Working Programs for the Pilot Work of CP Audit Institutions, Regulations of CP Audit Process for Key Firms, Interim Procedures for Auditing CP, Notice of Further Enhancing the CP audit of Key Firms etc. Basically, the development of CP in China is still on the groping stage. The firms' consciousness and ability of CP urge for further development, and the regulations for CP required to be further perfected. As a result, CP audit work has been involved in almost all the policies related to CP ever since 2001. For firms who use and release toxic substances or those whose total pollution discharge exceeds the official limits, strengthening the supervision, auditing, and constraint work of CP contributes to finding the source of pollution, and implementing the specific tracking mechanism for specific substances. In foreign countries, the authorities have also attached great importance to the constraints and regulating policies, however, different with China, their constraints and regulating policies are particularly embodied in the PRTR. PRTR systems provide the decision maker with the basic data and information about emissions of pollutants (Lerche et al., 2004), thus better evaluate and modify the manufacturing processes and better implement CP (Jobe, 1999). Japan initially conducted the pilot project of the PRTR in 1997, and in 1999, it adopted a law to promote the establishment of a national PRTR (Lerche et al., 2004), through which the authorities in Japan can directly and indirectly constrain and regulate enterprises' production behaviours. In the OECD countries, PRTR were also widely used by the authorities, including Canada, United States (known as the Toxic Release Inventory), United Kingdom (known as the Chemical Release Inventory), Netherlands, Australia etc. (Lerche et al., 2004). Taking Australia as an example, industrial and other facilities are required to report the emissions to the environmental authorities if they have triggered the thresholds by Australian PRTR (Kolominskas and Sullivan, 2004). The establishment of a CP constraint and regulating mechanism contributes to coordinate supervision and management among competent administrative departments of environmental protection, intermediaries providing audit work for CP and audit personnel of CP inside firms themselves. In order to ensure the constraint policies of CP to work properly and efficiently, much work need to be done, like strengthening the construction of CP audit institutions, perfecting the management mechanism of CP, and most importantly enforcing firms' self-discipline consciousness of CP. The selection and implementation process of CP ~~are~~is the process of a dynamic game among firms, their competitors, and the governments. Only when the constraint policies which government issued become the real "threat" can firms fully adopt self-disciplined behaviours in CP. At this point, firms will actively and comprehensively promote CP, and use CP as a competitive advantage to compete with other firms.

The formulation and implementation of CP policies in China were endowed with the typical characteristic of collaboration, echoing the opinion of Wang (1999) and Geng et al. (2010). The characteristic is manifested in the collaboration between different ministries in the national level, and the collaboration between national ministries and local government. More specifically, the NDRC cooperates with the SEPA to carry out the CP audit work, and the national ministries cooperate with local competent administrative departments to implement CP policies. For example, the SEPA cooperated with CP audit organizations to compile audit guidelines and technological requirements of CP. Besides, public awareness about environmental protection forms the invisible supervision for CP, contributing to the popularization of CP. From the above analysis, the CP policies in China advocate the collaboration among multiple organizations. It is necessary for government to guide and promote CP before it becomes the primary production model and this opinion has been widely recognized by scholars, like Wang (1999), Geng et al. (2007) etc. At the groping stage of CP, it is undoubtedly ~~that~~ ~~getting~~necessary to get more governmental organizations ~~to be~~engaged in the formulation of CP policies. Similarly, more intermediaries in CP audit work, and more firms in pilot work will promote its development. From the above analysis, the Chinese government highly treats the cooperation between different ministries, both local and state level, however, the importance of the cooperation among governmental sectors, industrial sectors and enterprises to integrate CP into policies and practice also should be underscored (Almeida et al., 2015). In many foreign countries, the authorities have attached great importance to the cooperation among governments, enterprises, universities etc. In order to better promote CP policies by means of providing expertise, technologies and funds, many environmental protection ministries or institutions cooperate with enterprises, universities, etc., such as Canadian International Development Agency, United States Environmental Protection Agency, United Nations Industrial Development Organization etc. (Shi et al., 2008). The cooperation between authorities and enterprises are exclusively important, which not only helps enterprises to build up a broad understanding of CP, but also helps authorities to gain the trust of enterprises, thus reinforcing their management commitment of CP (Zwetsloot and Geyer, 1996). In Slovenia, the authorities believe that the sustainable development of CP needs the long-term cooperation among governments, universities and industries (Petek and Glavic, 2000), and endeavour greatly to promote the cooperation among them. In Japan, the importance of cooperation among the stakeholders has also been stressed, which means that it is essential for the governments to cooperate with non-governmental organizations in order to promote CP.

