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Developing a greenhouse gas management evaluation system for Chinese textile enterprises

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ABSTRACT

With increased attention on the global warming phenomenon, greenhouse gas management has become an important issue, especially in textile industry. Therefore, an effective greenhouse gas performance appraisal system is necessary for textile enterprises to assess their sustainability and recognize their weakness in the greenhouse gas management. However, few studies have identified the comprehensive connotation of the enterprise's greenhouse gas management. And there is no relevant research targeting at analyzing the textile enterprises' greenhouse gas management performance. This paper aims at providing a better understanding of the greenhouse gas management and establishing an evaluation system for textile enterprises. The system divided the evaluation into four categories, including Greenhouse gas management commitment and policy, Greenhouse gas management target and program, Implementation and operation, and Corrective action and public reporting. Literature review, expert interview and on-site investigation were used to supplement the indicators and the weights were determined by Monte Carlo-Analytic Hierarchy Process method. Case studies were conducted on eight typical Chinese textile manufacturers to verify the effectiveness of the evaluation system. The result shows that the new evaluation system can reflect the actual greenhouse gas emission performance of textile enterprises. And the system not only allows textile enterprises to recognize their weakness in the greenhouse gas management and better improve their management level, but also provides reference and experience for other industries to draw upon in establishing the greenhouse gas evaluation system.

1. Introduction

The climate change, being one of the most severe and prominent global phenomena in the 21st, is an extremely huge challenge for mankind. The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) pointed out that global warming caused by the rapidly increasing global emissions of greenhouse gas (GHG, including CO_2, CH_4, N_2O, HFC_5, PFC_5 and SF_6) is resulting in sea level rise and increasing the frequency and intensity of extreme climate events; these changes are seriously threatening global food production, human life, and the natural environment (Chen et al., 2017; IPCC, 2014; Ku et al., 2017). Textile industry is the second most polluting industry and accounts for 10% of GHG emissions on earth, owing to its huge scale and scope as well as the great many of processes and products that go into the making of textiles and finished textile products (Aiama et al., 2016; Islam, 2016). In the developing world, where the textile industry represents a large percentage of GDP and plants are often antiquated, the GHG emissions are even larger. China has become the most important GHG emitter in the world, accounting for 24.6% of global GHG emissions (Jiang et al., 2014). And the challenge of CO_2 emissions reduction from the textile industry in China is particularly important because of the rapid growth of that industry and the pillar role it has in the Chinese economy. In 2010, the textile industry represented 9.4% of the total gross output in the Chinese manufacturing sector (Lin and Moubarak, 2013), and in 2016, the number of the textile manufacturers reached 45350, occupying 11.8% of the whole country's enterprises (National Bureau of Statistics of China, 2016), all of which indicates the considerable position of this sector in the national economic industry structure. So it is in great urgency to develop GHG management system and promote fundamental countermeasures to mitigate the carbon emissions from Chinese textile manufacturers.

The GHG emission sources from the textile manufacturers can be divided into two parts – direct emissions and indirect emissions. The direct emissions include the GHG emissions that occur from source that are owned or controlled by the textile companies, for example, fossil-fuel combustion in owned or controlled boilers, furnaces, vehicles, etc.;

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emissions from chemical production or material processing and manufacture (Chen et al., 2011) in owned or controlled process equipment. And the indirection emissions are defined the emissions from the generation of purchased electricity, heat, steam, etc., consumed by these companies (Huang et al., 2017; Shao et al., 2014). Meanwhile, how to reduce the direct and indirect emissions from the perspective of GHG management is very crucial for firms to mitigate carbon risk (Hsu et al., 2013; Subedar et al., 2015; Wu et al., 2016), identify practical strategies (Alemu et al., 2017) and reap benefits from opportunities. As people are increasingly concerned about climate change, governments around the world are developing regulations to limit emissions. Already established GHG emission accounting, management and reporting system in company can create suitable environment to be ready for such regulations (Shailesh, 2013). In addition, GHG management can also create opportunities for the enterprises through cost savings achieved by optimization of energy profile and then careful selection of best energy efficiency measures and sourcing of renewable energy technologies.

However, few studies have identified the comprehensive connotation of the enterprise's GHG management. And to the best of our knowledge, there is no related research targeting at analyzing the textile enterprises' GHG management performance. Although ISO 14001 contains the organizational evaluation, or the environmental management system (EMS) and the auditing and performance criteria used to evaluate the enterprises (Melnyk et al., 2003), this standard does not state explicitly the actual contents of the environmental aspects to be managed and the requirement of environmental performance, but leaves the decision to each organization (Delmas and Montes-Sancho, 2011; International Institute for Sustainable Development, 1996). And the detailed evaluation indicators to assess the environment and GHG management performance of enterprises are also very limited (Hsu and Hu, 2009; Lee et al., 2009). Most of the established criteria or sub criteria have a wide range of meanings, leading to ambiguousness or bewilderment. As a consequence, it is not conducive for people to apply the proposed measures in the real practice and make right judgments. Besides, the approaches for assessing the determinants and consequences of corporate GHG mitigation strategies remain scarce (Boiral et al., 2012; Böttcher and Müller, 2015; Damert, 2017). Existing researches have proposed some GHG evaluation systems and strategies but have not sufficiently proved their effectiveness.

