THE DIFFERENTIAL OF SUPPLY CHAIN MANAGEMENT IN THE FOOD INDUSTRY TO REDUCE CARBON FOOTPRINTS : THE CASES IN ASIA

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Abstract

Nowadays concerning about the adverse effects of global warming and climate change has been a key issue debated. The concept of carbon footprint emerged to measure what impact (measured in CO2-equivalent) products, services or organizations haves on climate change and consumers are increasingly aware, not only of their own carbon footprints, but also that of the products and businesses they use. This paper examines the differential of supply chain management in food industry to reduce carbon footprints. The target group is the companies in food industry that have gotten carbon footprints certificate from any of the three country: Thailand, Taiwan and Japan. The validated secondary data was used for data collection and to be analyzed for frequency, percentage, average, t-test, ANOVA and Pearson correlation. The result showed that the most significantly effects from supply chain management to carbon footprints were the raw materials section, manufacture section, waste recycling section, distribution sales section, and use section, respectively. And there were significant differences of supply chain management in food industry among countries and product boundaries. To increase efficiency of supply chain management in food industry and has to reduce the carbon footprint, the executives in food industry should emphasize and promote logistics planning (e.g. all transportation related activities, shipment consolidation, route lengths and lack of desire by suppliers to share shipments as opposed to retaining control), reusable or recyclable packaging and use quality management system to production control and prevent those effects.

Keywords: Supply chain management, Carbon footprints, Food industry, Waste, Recycle

1. INTRODUCTION

During the past decade we saw how increasing levels of carbon dioxide may have contributed to changes in global climate spanning thousands and even millions of years. Nowadays, many industries are modifying the chemistry and characteristics of the atmosphere by releasing vast quantities of particles and greenhouse gases into the air without fully understand of the long-term consequences. (Ahrens. 2013; Barrow. 2006). Society at large has currently been awakened to the issue of climate change. Climate change and global warming are highly concerned among consumers around the world than ever before. Top management in a broad range of sectors has recognized that climate change and carbon management are clearly a business reality now (McKinsey. 2008). Within the context of a carbon constrained business future, there is great uncertainty over how a shift to a low-carbon business market will play out. Also, given the global trend in today's business economy, 'that competition is becoming less "firm vs. firm" and more "supply chain vs. supply chain"' a number of companies in different industry sectors begin to recognize the carbon issue as one of the critical factors in supply chain management (Bowersox et al. 1996; Hult et al. 2007).

The CO2 footprint, (i.e. the climate change impact of food manufacturing industry), is one of the most important issues in improving the environmental responsibility of the food chain and also the most intensively discussed at the moment. Farmers, industry, trade and consumers are all keen to reduce climate change impact but currently lack the means to address the problem adequately. Therefore, the primary challenge for science is to provide those involving in the food system with the necessary information and tools to understand and influence key issues such as the potential for carbon sequestration and the mitigation of carbon footprints, including reducing the negative impacts of poor farming techniques and consumer choices. The carbon footprint concept emerged to measure the impact (measured in CO2-equivalent) that a product, service or organization has on climate change (Scipioni et al. 2012; Virtanen et al. 2011; Yuttitham et al. 2011). Many countries have implemented environmental protection laws to reduce the environmental impact of industry and under the trends of strict international environmental regulations, conventions of environmental protection and popular environmental awareness of consumers impact the rules and patterns of the global industrial competition in the food industries around the world (Ar. 2012). Practically, companies have begun to apply the results of carbon footprint to reduce costs associated with manufacturing, energy use, and packaging as well as to inform a design using a life cycle approach. In addition, companies have published the results of carbon footprints externally to manage risks associated with climate change, and to increase market share and secure preferential product placement. However, environmental impacts such as energy and emissions are usually assessed as attributes of 'on-site' or 'direct' allocation rather than as attributes of 'the supply chains of products' (Matthews et al. 2008; Sundarakani et al. 2010).