The CP policies in China have specific guidance and the demonstration significance to firms' behaviours, similar to the viewpoint of Peltier and Ashford (1998), Wang (1999), and Ortolano et al. (1999). To be specific, government publishes the lists of key firms to be undertaken CP audit as well as the CP audit institutions. The lists published not only constraints and regulates pilot firms' behaviours, but also gives guidance to them. Meanwhile, the lists facilitates government, third-party institutions, and the public to supervise the firms and institutions concerned, thus promoting transparency and accountability of CP and reducing CP information asymmetry among government, firms and customers. They also can advances the development of relatively fair competition and suppress the cutthroat competition under the condition of high-energy consumption, high pollution, and low cost. With the potential "threat" come from the influence of the lists, firms' self-discipline behaviours shall be enhanced unconsciously, which in turn expands the scope for CP and increases the efficiency of CP audit institutions. With all the achievements being accomplished, the CP policies will go further in China. Comprehensive and universal standards and principles about production technologies and equipment, CP management, product characteristics, etc. will all be formed and clearly elaborated. As a result, it will be easier to

evaluate the results of the pilot work of CP, making the pilot work more convincing and more reliable. With the concept that government should change its role from being interventionist to playing an active guiding and supporting role (Frijns and Vliet, 1999), authorities in foreign countries also attach great importance to their guidance and demonstration roles in promoting CP. For example, the governments in Germany, United Kingdom, Netherlands and Portugal, have conducted the program called ENVIROCARE, which is designed to present the trainers about the environmental problems that industry can bring and how they can solve these problems when they enter the workforce in order to implement the approaches and concepts of CP and guide them to voluntarily integrate CP into practice (Coakley, 2003). In Zambia, the environmental policy is characterized by its emphasis on guiding policies and it has a long history of using the policy to guide the utilization and conservation of resources (Siaminwe et al., 2005), making the guiding policy an important component of CP policies. The Egyptian government is another good example, which has issued guidelines to compare the costs of CP with the costs of current production method (Hamed and Mahgary, 2004). In summary, guiding policies of CP is an important part of CP policies and more and more government worldwide start to realize their guiding and supporting role in promoting CP. As a result, they are trying to guide enterprises to carry out CP voluntarily rather than using the mandatory methods to force them to promote CP.

6 Conclusions

This article focuses on exploring **what are** the general rules of the CP policies in China and how they guide firms' CP behaviours. By means of content analysis, this article **makes draws** the conclusions that CP has the highest correlation coefficients with “audit”, “implementation” and “environmental”, and the results of thematic analysis of CP policies can be classified into four factors, namely, “Pilot”, “Indicator”, “People” and “List”. In addition, we also find that the formulation and implementation of CP policies in China are endowed with typical characteristics of collaboration, and the characteristics of CP policies in China are typically constraining types that evidently guide and regulate the behaviours of firms.

6.1 Research implications

Through the comprehensive and in-depth literature analysis, we find that most of the research of CP policies in China focus on particular industries. For example, Dong et al. (2010) analysed the implementation of Chinese CP policies in the electroplating industry. Li et al. (2010) focused on the influences of CP policies in the saponin industry in China. There are also many research related to CP policies in China focusing on particular locations. For instance, Zhou and Zhao (2016) specifically explored the impact of CP policies for coal industry in the Inner Mongolian. Geng et al. (2010) analysed the regional initiatives on promoting CP policies through the case study of Liaoning province in China. Huang et al. (2013) carried out the research on the application of CP policies in the ceramic tile plant through a case study of Guangzhou, Guangdong Province. Moreover, most of the research are qualitative, and few has utilized quantitative approaches to systematically review and analyse CP policies.

In this research we apply content analysis to systematically and quantitatively interpret the content of CP policies in order to discover the findings more directly and vividly. The comprehensive analysis with quantitative data of all the CP policies published in China contributes to discover the essence of CP policies from the contents point of view.

Compared with the existing studies, this research contributes to comprehensive and quantitative understanding and evaluation of the CP policies in China. It is essential to find the key rules of CP policies and explain the firms' CP behaviours in China, and then guide them to take effective measures.

China's experiences and lessons learned regarding environment protection provide an important guidance and reference for other developing countries (Zhang et al., 2013). Therefore, this research also sheds light and contributes as an important general reference of CP policies for governments and firms in the emerging countries.

6.2 Limitations and future research

This study has profound implications on researching CP policies. However, it still leaves some gaps for further research. It explores the CP policies from the static perspective, without describing the dynamic trajectory of their evolutionary process. In addition, it focuses upon analysing and summarizing the rules of the policies from the perspective of policy-makers without considering the implementation effects. In terms of future studies for CP policies, we suggest that the rules should be examined through comparing and contrasting from the perspectives of the government, industries and experts.

Acknowledgements

This research is supported by National Natural Science Foundation of China (70902051), Soft Science Research Program of Hubei Province (2012GDA00303) and International Scientific and Technological Cooperation Projects of Wuhan City (2014030709020311).

Appendix 1. Correlation coefficients of CP.

LEMMA	COEFF ^a	C.E.(A) ^b	C.E.(AB) ^c	CHI2 ^d
Audit	0.666	148	145	62.184
Implementation	0.594	117	115	45.452

Environmental	0.589	174	139	3.105
Department	0.581	169	135	2.952
Protection	0.544	157	122	0.673
Enterprise	0.53	147	115	0.926
Level	0.467	106	86	2.446
Management	0.423	63	60	15.617
Development	0.418	71	63	8.101
Work	0.403	56	54	15.308
Key	0.396	67	58	5.292
Implement	0.396	54	52	14.496
National	0.385	76	60	0.604
Technology	0.374	86	62	0.665
State	0.372	76	58	0.036
System	0.367	49	46	10.139
Promote	0.367	47	45	11.736
Industry	0.362	62	51	1.807
Promotion	0.349	39	39	13.959
Carryout	0.349	39	39	13.959
Local	0.348	67	51	0.018
Relevant	0.339	48	42	4.23
Government	0.333	57	45	0.43
strengthen	0.326	36	35	10.054
Training	0.321	33	33	11.63
Region	0.32	44	38	3.146
Emission	0.319	65	46	0.917
Focus	0.317	38	35	6.239
Plan	0.317	36	34	7.65
Evaluation	0.308	38	34	4.421
People	0.3	50	38	0.009
Develop	0.298	43	35	0.907
Organization	0.296	32	30	6.247
Support	0.296	30	29	7.834
Project	0.295	39	33	1.94

Agency	0.287	32	29	4.293
Pollution	0.282	51	36	0.747
Administrative	0.279	61	39	5.123
Production	0.278	75	43	16.194
Province	0.276	30	27	3.681
Acceptance	0.274	26	25	6.4
Report	0.271	31	27	2.442
Supervision	0.271	31	27	2.442
Technical	0.271	31	27	2.442
Economic	0.271	41	31	0.001
Process	0.269	50	34	1.709
Organize	0.268	25	24	6.048
Pollutant	0.267	60	37	7.195
Requirement	0.263	26	24	4.241
Service	0.263	33	27	0.779

^a COEFF = value of the selected index.

^b C.E.(A) = total amount of elementary contexts (EC) that contains the selected lemma (A).

^c C.E.(AB) = total amount of elementary contexts (EC) where lemmas “A” and “B” are associated (co-occurrences).

