Reducing greenhouse gas emission through green supply chain management practices in the UK chemical industries

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Abstract

Despite the growing exploration between green supply chain management practices (GSCMP) and environmental performance, research till date has rarely focused on reducing greenhouse-gas-emission (GHGe) through GSCMP. It investigates the relationship between GSCMP and GHGe through multiple-regression. Data has been collected from 45 environmental reports from UK applying quantitative content analysis.

Keywords: Green supply chain management practices, greenhouse gas, content analysis.

INTRODUCTION

Anthropogenic GHG emission is a serious threat to the planet's eco-system. Natural eco-system is affected by disruption of food and water supplies, submerging coastal wetlands, and causing severe weather patterns and species distinction (Gupta and Palsule-Desai, 2011). Observations of the atmosphere, land, oceans and cryosphere are the most compelling evidence of climate change. Evidence has shown that greenhouse gases such as carbon dioxide, methane, and nitrous oxide have increased over the last few centuries (Cubasch et al. 2013). Thus the accumulation of green house gases in the atmosphere leads to the risk of a more than 2 degree Celsius temperature rise (IPCC 2013a). It has already been warned that the continuous accumulation of GHG in the atmosphere can lead the planet into inundation over the next 45 years (Brundtland 1987) if the initiatives are not taken. Even if emissions of carbon dioxide are stopped, most aspects of climate change will persist for many centuries (IPCC 2013b).

Consequently, GHG emission reduction in the atmosphere is becoming an urgent requirement for a safer planet to live in for the present and future. The businesses need to look at its rudimentary level of operation, and consider the environmental emission (Gupta and Palsule-Desai, 2011; IPCC 2013b). Like other countries in the Kyoto Protocol agreement, the UK has committed to reduce its

emission by 80 % by 2050 from the base year of 1990 (Gilbert 2013). In the case of UK chemical industry's GHG emission, it has been reducing sharply since 1990 but the industrialists have expressed their concern to increase in the coming year due to upcoming economic growth and more production. Hence, the industry is under acute pressure due to the unprecedented emission related laws and regulations (Gilbert 2013; CIA 2013).

Supply chain activities, on the other hand, are identified as a significant source of GHG emission in process industries (Paksoy 2011). Managing environment by reducing greenhouse gas emission and pollution has led companies to redesign their supply chain (Amemba et al. 2013). The conventional business process, however, has been altered considerably through the initiation of innovative Green Supply Chain Management Practices (GSCMPs) for reducing environmental degradation throughout the entire operation. However, GSCMPs vary across different industries and contexts (Zhu and Sarkis, 2006; Zhu et al. 2013).

Even though researchers have developed different GSCMPs such as remanufacturing, recycling, reuse (Quariguasi et al. 2010), reverse logistics, internal environmental management, green design, green purchasing, investment recovery (Zhu and Sarkis, 2007; Zhu and Sarkis, 2004) for addressing either overall environmental performance or both environmental and economic performance, the validity and acceptability of these theoretical practices across different industries in different contexts is still an issue (Darnall and Kim, 2012; Thun and Muller, 2010; Zhu and Sarkis, 2007; Zhu and Sarkis, 2006;). Hence, it has been suggested repeatedly in the literature for continuous validation of theoretical practices across different contexts and industries (Zhu et al. 2005; Zhu and Sarkis, 2006; Zhu et al. 2013).

In practice, the study of GCMPs in the UK chemical manufacturing industries still remains undiscovered. Additionally, research to date in the supply chain and operation management domain has explored predominantly the relationship between GSCMPs and overall environmental performance instead of focusing on elemental environmental performance such as GHG emission (Darnall and Kim, 2012; Zhu et al. 2013).

To address the issue of GHG emission for sustainable business, however, pile of interdisciplinary research have been conducted, and provide mitigating options (Braschel and Posch, 2013; Hassini et al. 2012; Plambeck 2012). Majority of these studies focus on technological instrumentation for reducing emissions rather than stressing on innovative business process and supply chain operations.

Rather than investigating on how to reduce GHG emission through supply chain management practices, it has been sought to investigate how to quantify the GHG emission throughout the supply chain operations. For instance the study of Gaussin et al. (2013) and Filimonau et al. (2011) have presented the comprehensive assessment (e.g., LCA analysis) of measuring GHG emission. The reason is the lack of unique and comprehensive measurements technique of GHG emission to enact emission regulations.

Therefore, considering the practical issues and theoretical gap this study is intended to provide an ad hoc understanding in the relationship between GSCMPs and GHG emission level in the UK chemical industries. The study is also aimed to extend the understanding of current green supply chain management practices in the light of environmental sustainability. Hence, the study involves two major dimensions of investigations: Green Supply Chain Management Practices and Green

House Gas emissions. This paper has only focused on scope one emission (or direct emission) to get an in-depth on how a particular GSCMP is interrelated to the emission controlled solely by the companies. In order to achieve the proposed aim the following four objectives have been proposed:

I. To critically review relevant literature on the concept of GSCMPs and GHG emission in supply chain operations to develop a conceptual framework for the investigation.
II. To examine the effects of selected 'GSCMPs' on the 'GHG emission level' in the UK Chemical Industries.
III. To analyze other environmental management practices or activities employed by the companies for reducing GHG emission
IV. To recommend a new framework for practitioners to manage reducing GHG emission in the industry.

Prior to contribute to the evolving field of environmental operation management, the objective two is attributed as both exploratory and confirmatory. As the previous papers have not considered GHG emission level against the GSCMPs, the new link is to explore this relationship. The confirmatory aspect is to confirm the GSCMPs – GHG emission level link. The next section reviews literature involving GSCMPs and its effects on the environmental performance, especially air emission performance.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Even though the initial efforts for environmental protection were inspired by studying and imitating the natural eco-system (Erkman 1997; Jelinski 1992) to adjust it with industrial eco-system, as time goes, different environmental practices are being adopted through ecological modernization. It is apparent that today's corporate environmental management is multidimensional, and different practices exist in different industries within different contexts due to different drivers and pressures (Zhu and Sarkis, 2006; Zhu and Sarkis, 2007; Zhu et al. 2013).

However, this study has intended to investigate a set of GSCMPs which are: Internal Environmental Management (IEM), Green Purchasing (GP), Eco-Design (ECO) and Investment Recovery (IR). These practices have been chosen because this set of practice has become a new paradigm in the study of GSCMPs due to continuous validity and acceptability in different industries across different countries around the world (See Table 1).

Linking GSCMPs and Environmental (emission focused) Performance

The win-win arguments have been evidenced to justify the relationship between adoption of GSCMPs and environmental performance (Jr et al. 2012; Zhu and Sarkis, 2007; Zhu et al. 2013), especially emission based performance. It is important to note that a case study based analysis has contextualized that even though the statistical relationship exists between GSCMPs and environmental performance, the tangible and direct results are not always distinct (Zhu et al. 2007). Table 1 shows the summary of major investigations in the field.

Table 1 – Summary of major investigations in the GSCMPs and environmental performance

Authors	GSCMPs	Industry	Country	GSCMPs Vs environmental performance

				including air emission
Zhu et al. (2013)	Internal environmental management	Manufacturing firm	China	Positive
	Green purchasing			Positive
	Eco design			Positive
	Co-operation with customers			Positive
	Investment recovery			Positive
Azevedo et al. (2012)	Environmental management system	Automobile Industry	Portuguese	Reduce CO2 emission
	Monitoring supplier's Environmental performanc			Reduce CO2 emission
	Green purchasing			Reduce CO2 emission
	Using reusable packaging (eco-design)			Doesn't reduce CO2 emission
Jr et al. (2012)	Co-operation with customers	Manufacturing companies	USA	Positive
	Eco-design			Positive
	Investment recovery			Positive
Laosirihongthong et al. (2013)	Green purchasing	Manufacturing firm	Thailand	Positive
	Eco-design			Not significant
	Reverse logistics			Not significant
Prajogo et al. (2012)	Internal environmental management	Firms	Australia	Positive
	External environmental management			Negative

IEM and Environmental (Emission Focused) Performance

IEM has been sought as an effective management practice since the inception of ecological practice in organizations (Giovanni 2012**;** Zhu et al. 2013). Zhu and Sarkis (2004) has evaluated the IEM through measuring a set of instruments (management activities). The investigation shows positive result against environmental performance having reduced air emission. Same statistical results have been evidenced from other studies (Giovanni 2012; Giovanni and Vinzi, 2012; Zhu and Sarkis, 2007; Zhu et al. 2007; Zhu et al. 2013)

Apart from the statistical observation, an explanatory case study based analysis has evidenced that IEM practices such as collaborative environmental management practice with first tier suppliers reduce the Co2 emission from the Portuguese automaker (Azevedo et al. 2012). Similar argument can be supported by the study of Plambeck (2012). Based on the arguments provided it can be hypothesized as follows***:***

Hypothesis1. IEM practice reduces GHG emission in the UK Chemical Industries.

GP and Environmental (Emission Focused) Performance

There are enormous evidences in the literature which show the positive impact of green purchasing practice to the environment including reduced air emission (Azevedo et al. 2012; Eltayeb et al. 2011; Laosirihongthong et al. 2013; Zhu and Sarkis, 2007; Zhu et al. 2013). Zhang et al. (2012) has concluded that green purchasing program is an effective tool for CO2 reduction and energy conservation in the Iron and Steel manufacturing companies in China. Same arguments are evidenced in the study of Ho et al. (2010). Even though numerous statistical evidences show positive impact of implementing GP, there are few negativity exists in the literature. For instance, Jr et al. (2012) has conducted an investigation related to the impact of GSCMP on performance among the US manufacturing managers. The result shows that GP practice doesn't significantly impact environmental performance including air emission criteria. It is consistent with another study of Zhu and Sarkis (2007). However, a case study (Ho et al. 2010) analysis supports environmental performance including reduced GHG emission against GP. The aforementioned arguments lead to following hypothesis:

Hypothesis 2: GP Practice reduces GHG emission from the UK Chemical industries.

Eco-Design and Environmental (Emission Focused) Performance

Significant win-win opportunities have been sought for implementing Eco-design practice in the diverse sectors due to perceived environmental performance (Laosirihongthong et al. 2013; Jr et al. 2012; Zhu and Sarkis, 2007). Zhu and Sarkis (2004) observe direct positive relationship between Eco design practice and environmental performance measuring the construct of 'reduction of air emission'. Study of Eltayeb et al. (2011) shows similar result.

However, Zhu et al. (2013) has observed an indirect relationship between eco-design practice and environmental performance. The study claims that eco design can affect environmental performance through GP and CC (customer cooperation). On the contrary, Laosirihongthong et al. (2013) has examined the relationship between eco design and environmental performance by controlling two strategies: low cost strategy, and quality and time based strategy. The result doesn't show any significant relationship between the variables including air emission criteria. Even though some degree of ambiguities exists between eco design and environmental outcomes including air emission, majority of studies indicate and anticipate positive outcomes. Hence it can be hypothesized:

Hypothesis 4: Eco design reduces GHG emission from the UK Chemical Manufacturing Industries.

IR and Environmental (Emission Focused) Performance

IR has been evidenced as a promising practice in terms of cost reduction through reuse, recycle and remanufacture of used products (Eltayeb et al. 2011; Zhu et al. 2005). Numerous empirical evidences have shown significant positive impact of IR on environmental performance (Eltayeb et al. 2011; Jr et al. 2012; Zhu and Sarkis, 2004). Zhu et al. (2013) has shown an indirect positive relationship between IR and environmental performance including air emission performance in the Chinese manufacturing firms. Study of Jr et al. (2012) has confirmed significant positive relationship between IR and environmental performance including air emission criteria. Similar finding has been confirmed by the case study of Azevedo et al. (2012).

However, Zhu and Sarkis (2007) have confirmed that there are no significant environmental improvements of implementing IR during investigating among Chinese manufacturers. Laosirihongthong et al. (2013) has examined proactive and reactive GSCMPs against environmental improvement among ISO certified manufacturers in Thailand. The result shows lower level of adoption of reverse logistics, and this practice is not significantly associated with environmental dimension. Same argument is evidenced by Zhu et al. (2005). Thus the subject of IR related environmental performance has become a new debate. So, more studies are required to justify it. The balanced argumentations lead to hypothesize as follows:

Hypothesis 5: IR practice reduces GHG emission level from UK Chemical Manufacturing Industries.

Hypothesis 6: IR practice does not reduce GHG emission level from UK chemical Manufacturing Industries.

RESEARCH METHODOLOGY

Even though majority of studies in the related field have used survey method as primary source of data (Jr et al. 2012; Thun and Muller, 2010; Zhu et al. 2007), content analysis technique starts exploring recently by means of innovative data source (Hofer et al. 2012; Montabon et al. 2007). Objectivity, systematization and quantification are the main distinguishing features of the content analysis approach (Krippendorff 1980).

Quantitative Content Analysis for Collecting Data

The study has used content analysis of environmental/sustainability/corporate social responsibility/environmental citizenship reports and Carbon Disclosure Project (CDP) Report as the primary data source. The unit of analysis in the data collection is each company. Each company report is subjected to interpret, evaluate, and is rated by the researcher on a structured rating-matrix. The concept of rating-matrix is adapted from the study of Montabon (2007).

The rating-matrix is composed of a set of simple statement (or construct) related to each variable. It involves four independent variables (IEM, GP, ECO & IR) and one dependent variable (scope one GHG emission). Each construct of independent variable is measured on a five point Likert scale. Scope one GHG emission is available on the CDP report. The emission reported has been measured as carbon dioxide equivalent (CO2e) in metric ton.

The constructs for independent variables have been adapted from previous study of Zhu et al. (2008). Similar or somewhat deviated constructs have been repeatedly used by other studies of Zhu et al. (2007); Zhu et al. (2013). Even though these constructs have been used in Chinese context, other countries have adapted those construct as well. The universal acceptability of these constructs has inspired this study to validate in the new context of UK chemical industry.

However, rather than employing human raters involved in the previous studies (Montabon et al. 2007; Hofer et al. 2012), this study has used an evidenced based rating technique where rating is done by the researcher, and attribution for each rating is written in a specific note section on the rating-matrix. This new approach avoids unnecessary complexities of recruiting and training human raters. It reduces cost and time. Opposing to the previous studies (Hofer et al. 2012;

Montabon et al. 2007) the main researcher's knowledge on the relevant variables is more insightful than the recruited and trained human raters. Hence the rating is much more reliable and valid.

Data Source and Sampling

A list of potential UK chemical companies has drawn from five sources. The first source is CIA (http://www.cia.org.uk/, Chemical Industry Association, UK) which represents a strong voice of all chemical companies around the country. The second source is CBA (http://www.chemical.org.uk/, Chemical Business Association) which is a voice of UK chemical supply chain. The third source is North-west chemical sector (http://www.chemicalsnorthwest.org.uk/) that works in partnership with both private and public sector. The fourth source is www.corporateregister.com and www.globalreporting.org where the websites record environmental reports of the companies from all over the world. The final source is CDP (Carbon Disclosure Project, www.cdp.net) which provides an independent global system for companies and cities to measure, disclose, manage and share vital environmental information. This has yielded a list of 420 including all sizes. However, the final sample size is 45 environmental and CDP report which disclose required information. To date, 33 reports have been analyzed and completed the rating-matrix accordingly. All the reports are published between 2010 and 2015. However, most recent one is selected. The sample size of 45 is consistent with other studies in the same filed (Montabon 2007; Ramanathan et al. 2010).

Statistical Analysis

In order to execute objective two multiple regressions will be used. Final data set will be extracted from the 45 rating-matrix. The constructs of variables for this study confirm that the independent variables are non-metric (ordinal number) and the dependent variable is metric. The Multiple discriminant analysis is appropriate for non-metric dependent variable and the structured equation modeling is effective when the study requires understanding series of causal relationships between multiple dependent and independent variables (Hair et al. 1992). In accordance with the data set (metric single dependent variable) and the primary requirements (prediction on dependant variable and explain relationship between variables) of the study, multiple regressions Analysis is appropriate.

Qualitative Content Analysis

Thematic qualitative content analysis is designed to answer objective three. Qualitative content analysis allows researcher to judge multiples interpretations during extensive text analysis (Krippendorff 1980). In depth qualitative content analysis in the related field is evidenced in the literature (Morali and Searcy, 2012; Turker and Altuntas, 2014). The qualitative phase of this study undergoes two important thematic analyses. Theme one includes program/project, technology, activities/actions and management practices employed to reduce GHG emission, and theme two involves the main focus of those activities/management practices observed through extensive categorization in the selected environmental reports. Keywords extraction and categorization help the researcher to explore the thematic points. Objective three is expected to enrich the understanding of existing theoretical GSCMPs through analyzing the ongoing green activities and other green supply chain related decisions employed in the industry. The final objective is an outcome of objective two and three.

CONCLUSION

The study is expected to contribute to the environmental operation management field through exploring the relationship between GSCMPs and scope one GHG emission level in the industry. It is also expected to address previous researchers' (Zhu and Sarkis, 2007) concern whether GSCMPs improve elemental environmental performance. New variables are expected to come out from the qualitative study in order to incorporating it into the new framework for reducing scope one GHG emission in the chosen industry. Evidence based rating-matrix approach will explore further for methodological consideration in the field.

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