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Interpretive Structural Modeling based factor analysis on the implementation of Emission Trading System in the Chinese building sector

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ABSTRACT

The Emission Trading System has been promoted as a tool for providing financial and cost-effective incentives to carbon emitters to apply emission reduction measures. The mechanism of Emission Trading System has been applied in many energy-intensive industries such as electric power industry. However, it appears that Emission Trading System finds limited application in building sector due to the unique characteristics of buildings. This study presents an identification and analysis on the factors affecting the implementation of Emission Trading System in the building sector within the context of China. Research data are collected from semi-structured interviews with a group of carefully selected experts. As a result, fifteen representative factors have been identified, and discussions on their representativeness have been conducted. The intricate interrelationships between the identified factors have been examined based on a hierarchy structure established by using the Interpretive Structural Modeling method. Furthermore, these factors have been classified into four categories: autonomous factors, dependent factors, linkage factors, and driving factors, which is based on the calculation of the factors' driving/dependence power by applying the Matrice d'Impacts croises-multipication appliqué a classement (MICMAC) technique. This classification provides a different profile between individual factors from that by traditional study where the relative importance is generally given between factors. The findings on these factors provide valuable references for helping policy designers and practitioners adopt effective policies and measures to promote the development of ETS in the Chinese building sector.

1. Introduction

Energy consumption in building sector is commonly appreciated as a major contributor to the global warming and environmental unsustainability as it produces large amount of greenhouse gas (GHG) emissions (Al-Sallal, 2014; Nejat et al., 2015). According to the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), building-related GHG emission has exceeded twice since 1970 to reach 9.18 $GtCO_2eq$ in 2010, representing 19% of all global GHG emissions in 2010. The report further suggests that this figure may double or even triple by the middle of this century if the growth of the emission cannot be effectively controlled. With the high population densities and the unprecedented rate in economic development, China has become the largest GHG emitter worldwide, and its building sector is becoming the second largest carbon emitter (Eom et al., 2012; Lu et al., 2016; Oberheitmann, 2012). It was estimated by Tsinghua University Building Energy Conservation Research Center (TUBECRC, 2014) that the current total energy consumption in building operations in China accounts for nearly 20% of the total national energy consumption. Due to the rapid urbanization process in China, the total carbon emissions in its building sector will continue to grow if no appropriate control measures are implemented. Therefore, the participation in controlling carbon emissions by the Chinese building sector plays an important role in mitigating carbon emission globally. It is important to adopt effective policies and management measures for

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mitigating the carbon emissions caused by the Chinese building sector.

In recent years, Emission Trading System (ETS) has been promoted as a market instrument tool to reduce carbon emission through providing financial and cost-effective incentives to GHG emitters. This mechanism has been commonly accepted internationally and its effectiveness has been appreciated by many economic sectors, such as electricity, materials, and other energy-supply sectors. The principle of Emission Trading System has been well appreciated in previous researches (Chen et al., 2015; Kang et al., 2015). Emission trading is a broad concept referring "cap-and-trade", "rate-based", and "project-based" principles, which lead to the development of three major types of emission trading schemes, namely, International Emission Trading (IET), Joint Implementation (IT), and Clean Development Mechanism (CDM) (Uddin and Holtedahl, 2013). In a specific emission trading system, emission cap for business is firstly set by authority (typically a government agency). Secondly, under that cap, emission allowances are distributed for free or auctioned at a cost amongst participating companies. Within compliance period, if permit-holders emit less than they are allocated, they can sell their surplus allowances and make a profit. Emitters whose emissions exceed their allowances can buy permits from others, as long as there is available supply (Han et al., 2012). If emission levels between all participants are high, emission permits will become relatively scare, which will drive up the carbon price for exchange. It can be seen that the carbon price is mainly determined by the demand and the supply of carbon emission allowances. As a market-based mechanism, ETS can encourage the optimization of energy consumption structure and the improvement of energy efficient technologies, which will in turn contribute to the achievement of emission reduction target (Lu et al., 2012).