^d CHI2 = chi square value concerning the co-occurrence significance.

Appendix 2. Cluster 1 obtained from the thematic analysis of elementary contexts.

LEMMA	CHI2	EC IN CLUSTER	EC IN TOTAL
Pilot	53.566	21	28
Establishing	45.582	15	18
Training	44.867	24	38
CP	41.417	190	641
SME	40.337	10	10
Activity	36.299	9	9
Work	35.555	31	62
System	32.918	33	70
Leadership	30.896	9	10
Cost	30.317	11	14
Fund	29.75	15	23
Engage	28.226	7	7

Publicity	28.226	7	7
Awareness	26.929	8	9
Certification	26.589	10	13
Audit	23.685	81	254
Support	21.95	18	35
Information	21.48	11	17
River	20.157	5	5
Incentive	19.901	9	13

Appendix 3. Cluster 2 obtained from the thematic analysis of elementary contexts.

LEMMA	CHI2	EC IN CLUSTER	EC IN TOTAL
Indicator	118.943	70	72
Waste	79.136	48	50
Product	61.201	66	87
Energy	57.525	46	54
Process	55.885	48	58
Utilization	50.104	37	42
Resource	48.945	58	79
Equipment	46.46	38	45
Material	42.64	49	66
Production	36.208	60	91
Project	36.049	41	55
Water	32.893	27	32
Value	32.282	18	18
Method	26.892	15	15
Evaluation	26.477	39	57
Chemical	25.564	18	20
Reference	23.371	15	16
Design	23.301	13	13
Impact	22.764	18	21
Pollution	22.393	37	56

Appendix 4. Cluster 3 obtained from the thematic analysis of elementary contexts.

LEMMA	CHI2	EC IN CLUSTER	EC IN TOTAL
People	98.278	38	54
Promotion	90.517	36	52
Government	73.496	37	61
County	68.883	24	32
Council	65.223	32	52
State	51.725	46	100
Economy	42.378	13	16
Science	38.201	11	13
Department	37.105	80	240
Cooperation	35.667	8	8
Agriculture	35.667	8	8
Formulate	35.667	8	8
Responsibility	34.377	12	16
Fine	31.205	7	7
Yuan	31.205	7	7
Social	29.646	9	11
Responsible	29.071	15	25
Administrative	27.99	32	77
Violation	26.401	10	14
Republic	22.525	9	13

Appendix 5. Cluster 4 obtained from the thematic analysis of elementary contexts.

LEMMA	CHI2	EC IN CLUSTER	EC IN TOTAL
List	133.791	57	64
Administration	66.181	35	44
Region	63.151	36	47
Municipality	55.888	24	27
Province	51.64	25	30
Autonomous	45.816	24	30
Company	45.369	29	40
Publish	41.384	31	46
Protection	39.751	83	179

Audit	37.496	108	254
Major	31.566	25	38
Medium	30.508	16	20
Report	29.716	25	39
Separately	28.593	10	10
Submit	28.593	10	10
Environmental	26.926	94	231
Reform	26.716	22	34
Corps	24.208	10	11
Xinjiang	24.208	10	11
Notice	22.869	8	8

Uncited references

[Gina, 2015](#); [Greg and Lesley, 2007](#); [Juan et al., 2014](#); [Yong et al., 2010](#); [Yoshiaki et al., 2012](#).

References

Almeida C.M., Agostinho F., Giannetti B.F. and Huisingh D., Integrating cleaner production into sustainability strategies, an introduction to this special volume, *J. Clean. Prod.* **96**, 2015, 1–9.

Antoine J.P., Tixier, Matthew R.H., Balaji R. and Dean B., Automated content analysis for construction safety: a natural language processing system to extract precursors and outcomes from unstructured injury reports, *Autom. Constr.* **62**, 2016, 45–56.

Baynham M. and Stevens M., Are we planning effectively for climate change? an evaluation of official community plans in British Columbia, *J. Environ. Plan. Manag.* **57**, 2014, 557–587.

Bai Y.J., Yin J., Yuan Y., Guo Y.J. and Song D.N., An innovative system for promoting cleaner production: mandatory cleaner production audits in China, *J. Clean. Prod.* **108**, 2015, 883–890.

Blackman A., Small Firms and the Environment in Developing Countries, Collective Impacts, Collective Action, 2006, Economic Development and Cultural Change; Washington DC, USA.

Bonilla S.H., Almeida C.M., Giannetti B.F. and Huisingh D., The roles of cleaner production in the sustainable development of modern societies, an introduction to this special issue, *J. Clean. Prod.* **118**, 2010, 1–5.

Brown G. and Stone L., Cleaner production in New Zealand: taking stock, *J. Clean. Prod.* **15** (8–9), 2007, 716–728.

Butnaru G.I., The method of ethnographic and content analysis in determining development factors of economic and managerial tourism performance, *Proced. Econ. Financ.* **20**, 2015, 104–111.

Chang I.S., Wu J., Qiao H.M. and Zhang Z.L., The spatio-temporal approach to regional analysis on cleaner production in China, *Renew. Sustain. Energy Rev.* **52**, 2015, 1491–1503.

Coakley T., The ENVIROCARE CD-ROM—cleaner production training for vocational students, *J. Clean. Prod.* **11** (5), 2003, 511–517.

D'Agostino A.L., et al., What's the state of energy studies research? a content analysis of three leading journals from 1999 to 2008, *Energy* **36** (1), 2011, 508–519.

Dong X.Q., Li C.L., Li J., Wang J. and Huang W.T., A game-theoretic analysis of implementation of cleaner production policies in the Chinese electroplating industry, *Resour. Conserv. Recycl.* **54** (12), 2010, 1442–1448.

Edward L., Martin W. and Zeng C., Do Chinese government subsidies affect firm value? accounting, *Organ. Soc.* **39** (3), 2014, 149–169.

Frijns J. and Vliet B., Small-scale industry and Cleaner Production Strategies, *World Dev.* **27**, 1999, 967–983.

Geng Y., Haight M. and Zhu Q.H., Empirical analysis of eco-industrial development in China, *Sustain. Dev.* **15** (2), 2007, 121–133.

Geng Y., Wang X., Zhu Q. and Zhao H., Regional initiatives on promoting cleaner production in China: a case of Liaoning, *J. Clean. Prod.* **18** (15), 2010, 1502–1508.

~~Gina I.B., The method of ethnographic and content analysis in determining development factors of economic and managerial tourism performance, *Proced. Econ. Finance* **20**, 2015, 104–111.~~

Glavic P. and Lukman R., Review of sustainability terms and their definitions, *J. Clean. Prod.* **18**, 2007, 1875–1885.

Gombault M. and Versteeg S., Cleaner production in SMEs through a partnership with local authorities, successes from the Netherlands, *J. Clean. Prod.* **7**, 1999, 249–261.

Graneheim U.H. and Lundman B., Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness, *Nurse Educ. Today* **24**, 2004, 105–112.

~~Greg B. and Lesley S., Cleaner production in New Zealand, taking stock, *J. Clean. Prod.* **15**, 2007, 716–728.~~

Guo H.C., Chen B., Yu X.L., Huang G.H., Liu L. and Nie X.H., Assessment of cleaner production options for alcohol industry of China, a study in the Shouguang Alcohol Factory, *J. Clean. Prod.* **14**, 2006, 94–103.

Haapanen L. and Tapio P., Economic growth as phenomenon, institution and ideology: a qualitative content analysis of the 21st century growth critique, *J. Clean. Prod.* **112**, 2016, 3492–3503.

Hamed M.M. and Mahgary Y.E., Outline of a national strategy for cleaner production, the case of Egypt, *J. Clean. Prod.* **12**, 2004, 327–336.

Hendryx M., Luo J. and Chen B.C., Total and cardiovascular mortality rates in relation to discharges from toxics release inventory sites in the United States, *Environ. Res.* **133**, 2014, 36–41.

Hicks C. and Dietmar R., Improving cleaner production through the application of environmental management tools in China, *J. Clean. Prod.* **15**, 2007, 395–408.

Hong J.L. and Li X.Z., Speeding up cleaner production in China through the improvement of cleaner production audit, *J. Clean. Prod.* **40**, 2013, 129–135.

Hsieh H.F. and Shannon S.E., Three approaches to qualitative content analysis, *Qual. Health Res.* **15**, 2005, 1277–1288.

Huang Y., Luo J. and Xia B., Application of cleaner production as an important sustainable strategy in the ceramic tile plant – a case study in Guangzhou, China, *J. Clean. Prod.* **43** (3), 2013, 113–121.

Jin J.S., Japanese agricultural environmental policies and the implications, *Contemp. Econ. Jpn.* **173** (5), 2010, 60–64.

Jobe M.M., The power of information: the example of the U.S. toxics release inventory, *J. Gov. Inf.* **26** (3), 1999, 287–295.

Joubish M.F. and Khurram M.A., Outlook on some concepts in the curriculum of social studies, *World Appl. Sci. J.* **12** (9), 2011, 1374–1377.

Julien H. and Fourie I., Reflections of affect in studies of information behavior in HIV/AIDS contexts: an exploratory quantitative content analysis, *Libr. Inf. Sci. Res.* **37** (1), 2015, 3–9.

~~Juan J., Cabello E., Alexis S.G., Dunia G.L., Juan B., Cogolles M., Lue H. and Carlo V., Bridging universities and industry through cleaner production activities. Experiences from the Cleaner Production Center at the University of Gienfuegos, Cuba, *J. Clean. Prod.* **108**, 2014, 1–10.~~

Ju-Pak K., Content dimensions of web advertising: a cross-national comparison, *Int. J. Advert.* **18**, 1999, 207–231.

Khalili N.R., Duecker S., Ashton W. and Chavez F., From cleaner production to sustainable development, the role of academia, *J. Clean. Prod.* **96**, 2014, 1–14.

Khuriyati N. and Wagiman Kumalasari D., Cleaner production strategy for improving environmental performance of small scale cracker industry, *Agric. Agric. Sci. Proced.* **3**, 2015, 102–107.

Klueh U.H., Pastor G. and Segura A., Policies to improve the local impact from hydrocarbon extraction: observations on West Africa and possible lessons for Central Asia, *Energy Policy* **37** (3), 2009, 1128–1144.

Kolominskas C. and Sullivan R., Improving cleaner production through pollutant release and transfer register reporting processes, *J. Clean. Prod.* **12** (7), 2004, 713–724.

Konar S. and Cohen M.A., Information as regulation: the effect of community right to know laws on toxic emissions, *J. Environ. Econ. Manag.* **32** (1), 1997, 109–124.

Kong G. and White R., Toward cleaner production of hot dip galvanizing industry in China, *J. Clean. Prod.* **18**, 2010, 1092–1099.

Li H., Ni J., Liu W. and Zhu Y., Cleaner production alternatives for saponin industry by recycling starch, *Resour. Conserv. Recycl.* **54** (12), 2010, 1145–1151.

Lemiengre J., et al., How do hospitals deal with euthanasia requests in Flanders, Belgium? a content analysis of policy documents, *Patient Educ. Couns.* **71** (2), 2008, 293–301.

Lerche D., et al., Ranking of chemical substances based on the Japanese Pollutant Release and Transfer Register using partial order theory and random linear extensions, *Chemosphere* **55** (7), 2004, 1005–1025.

Liao Z., The evolution of wind energy policies in China (1995-2014): an analysis based on policy instruments, *Renew. Sustain. Energy Rev.* **56**, 2016, 464–472.

Lin L. and Mao P.C., Food for memories and culture a content analysis study of food specialties and souvenirs, *J. Hosp. Tour. Manag.* **22**, 2015, 19–29.

Lingard J., Agricultural Subsidies and Environmental Change, 2002, University of Newcastle upon Tyne, Newcastle upon Tyne, UK. Encyclopedia of Global Environmental Change. John Wiley & Sons, Ltd.