Therefore, this study aims to explore current business practices in supply chain management and carbon footprint with the case of the food industry and analyze the differential of supply chain management in the food industry to reduce carbon footprints.

2. LITERATURE REVIEW

2.1 Understanding Life Cycle Impacts

The literature is replete with buzzwords such as: integrated purchasing strategy, integrated logistics, supplier integration, buyer supplier partnerships, supply base management, strategic supplier alliances, supply chain synchronization and supply chain management in order, to address elements or stages of this new management philosophy (Tan. 2001). Green supply chain management (GrSCM) can be defined as the integration of environmental thinking into supply chain management, where supply management is thought of managing business activities and relationships (1) internally within an organization, (2) with immediate suppliers, (3) with first and second-tier suppliers and customers along the supply chain, and (4) with the entire supply chain, and its including product design, supplier selection and material sourcing, manufacturing processes, product packaging, delivery of the product to the consumers, and end-of-life management of the product after its use. (Sundarakani et al. 2010).

Figure 1 shows the supply chain activities and firms involving in such a value chain as portrayed by University of Toronto (2013). It begins with the extraction of raw materials or minerals from the earth, through the manufacturers, wholesalers, retailers, and the end users. Where appropriate, supply chain management also encompasses recycling or re-using of the products or materials. Supply chain management appears to treat all organizations within the value chain as a unified & virtual business' entity. It includes activities such as planning, product design and development, sourcing, manufacturing, fabrication, assembly, transportation, warehousing, distribution, and post delivery customer support. In a truly & integrated supply chain, the final consumers pull the inventory through the value chain instead of the manufacturer pushing the items to the end users which in each supply chain activity have transportation pollutants (Ahrens. 2013; Arvanitoyannis. 2008; Rojey. 2009).

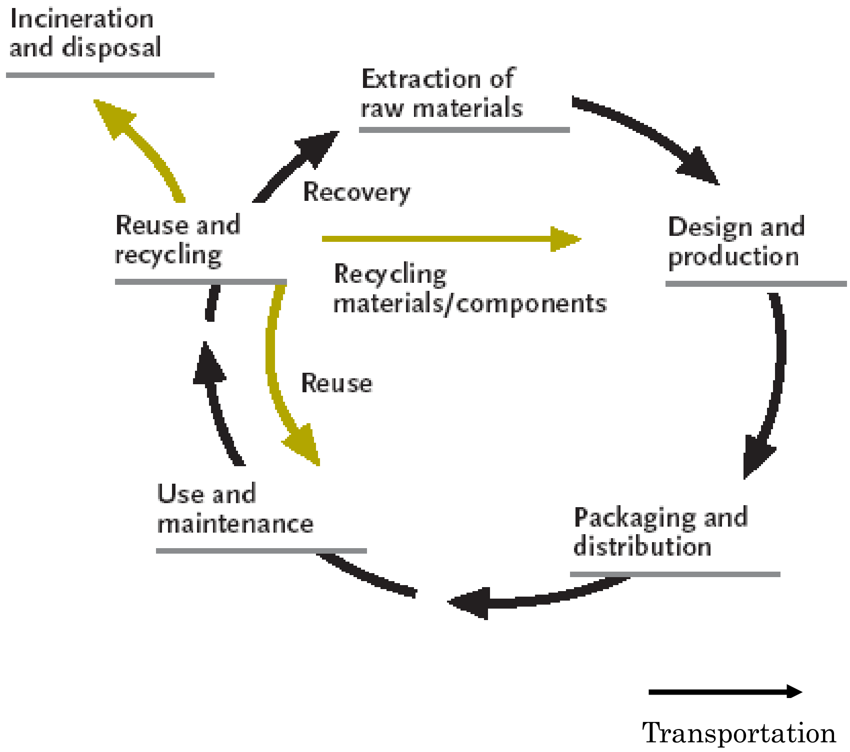

Figure 1: Supply chain activity in food industry. Source: University of Toronto (2013)