Previous policy instruments for addressing emission reduction in building sector range from mandatory instruments, voluntary schemes, and various economic instruments (Lu et al., 2013; Shen et al., 2016). Researchers have debated extensively on the advantages and disadvantages of various policy instruments such as green building code, White Certificates, Energy Performance Contracting, and Emission Trading System (Iwaro and Mwasha, 2010). ETS is appreciated as a typical market-based instrument for promoting GHG savings in buildings (Koeppel and Ürge-Vorsatz, 2007). Compared with traditional mandatory instruments such as green building code, ETS offers two typical advantages: high incentives to promote technology investment, active adoption of low carbon technologies and process innovations etc. (Huang et al., 2016; Wang et al., 2014); and less impact on the practice and production of building industry while being able to reduce emissions (Lu et al., 2012). On the other hand, ETS has advantages over other economic and market-based instruments, such as Energy Performance Contracting, White Certificate. ETS can be applied both domestically and internationally, in which international collaboration on GHG mitigation is encouraged and implementable due to the simple, explicit and uniform auditing scope and rules (Koeppel and Ürge-Vorsatz, 2007). ETS aims to mitigate GHG emissions and it is a more direct mechanism for addressing climate change which is mainly contributed by GHG emissions, whilst other instruments such as Energy Performance Contracting and White Certificate address more on energy conservation (Wang et al., 2014). Furthermore, the implementation of ETS can promote the application and development of the advanced technologies for auditing and monitoring GHG emissions of buildings (Figueres and Bosi, 2006; Koeppel and Ürge-Vorsatz, 2007). Nevertheless, it is appreciated that implementing ETS in building sector encounters difficulties, such as high transaction costs, high institutional costs, fragmented and small-scale demands (Koeppel and Ürge-Vorsatz, 2007; Lam et al., 2014, 2015). These difficulties currently contribute to the limitation in application of ETS in building sector, however, the benefits and advantages of ETS in building sector have been increasingly accepted. Especially after the Paris Agreement signed in December 2015, ETS will play a significant role in combating global climate change.

In fact, there is growing application of ETS in building sector. For example, the Japanese Tokyo Cap-and-Trade Program (TCTP), which is considered one of significant ETSs globally, has been applied to full extent in building sector since 2010 (Huang et al., 2016; Takao, 2014). The Chinese government has also contributed efforts in introducing ETS in its building sector. The Ministry of Housing and Urban-Rural Development (MOHURD) of China has proposed three carbon trading schemes targeting respectively for nonresidential buildings, existing residential buildings in heating regions, and heat supply facilities respectively (Greiner and Lieberg, 2011). However, the implementation of ETS in building sector encounter various challenges due to the special characteristics of buildings, and these challenges are more prominent in those developing countries such as China (Bartels et al., 2005; Lam et al., 2014). According to the previous studies (Raines et al., 2005; Ren et al., 2013), buildings' unique characteristics affecting ETS application mainly include scattered ownership of buildings, relatively small quantities of emission reduction from individual buildings, various types of related stakeholders in a building, split economic interests between developers, property owners, and energy bill payers. Therefore, it is very important to conduct a comprehensive investigation on the factors affecting the implementation of ETS within the context of building sector and a deep insight into the intricate relationships between these factors, which will help concerned stakeholders develop effective measures and knowledge on the implementing of ETS and formulate more targeted policies. There are some existing researches conducted in analyzing the factors affecting the implementation of ETS in building sector. For example, the study by the ChiCenter of Science and Technology of Construction in Ministry of Housing and Urban-Rural Development (2013) identifies the key barriers preventing the application of emission trading mechanism in building sector including the lack of mandatory legislations and sufficient supporting policies, the lack of mature international referential experience, unreliable data about building carbon emissions, ineffective Monitoring, Reporting, and Verification (MRV) system, and the insufficient supervision and penalty mechanism.

The implementation of ETS is influenced by many factors which have interactive relationships. However, there are few existing researches examining systematically the interactive relationships between the influencing factors within the context of the Chinese building sector and it is therefore the aim of this study to find out the interactive relationships between the influencing factors. The Interpretive Structural Modeling (ISM) method is employed to establish a hierarchy structure between factors, and the Matrice d'Impacts croises-multipication appliqué a classement (MICMAC) technique is used to analyze the driving-power and dependence-power for each factor. The analysis serves to identify which factors are performing as the driving factors to the ETS application in the Chinese building sector, and which factors are performing as the dependent factors.

2. Methods

In order to achieve the aim of this study, the research works are planned as follows: