Sustainability **2015**, *7*, 2787-2803; doi:10.3390/su7032787

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

Using the Electronic Industry Code of Conduct to Evaluate Green Supply Chain Management: An Empirical Study of Taiwan's Computer Industry

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Academic Editor: Marc A. Rosen

Received: 7 November 2014 / Accepted: 25 February 2015 / Published: 6 March 2015

Abstract: Electronics companies throughout Asia recognize the benefits of Green Supply Chain Management (GSCM) for gaining competitive advantage. A large majority of electronics companies in Taiwan have recently adopted the Electronic Industry Citizenship Coalition (EICC) Code of Conduct for defining and managing their social and environmental responsibilities throughout their supply chains. We surveyed 106 Tier 1 suppliers to the Taiwanese computer industry to determine their environmental performance using the EICC Code of Conduct (EICC Code) and performed Analysis of Variance (ANOVA) on the 63/106 questionnaire responses collected. We test the results to determine whether differences in product type, geographic area, and supplier size correlate with different levels of environmental performance. To our knowledge, this is the first study to analyze questionnaire data on supplier adoption to optimize the implementation of GSCM. The results suggest that characteristic classification of suppliers could be employed to enhance the efficiency of GSCM.

Keywords: environmental performance; code of conduct; self-assessment questionnaire; green supply chain management; EICC Code

1. Introduction

Greater global capital mobility and information flow has led multinational enterprises in all industries to move supply chains offshore to developing countries with lower labor and environmental costs. Such outsourcing has allowed these enterprises to establish a low-cost global supply chain and compete for growth in major developing markets.

Outsourcing business operations doesn't mean relinquishing responsibilities or risks. Due to the pressure from stakeholders, including consumers and employees, firms continue to be motivated to adopt higher social and environmental standards [1,2]. The Greenpeace campaign accusing Nestlé of sourcing palm oil from a supplier who harms the environment forced Nestlé to change its outsourcing decision [3]. Based on the threat of media exposure, firms must consider not only their own behavior, but also the behavior of their associates, including outsourcing companies, licensees, agents, and partners. In principle, they are legally bound to comply with international norms and standards besides local laws [4].

Many firms have recognized that their competitiveness depends not only on their internal operations but also the whole supply chain [5]. Cao and Zhang [6] empirically confirm that supply chain collaborative advantage directly improves firm performance. In the Electronics industry, which includes a range of information and communication technologies, the trend to outsource manufacturing sub-assemblies has increased the number as well as the complexity of supplier networks [7]. Because of this greater complexity, supply chain management has evolved from being a "traditional" business concern to being a "strategic" one [8]. Thus, environmental considerations in the supply chain become strategic from a corporate perspective.

In the related area of social and labor standards, many companies have adopted formal Corporate Social Responsibility (CSR) strategies in their relationships with suppliers. Notwithstanding its growing diffusion, factors, such as the lack of metrics, still hinder CSR and GSCM adoption around the world [9]. Overall, GCSM is more narrowly focused than CSR, focusing overwhelmingly on environmental issues. CSR on the other hand adopts a broader, triple bottom line, perspective [10]. Within business, GCSM and CSR play an increasingly important role in the realization of sustainability [11]. The various social and environmental standards frequently present different compliance requirements. Tier 1 suppliers who cooperate with large companies may be confronted with multiple Codes of Conduct that they are expected to meet. This multiplicity of standards leads to additional costs limiting the commercial benefits of improved performance [12].

The development of industry-wide Codes of Conduct represents an effort on the part of large global corporations located in developed countries interested in managing their supply chains in developing countries [13]. Corporate Codes of Conduct have been drawn up by various industry associations to provide guidance for members, for example the International Council of Toy Industries (ICTI), the Forest Stewardship Council, the Global e-Sustainability Initiative (GeSI), and the Electronic Industry Citizenship Coalition (EICC) [14,15]. Through intra-industrial collaboration, the resources required for GCSM are not only shared, but the burden on suppliers to respond to multiple demands is also reduced.