Liu Y., Sustainable competitive advantage in turbulent business environments, *Int. J. Prod. Res.* **51**, 2013, 2821–2841.

Liu Y. and Liang L., Evaluating and developing resource-based operations strategy for competitive advantage: an exploratory study of Finnish high-tech manufacturing industries, *Int. J. Prod. Res.* **53**, 2015, 1019–1037.

Liu Y., Liu F.Y., Zhang J.F. and Gao J.B., Insights into the nature of food safety issues in Beijing through content analysis of an Internet database of food safety incidents in China, *Food Control* **51**, 2015, 206–211.

Luo L.G., Wang Y. and Qin L.H., Incentives for promoting agricultural clean production technologies in China, *J. Clean. Prod.* **74**, 2014, 54–61.

Luken R.A., Van Berkel R., Leuenberger H. and Schwager P., A 20-year retrospective of the National Cleaner Production Centres programme, *J. Clean. Prod.* **112**, 2016, 1165–1174.

Mol A. and Liu Y., Institutionalising cleaner production in China, the cleaner production promotion law, *Int. J. Environ. Sustain. Dev.* **4** (3), 2005, 227–245.

Nyaupane N.P. and Gillespie J.M., Louisiana crawfish farmer adoption of best management practices, *Soil. Water Conserv.* **66** (1), 2011, 61–70.

Otolano L., Cushing K.K. and Warren K.A., Cleaner production in China, *Environ. Impact Assess. Rev.* **19**, 1999, 431–436.

Papaleo Bruno, Cangiano Giovanna and Calicchia Sara, Occupational safety and health professionals' training in Italy, Qualitative evaluation using T-LAB, *J. Workplace Learn.* **25** (4), 2013, 247–263.

Peltier N.P. and Ashford N.A., Assessing and rationalizing the management of a portfolio of clean technologies, experience from a French environmental fund and a World Bank Cleaner Production demonstration project in China, *J. Clean. Prod.* **6**, 1998, 111–117.

Petek J. and Glavic P., Improving the sustainability of regional cleaner production programs, *Resour. Conserv. Recycl.* **29**, 2000, 19–31.

~~Rahim R. and Abdul R.A., Cleaner Production implementation in a fruit juice production plant~~Rahim, R., Raman, A.A.A., 2015. Cleaner production implementation in a fruit juice production plant, *J. Clean. Prod.* **101**, 2015, 215–221.

Ren X., Cleaner production in China's pulp and paper industry, *J. Clean. Prod.* **6**, 1998, 349–355.

Richardson C.W., Bucks D.A. and Sadler E.J., The conservation effects assessment project benchmark watersheds, synthesis of preliminary findings, *Soil Water Conserv.* **63** (6), 2008, 590–604.

Schramm W., New findings on the generation of waste and emissions, and a modified cleaner production assessment approach—illustrated by leather production, *J. Clean. Prod.* **5** (4), 1997, 291–300.

Sengers F., Raven R.P. and Van V., From riches to rags, Biofuels, media discourses, and resistance to sustainable energy technologies, *Energy Policy* **38**, 2010, 5013–5027.

Shi H., Peng S.Z., Liu Y. and Zhong P., Barriers to the implementation of cleaner production in Chinese SMEs, government, industry and expert stakeholders' perspectives, *J. Clean. Prod.* **16**, 2008, 842–852.

Shi L. and Qian Y., The review and perspective of cleaner production: the state of the art. China Pollution, *Resour. Environ.* **12** (2), 2002, 121–124.

Siaminwe L., Chinsembu K.C. and Syakalima M., Policy and operational constraints for the implementation of cleaner production in Zambia, *J. Clean. Prod.* **13** (10–11), 2005, 1037–1047.

Silvestre B.S. and Silva Neto R. e, Are cleaner production innovations the solution for small mining operations in poor regions? the case of Padua in Brazil, *J. Clean. Prod.* **84**, 2014, 809–817.