Motivated by the research gap outlined above, this paper aimed at providing a better understanding of the GHG management evaluation for textile enterprises and trying to prove the effectiveness of the proposed evaluation system. Specifically, this study aims at the following: (1) analyzing the existing GHG evaluation indicators and develop new criteria and strategies to complement the connotation of the corporate GHG management; (2) establishing corporate GHG management system to evaluate the GHG management performance of textile enterprises; (3) proving the effectiveness of the system by assessing the relationship between the corporate GHG emission performance and the corporate GHG management evaluation score.

This paper makes several contributions to the literature and the practical use to mitigate the GHG emissions from textile enterprises. Firstly, it proposes a novel framework for evaluating textile enterprises' GHG management performance. Based on the existing indictors put forward by former researchers and standards, some new indicators and strategies also proposed through on-site investigations and interviews with authoritative experts. Secondly, detailed regulations and grading rules are set to improve the operability of the evaluation system and guarantee its wide application and better generalization (Xie et al., 2017). Third, empirical evidence from textile manufacturers are collected. By analyzing the relationship between the GHG management performance score and the GHG intensity value, this paper also makes a contribution to providing a new approach to check the effectiveness of GHG evaluation system.

The rest of this paper is organized as follows. Section 2 reviews the literature related to GHG mitigation and management, including environmental management, green supply chain management, and green supplier evaluation and selection. Section 3 introduces the construction of the GHG management evaluation system. In section 4, the case study of 8 typical textile manufactures is carried out to confirm the effectiveness of the proposed system. Conclusions and final remarks are drawn in the last section.

2. Literature review

A related literature review of GHG mitigation and management has been conducted to collect the GHG management evaluation indicators, which contains the themes such as environmental management, green supply chain management and green supplier evaluation and selection.

At present, there is no explicit definition of EMS in China or in the wider international sphere. The former version ISO 14001 does not give us a clear awareness of the actual contents of the environmental aspects to be managed and the standard of environmental performance, and it leaves the decision to each organization (Delmas and Montes-Sancho, 2011; International Institute for Sustainable Development, 1996; Melnyk et al., 2003; Zobel, 2013). With this caveat, the evaluation of environmental management and performance is feasible, but the difficulty has been added since the indicators should be specified to suit the particular situation. Based on the ISO 14001, WWF-Hong Kong (2014) has developed the Low Carbon Manufacturing Program (LCMP) and provided the guideline for companies to better implement low-carbon manufacturing best practices in general utilities and manufacturing processes. The guideline includes four parts: the GHG/Energy Policy, GHG /Energy Targets and management program, Implementation and operation, and Checking and corrective action. And its terms are generic, not taking into account the characteristics of different industries. In ISO 14001:2015, some requirements are regulated to improve the organizational environmental performance, including leadership, planning, support, operation and performance, performance evaluation and improvement (ISO, 2015). And the requirements are further subdivided into the finer terms to guide the GHG management in the real scene. But the terms and regulations are still broadly defined and the content covers the whole environmental management but limited in the explanation of GHG management. The research in the development of corporate GHG management evaluation system is very limited.

At the same time, there are many researches related to the green supplier/ supply chain evaluation and selection, in which, a great number of evaluation indicators are proposed. Noci (1997) first proposed a green vendor rating system to support the decision-maker in the selection of the most effective supplier from an environmental viewpoint, involving four main qualitative assessment criteria: Green competence, Green image, Life cycle cost, and Environmental efficiency. Later, in consideration of the corresponding evaluation factors of environmental performances, Handfield et al. (2002) selected the top 10 important and easily assessed indicators by group study to evaluate the supplier environmental performance. Based on the literature review, several scholars established the indicator frameworks to assess the environmental management performance in the specific supplier selection and evaluation process (Awasthi et al., 2010; Cogan et al., 2014; Eveloy et al., 2005; Hoffman, 2005; Hsu and Hu, 2009; Humphreys et al., 2003; Lee et al., 2009; Liang et al., 2014; Rao, 2005; Wu and Lee, 2007; Yang, 2006). But most of them considered in the view of the whole environmental management level and the indicators involved in the GHG management were very limited. It was not until 2013 that a framework for low carbon supplier selection was proposed by Hsu et al. (2013). The management model contained 3 dimensions: Planning, Implementation and Management and 13 criteria including Carbon governance, Carbon policy and Carbon reduction targets and so on were used to evaluate the suppliers' performance. And in 2015, an indicator system for the evaluation of Low-carbon City was established by Tan et al. (2015). The evaluation system was constructed from the perspectives of economic, energy pattern, technology, social and living,