2.2 Carbon footprint

The term carbon footprint has been widely used among academia and practitioners in the last few years. A systematic definition of carbon footprint is offered by Wiedmann and Minx (2008), who write "carbon footprint is a value to serve as a good proxy of overall environmental impact (Laurent et al. 2010). The aim is to provide an alternative for consumers to contribute to GHG reduction emissions, as well as to promote and enhance the competitiveness of industrial sector in global market. CF is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product and considered to the nature of environmental impacts from production systems one may contest the ability of carbon footprint to represent the overall environmental performance of a product. This includes activities of individuals, populations, governments, companies, organizations, processes, industry sectors etc. Products include goods and services. In any case, all direct (on-site, internal) and indirect emissions (off-site, external, embodied, upstream, and downstream) need to be taken into account the quantity of GHG emissions from each production unit throughout the whole life cycle (cradle-to-grave) of a product. Carbon footprint thus is calculated by using the carbon dioxide equivalent (CO_2) of the GHG emissions releasing from the raw material acquisition, manufacture, use, waste management and final disposal including related transports in all stages. The 'total amount' of CO_2 is physically measured in mass units (kg, t, etc) and no conversion to an area unit (ha, m2, km2, etc) takes place. The CFP typically considers the six GHGs identified in the Kyoto Protocol, (i.e. Carbon Dioxide: CO2, Methane: CH4, Nitrous Oxide: N_2O, Sulphur Hexafluoride: SF6, Hydroflourocarbons or: HFCs. and Perfluorocarbons PFCs). The normalization reference for the CFP is calculated based on the global per capita emission data for these GHGs in 2004 applying the latest set of global warming potential (GWP) factors, released by the IPPC as characterized factors. The conversion into a land area would have to be based on a variety of different assumptions and increase uncertainties and errors associated with a particular footprint estimate. For this reason accountants usually try to avoid unnecessary conversions and attempt to express any phenomenon in the most appropriate measurement unit (Dong et al. 2013; Keuning. 1994; Stahmer. 2000; Laurent et al. 2010 and Glan. 2010). Following this rationale a land based measure does not seem to be appropriated and we prefer the more accurate representation in terms of carbon dioxide.

3. METHODS

This study is concerned a secondary data retrieved from the companies in food product industry whom received carbon footprints certificate from any of the following organizations in Asia: 1) Thailand Greenhouse Gas Management Organization: TGO (Thailand), 2) Environmental Protection Administration: EPA (Taiwan) and 3) Japan Environmental Management Association for Industry: JEMAI (Japan). The data will be based on a vital national statistics in 2012. 290 food products are samples in this study.

The numbers of the product of food industry from all 3 countries will be the primary dependent variable of the analysis. Supply chain management activity to reduce carbon footprints which are the raw materials section, manufacture section, distribution sales section, use section, and waste recycling section, respectively, are the independent variables in this study.

4. DATA ANALYSIS

Data was analyzed by using SPSS 19.0 (Statistical Package of Social Science). The data were summarized with descriptive statistics, including frequency, means, and standard deviations. Analysis of variance (ANOVA) and t-test were used to assess differences in average numbers of country, product boundary among supply chain factors. Correlation coefficients identified relationships among all variables including raw materials section, manufacture section, distribution sales section, use section, waste recycling section, and carbon footprints, respectively.