Because stakeholders introduce significant pressures concerning corporate environmental responsibility, corporations must ensure their suppliers compliance with law and the supplier code of conduct, the green supply chain management. Corporate resources and capacities are usually insufficient

to investigate all its suppliers in person, so they are forced to conduct industry-wide assessments. An industry wide assessment tool, the EICC SAQ offers an efficient tool to identify risks for both customers and suppliers and it has been adopted by leading computer companies, like HP, Dell and Acer [16–18]. The key challenge lies in effectively identifying supplier risks, since most companies sell products and services that they purchase from other organizations in the supply chain.

Using Data Envelopment Analysis (DEA) to examine corporate sustainability performance and changes across 16 industries, Chang *et al.* [19] revealed significant variation in industry environmental performance. In another study, Zhu *et al.* [20], found that the electrical/electronics industries in China appeared to be a leader among industrial sectors in its adoption of improved environmental management practices. They also described empirical findings between operational practices and performance among early adopters of green supply chain management in Chinese manufacturing enterprises [21]. Tian *et al.* developed a system dynamics model to promote the diffusion of GCSM in China's automobile industry [22]. Hsu and Hu examined consistency approaches by fuzzy Analytic Hierarchy Process (AHP) to determine the adoption and implementation of GSCM in Taiwanese electronic industry [23]. GSCM is gaining increasing interest among researchers and practitioners of operations and supply chain management [24–26]. However, earlier studies have seldom focused on the industry-wide code perspective, which is an emerging topic in multinational companies.

This study focuses on the exploration of environmental performance of the multinational supply chain in the Taiwanese computer industry. After describing the subject of our analysis, we propose three hypotheses regarding environmental performance based on firm characteristics. After presenting empirical results from the survey, we use statistical analysis to identify correlations between the environmental performance of Tier 1 suppliers and firm characteristics: product type, geographical area and number of employees. The final section of the article draws conclusions from our analysis and provides some suggestions for future research.

2. Literature Review and Hypothesis

Few companies are vertically integrated; most of what companies actually sell consists of products and services that they purchase from other organizations in their supply chain [27]. Due to outsourcing initiatives, organizations have become more dependent on suppliers performance. Environmental, social, and economic dimensions must be considered when selecting a well-rounded supplier to enhance supply chain performance [26]. Industries need to adopt environmental management concepts in traditional supply chain management. Thus, GCSM plays a vital role in the improvement and implementation of a firm's competitive advantages [28,29]. When selecting supply chain partners, firms evaluate the social and environmental responsibilities of suppliers using publicly available information, self-assessment questionnaires, review of other non-proprietary information, develop of assessment tools, and on-site audits [14,30]. Environmental on-site audits allow for a deep and broad understanding of the supplier's capabilities and activities but remain costly. A self-assessment, which includes completing a standardized questionnaire about environmental management, operational behaviors, and waste emissions, reduces this cost [27]. Some leading companies have found the right incentives and collaborative efforts so as to help their suppliers achieve better environmental performance through better management and greater operational efficiency [31].

Through the collaboration of leading firms, the global electronics industry established the EICC and the EICC Code of Conduct in 2004. One of the main goals of the EICC was to improve efficiency and allow tracking of social and environmental performance in the global electronics industry supply chain. EICC membership is broad and diverse. In 2014, the EICC included more than 100 electronics companies with combined annual revenue of approximately $3 trillion, directly employing over 5.5 million people [32]. The large majority of electronics firms in Taiwan had adopted the EICC Code to manage the social and environmental performance in their supply chain [33], which includes Acer, Foxconn, Wistron, Compal and Quanta. TSMC, the world's largest dedicated IC foundry, and Asustek, a global computer branding company, have joined the EICC as members since January 2015 [34,35].

The EICC has developed a code of conduct encompassing member behavior related to labor, health and safety, ethics, environmental, and management systems [36]. EICC environmental guidelines refer to the ISO 14001 and the Eco Management and Audit System (EMAS). The code lists the need for pollution prevention, source reduction, product content restrictions, waste reduction, and adherence to all local environmental permits and laws. It has developed a self-assessment tool, the Self-Assessment Questionnaire (SAQ), to report on conformance. Leading computer firms, such as HP, Dell and Acer, require suppliers to complete the SAQ to identify the most impactful issues and raise concerns in the supply chain of their supplier risk assessment process [16–18]. The EICC SAQ is often the first step in identifying risks in a facility's operations and areas needed for improvement. The SAQ, thus, serves to allow suppliers to provide a baseline for continuous improvement discussions and identify if there is need for a supplier audit. Based on the information found in the SAQ, suppliers are asked to develop management systems to ensure compliance with the code [37,38]. A key benefit of this approach is consolidating and standardizing compliance and reporting efforts. Moreover, the approach offers the promise of "share efficiencies" throughout the supply chain, rather than just compliance [27].

Recent legislative efforts to influence electronic products include the European Waste Electrical and Electronic Equipment (WEEE) Directive in 2005, and legislation restricting the use of hazardous substances in electrical and electronic equipment, the RoHS Directive in 2006. These governmental directives influence supply chain management in terms of cost, quality requirements, reporting requirements, as well as environmental provisions. However, legislation alone does not ensure the implementation of fundamental changes in the industry. Voluntary initiatives, market incentives and supplier engagement also play important roles in environmental improvement of the supply chain. Moreover, the adoption of GSCM practices implies the need for investment in resources, which are generally scarce. It is important that organizations have drivers to prioritize the adoption of GSCM practices [29].

Govindan *et al.* identified the relationship of driving force and dependence power in Brazilian electrical/electronic industry [29]. Jabbour *et al.* analyzed the relationship between the maturity level of environmental management and the adoption of GSCM practices at electrical/electronic companies in Brazil then confirmed a positive relationship between the company's environmental maturity and the adoption of GSCM practices [39]. Jabbour *et al*. also identified the factors that affect GSCM practices based on empirical evidence from the Brazilian electronics sector [40]. Mathiyazhagan *et al.* identified essential pressures for implementation of GSCM in Indian industries, including electrical/electronics industry [25]. Lee and Kim presented GSCM evidence from an empirical study, which showed that "environmental" pressures and standards are widely accepted and implemented for supply management in the Korean electronics industry [41]. Like the above countries, Taiwan plays a critical role in the

electrical/electronic industry, its notebook shipments in the global computer industry ranked first from 2006 to 2013 [42,43] and first in desktop computer shipments, since 2009 [44,45]. Yang *et al.* verified the inter-relationship among continuous improvement, supplier management, environmental management, and manufacturing competitiveness in both China and Taiwan electrical/electronic companies [46]. Hsu and Hu suggested that companies could emphasize suppliers' management performance when implementing GSCM through a survey of Taiwan electronic companies [23]. Because Taiwan is a key player in the global electronics industry, this study aims to determine the major factors affecting environmental performance in the Taiwanese computer industry in order to provide empirical results as a general reference for GCSM.

To examine the environmental performance of the multinational supply chain in the Taiwanese computer industry, we analyze results from respondents to the EICC Self-Assessment Questionnaire (SAQ) that was distributed among Tier 1 suppliers. We consider the data using three different classification schemes, according to product type, geographic area, and number of employees. In this section we propose three hypotheses that posit an association between environmental performance and these firm characteristics.

Our first hypothesis addresses the relationship between a supplier's product type and that firm's environmental performance. We consider hardware manufacturers, those that produce power, storage, memory, display, and other components as well as final assemblers. The power industry includes manufactures of battery pack assemblies, power supplies, and adaptors. Storage suppliers primarily include optical and hard disk drive manufacturers. "Other" suppliers make keyboard, mouse, card reader, and other auxiliary components. Each of these different product types corresponds to different business and technical requirements depending on things like capital requirements and rates of product innovation, based on our observations, we propose our first hypothesis.

Hypothesis 1: Suppliers of some product types consistently demonstrate better environmental performance than others in the computer industry.

Globally, suppliers of electronics sub-assemblies typically cluster in different regions. These clusters are linked by well-developed logistic networks that facilitate the just-in-time production methods typical in East Asia used to minimize system-wide costs while satisfying service level requirements [47]. Hiratsuka [48] notes that the global electronics industry generally forms clusters within a distance that provide a quick response time for problem solving. Due to labor costs, regulatory regimes, and levels of industrial development that differ between different countries and regions, the environmental performance of suppliers in various regions may also differ. The relationship between environmental performance and geographical area has been analyzed in previous studies, which are based mostly on case studies. Thus we expect that the environmental performance of Tier 1 suppliers in a clustered computer industry in different regions show significant differences. Based on our observations, we propose the second hypothesis.

Hypothesis 2: Suppliers in the computer industry located in some geographic areas consistently demonstrate better environmental performance than others.

Zhu *et al.* [49] argue that after reaching a certain threshold in the number of employees, firms generally become better environmental performers. One straightforward line of reasoning argues that

investments in environmental performance may not be economically feasible for smaller firms [50]. Large companies can take various actions to assist their supply chain partners, large and small, to institute preventive measures and encourage the development of environment-friendly technologies. Based on these observations, we propose our last hypothesis.

Hypothesis 3: After exceeding a threshold in the number of employees, a supplier's environmental performance improves.

3. Methodology

3.1. Questionnaire and Sample

The questionnaires were distributed to managers at 106 Tier 1 supplier-manufacturing facilities through their downstream Taiwanese computer firm, a firm devoted to designing IT products in the global PC market. For our analysis we classified the questions on the SAQ into three environmental dimensions, Environmental Management Systems, Law Compliance, and Cleaner Production. The dimensions themselves are further divided into environmental aspects, which correspond to the EICC SAQ sections. Environmental Management Systems includes the aspects: Management Accountability and History (MAH); Environmental Policies and Procedures (EPP); Management System Status (MSS); and Management System Elements (MSE). The questions under this dimension probe a firm's established environmental policies, performance objectives, communications, training and other critical factors of the environmental management system. The second environmental dimension, Law Compliance, considers a firm's compliance with the laws and regulations using the following environmental aspects: Environmental Permits (EP), Hazardous Substances (HS), Wastewater and Solid Waste (WSW), and Airborne Emissions (AE). The third environmental dimension, Cleaner Production considers the aspects Pollution Prevention (PP) and Product Content (PC) with questions that address a firm's planning and procedures for systematically reducing pollution and resource consumption reduction, as well as collaborating with suppliers to reduce or eliminate hazardous substances. All together, the SAQ consists of 59 questions that cover 10 environmental aspects, in three environmental dimensions, Table 1.

Table 1. Environmental dimensions, Environmental aspects, Number of questions, and Question types on the SAQ.

Environmental Dimension	Environmental Aspect	Number of Questions	Question Type
Environmental Management Systems	Management Accountability and History (MAH)	2	Environmental Management Representative, Violations
	Environment Policy and Procedures (EPP)	5	Environmental Policy, Scope of Environmental Policy, Communication Method, Contractual Requirement on Suppliers, Voluntary Environmental Standards on Suppliers
	Management System Status (MSS)	4	Environmental Management Systems, Registered Environmental Management System, Documentation, Periodical Review