Singh N., Zhao H. and Hu X., Cultural adaptation on the web: a study of American domestic and Chinese websites, *J. Glob. Inf. Manag.* **11**, 2003, 63–80.

Telukdarie A., Buckley C. and Koefoed M., The importance of assessment tools in promoting cleaner production in the metal finishing industry, *J. Clean. Prod.* **14** (18), 2006, 1612–1621.

Tosun J., Political parties and marine pollution policy, exploring the case of Germany, *Mar. Policy* **35** (4), 2011, 536–541.

Thorpe B., How the Toxics Use Reduction Act continues to promote clean production Internationally, *J. Clean. Prod.* **19**, 2011, 552–558.

Tseng M.L., Lin Y.H. and Chiu A.S.F., Fuzzy AHP-based study of cleaner production implementation in Taiwan PWB manufacturer, *J. Clean. Prod.* **17**, 2009, 249–256.

Vallet-Bellmunt T., Martínez-Fernández M.T. and Capó-Vicedoet J., Supply chain management: a multidisciplinary content analysis of vertical relations between companies, 1997-2006, *Ind. Mark. Manag.* **40**, 2011, 1347–1367.

Vonk Noordegraaf D., Annema J.A. and van Wee B., Policy implementation lessons from six road pricing cases, *Transp. Res. Part A Policy Pract.* **59**, 2014, 172–191.

Wang J., China's national cleaner production strategy, *Environ. Impact Assess. Rev.* **19**, 1999, 437–456.

Wickens C.M., Wiesenthal D.L., Hall A. and Roseborough J.E.W., Driver anger on the information superhighway: a content analysis of online complaints of offensive driver behavior, *Accid. Anal. Prev.* **51**, 2013, 84–92.

Williams B.C. and Plouffe C.R., Assessing the evolution of sales knowledge: a 20-year content analysis, *Ind. Mark. Manag.* **36**, 2007, 408–419.

Xie J. and Sidney S., Environmental policy analysis, an environmental computable general-equilibrium approach for developing countries, *J. Policy Model.* **22**, 2000, 453–489.

~~Yong G., Wang X., Zhu Q., et al., Regional initiatives on promoting cleaner production in China: a case of Liaoning, *J. Clean. Prod.* **18** (15), 2010, 1502–1508.~~

~~Yoshiaki T., Minoru Y., Ryohei T. and Shinsuke M., Quantitative evaluation of effects of the soft interventions or cleaner production in households and the hard interventions, a Social experiment programme in a large river basin in Japan, *Ecol. Indic.* **20**, 2012, 282–294.~~

Yusup M.Z., Wan Mahmood W.H., Salleh M.R. and Ab Rahman M.N., The implementation of cleaner production practices from Malaysian manufacturers' perspectives, *J. Clean. Prod.* **108**, 2015, 659–672.

Zhang B., Yang S.C. and Bi J., Enterprises' willingness to adopt/develop cleaner production technologies, an empirical study in Changshu, China, *J. Clean. Prod.* **40**, 2013, 62–70.

Zhang H.M., Wang Q.W. and Simon R.M., Waste cooking oil as an energy resource, Review of Chinese policies, *Renew. Sustain. Energy Rev.* **16**, 2012, 5225–5231.

Zhang J.Y., Jiang J.H. and Tian G.M., The potential of fertilizer management for reducing nitrous oxide emissions in the cleaner production of bamboo in China, *J. Clean. Prod.* **112**, 2016, 2536–2544.

Zhang K. and Wen Z., Review and challenges of policies of environmental protection and sustainable development in China, *J. Environ. Manag.* **88**, 2008, 1249–1261.

Zhou Y. and Zhao L., Impact analysis of the implementation of cleaner production for achieving the low-carbon transition for SMEs in the Inner Mongolian coal industry, *J. Clean. Prod.* **127**, 2016, 418–424.

Zwetsloot G.I. and Geyer A., The essential elements for successful cleaner production programmes, *J. Clean. Prod.* **4** (1), 1996, 29–39.

Footnotes

¹The SEPA became the Ministry of Environmental Protection (MEP) in 2008.

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