5. RESULTS

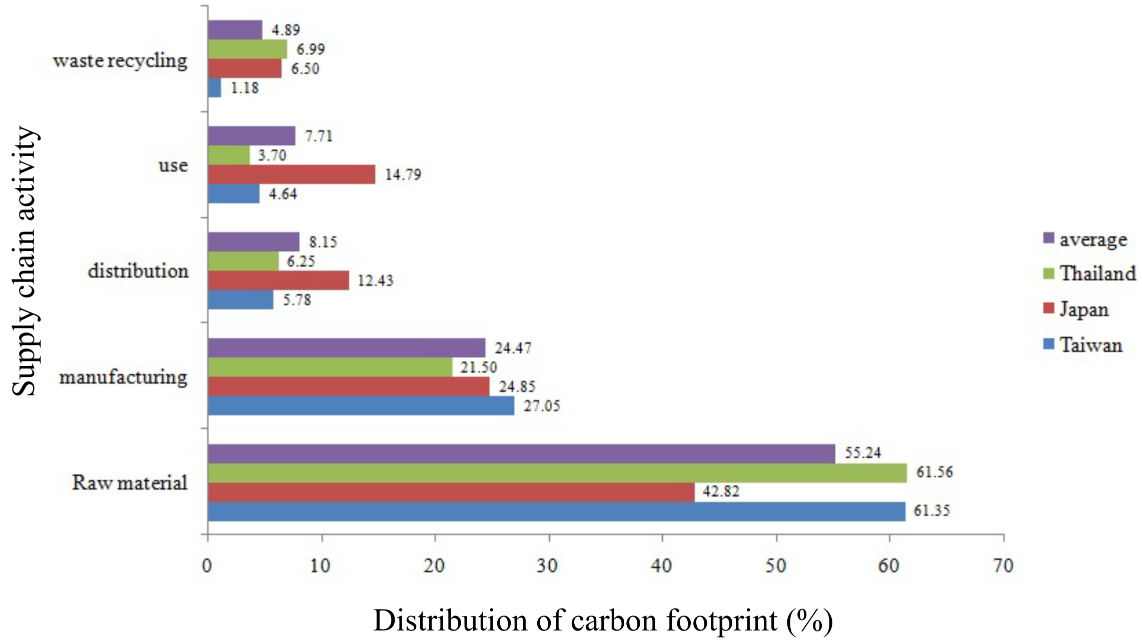

Figure 2: Distribution of carbon footprint of activities in food industry supply chain by country.

Figure 2 summarizes the distribution of carbon footprint of supply chain activities in food industry by country. The most of the supply chain activities listed were: raw materials section (55.24%), manufacture section (24.47%), waste recycling section (8.15%), distribution sales section (7.71%), and use section (4.89%), respectively.

Table 1: Pearson correlation matrix among activity supply chain management and carbon footprints.

Measure	1	2	3	4	5	6
1. Raw materials	-					
2. Manufacture	0.461*	-				
3. Distribution	0.525*	0.576*	-			
4. Use	0.611*	0.709*	0.648*	-		
5. Waste recycling	0.637*	0.530*	0.442*	0.570*	-	
6. Carbon footprint	0.942*	0.761*	0.711*	0.673*	0.750*	-

Note. * = $p < .05$

Correlation analysis was performed and table 1 presents the relationship between supply chain activity (e.g. raw materials, manufacture, distribution sales, use and waste recycling) and carbon footprints. This reveals that carbon footprint value and supply chain activity were significantly related in the industry sections as follows: raw material ($r = 0.942$, $p < 0.05$), manufacture ($r = 0.761$, $p < 0.05$), waste recycling ($r = 0.750$, $p < 0.05$), distribution ($r = 0.711$, $p < 0.05$), and use ($r = 0.673$, $p < 0.05$).

Table 2: Summary of ANOVA and LSD comparisons.

Supply chain management	Country			F	P
	Taiwan	Japan	Thailand		
Carbon footprint	0.66 (0.01)	0.65 (0.01)	0.83 (0.65)	1.812	0.165
Raw materials	0.61 (0.59)	1.22 (0.91)	0.84 (0.51)	6.728*	0.001
Manufacture	0.71 (0.74)	1.14 (1.13)	0.73 (0.60)	2.770	0.064
Distribution	0.60 (0.29)	1.48 (1.82)	0.61 (0.66)	10.075*	0.000
Use	0.61 (0.87)	1.31 (1.95)	0.50 (0.68)	7.011*	0.001
Waste recycling	0.85 (0.22)	0.74 (0.78)	0.70 (0.73)	0.714	0.490

Note. ** = p < .05. Standard deviations appear in parentheses bellow means. Means with differing subscripts within rows are significantly different at the p < .05 based on LSD post hoc paired comparisons.*

One-way ANOVA was conducted to compare the effect of supply chain management activity and carbon footprints in each country, (Thailand, Taiwan and Japan). There was a significant difference effect of supply chain management activity in terms of raw material [$F= 6.728$, $p = 0.001$], distribution [$F= 10.075$, $p = 0.000$] and use [$F= 7.011$, $p = 0.001$] at the alpha level of 0.05 among the three countries. While in terms of Carbon footprint, manufacture and waste recycling were not significantly difference at the alpha level of 0.05 for the three countries [$F= 1.812$, $p = 0.165$], [$F= 2.770$, $p = 0.064$] and [$F= 0.714$, $p = 0.490$] respectively. Post hoc comparisons using the LSD test indicated that the mean score for 1) Raw materials that Japan (M = 1.22, SD = 0.91) appears to more significantly different than Thailand (M = 0.84, SD = 0.51) and Taiwan (M = 0.61, SD = 0.59), 2) Distribution Japan (M = 1.48, SD = 1.82) also appears to be more significantly different than Thailand (M = 0.61, SD = 0.66) and Taiwan (M = 0.60, SD = 0.29), 3) Use section Japan (M = 1.31, SD = 1.95) appears to be more significantly different than Taiwan (M = 0.61, SD = 0.87) and Thailand (M = 0.50, SD = 0.68).

Table 3: T-test results comparing B2B and B2C on product boundary of food industry.

Supply chain	Product boundary		t	P
	B2B	B2C		
Raw materials	1.07 (0.42)	0.75 (0.57)	4.811*	0.000
Manufacture	0.88 (0.76)	0.71 (0.62)	1.797	0.075
Distribution	0.58 (0.07)	0.68 (0.87)	1.231*	0.000
Use	0.36 (0.03)	0.62 (0.95)	3.168*	0.01
Waste recycling	0.63 (0.01)	0.75 (0.8)	1.742*	0.015

Note. ** = p < .05. Standard deviations appear in parentheses bellow means.*

An independent-samples t-test was conducted to compare product boundary in B2B and no B2C. There were a significant difference in terms of raw material (t=4.811, p = 0.000), distribution (t=1.231, p = 0.000), use (t=3.168, p = 0.01) and waste recycling (t=1.742, p = 0.015), while there was no significant difference in terms of manufacture.

6. CONCLUSION

The major findings of this study are as follow:

1. The study intends to present the distribution of carbon footprint of supply chain activities in food industry by country. Most of supply chain activities listed were: Raw materials, manufacture, waste recycling, distribution sales, and use, respectively.
2. Different countries are found to have significant factor with respect to supply chain management in terms of raw material, distribution and use. However, there is found to be no significant difference among three countries in terms of carbon footprint, manufacture and waste recycling.
3. Product boundaries are proved to be significantly different with respect to supply chain management in terms of raw material, distribution, use and waste recycling, while there is no significant difference in terms of manufacture.

These outcome bear some implications to researchers and practitioners in terms of understanding the holistic and broad supply chain management in managing carbon footprints in food industry as well as being able to diagnose the limitations of their own production processes. To verify the results, future research will be extended to other countries from diverse food industry. Therefore, to increase efficiency of supply chain management in food industry and to reduce the carbon footprints the executive in food industry should emphasize and promote logistics planning (e.g. all transportation related activities, shipment consolidation, route lengths and lack of desire by suppliers to share shipments as opposed to retaining control), reusable or recyclable packaging and use quality management system to production control and prevent those effects.

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