Table 1. *Cont.*

Environmental Dimension	Environmental Aspect	Number of Questions	Question Type
Environmental Management Systems	Management System Elements (MSE)	16	Regulation Tracking System, Regulation Tracking Method, Written Performance, Periodic Review, Risk Assessment Process, Risk Management Program, Periodic Audit, External Audit, Corrective Actions, Root Cause Analysis, On-site Specialist, Employee Communication, Training Program and Measurement, Performance Communication, Method of Performance Communication
Law Compliance	Environmental Permits (EP)	4	Program and Procedures, Permit Law Compliance, Government Inspection Frequency, Permits Violations
	Hazardous Substances (HS)	5	Hazardous Material in Manufacturing Operations, Training, Reduction Plan for Hazardous Materials, Hazardous Waste, Reduction Plan for Hazardous Waste
	Wastewater and Solid Waste (WSW)	4	Type of Wastewater, Wastewater Management Plan, Solid Waste Management Plan, Wastewater and Solid Waste Reduction Program
	Airborne Emissions (AE)	5	Airborne Emissions, Airborne Emission Management Program, Airborne Emissions Reduction Program, Green House Gas (GHG) Reduction Program, Mobile Source Emissions Program
Cleaner Production	Pollution Prevention (PP)	5	Systematically Pollution Reduction Program, Systematically Resource Reduction Program, Power Consumption Reduction of Product, Environmental Impacts Assessment Program, Awards in Pollution Prevention
	Product Content (PC)	9	Materials List, Material Management Program, Materials Phase Out Program, Material Integrated Operation, Rejected or Banned, Recycled Materials Program, Information Disclosure Program, Work with Suppliers, Product Take-Back Program
	Total	59	

3.2. Data Collection

Most respondents to the questionnaire were facility and quality managers. The data collection lasted around two years from 2009 to 2010. Over 80% of the manufacturing facilities considered here were supplier owned. The response rate was 59% (63/106). Sixty-five percent of the respondents were located in China, with the majority in China-East, followed by China-South, Taiwan and Other Asian regions. Note that more than half of the respondents were suppliers with over 5000 employees. The profile of the respondents according to all three firm characteristics is shown in Table 2.

Table 2. Profile of SAQ Respondents according to firm characteristics.

	Number	Percentage
Product Type		
Final Assembly	16	25.4
Memory	10	15.9
Display	10	15.9
Power	8	12.7
Storage	12	19.0
Others	7	11.1
Total	63	100.0
Geographical Area		
China-East	24	38.1
China-South	17	27.0
Taiwan	12	19.0
* Other Asian regions	10	15.9
Total	63	100.0
Employees (Size)		
>5000	35	55.6
1001–5000	20	31.7
101–1000	7	11.1
<100	1	1.6
Total	63	100.0

* Japan, Korea, Malaysia, Philippines, Singapore and Thailand.

3.3. Data Analysis

A score of 0–3 (0 = none, 1 = planned, 2 = partial, 3 = completed) was assigned to each supplier based on the supplier's response to a question on their implementation status for the environmental aspects covered. By adding the scores for each question we calculated the total score for each firm and rankings were calculated based on best possible score and normalizing the results. One-way Analysis of Variance (ANOVA) was used to determine whether differences exist between the mean values of environmental performance in each of the supplier types being studied. The main objective of ANOVA is to extract from the results how much variation each aspect causes relative to the total variation observed in the result [51]. Analytic results having a p value are considered statistically significant at the p value <0.05. After a one-way ANOVA finds a significant difference in means, this study follows the Least Significant Difference (LSD) test, one way of *post hoc* test to compare the means using the equivalent of multiple *t*-tests.

4. Results

To begin, we calculated the mean percentage and standard deviation for each environmental aspect and dimension. Among these three dimensions, Environmental Management Systems had the highest score with a mean value of 0.914, followed by Law Compliance at 0.763. "Cleaner Production" was last at 0.583, a significant departure from the other two dimensions shown in Table 3.

Figure 1 shows the results for environmental performance according to product type. The environmental aspects are grouped into three dimensions shown along the x-axis. The error bars for each data point represent the standard deviation. Management Accountability and History (MAH); Environment Policy and Procedures (EPP); Management System Status (MSS); Management System Elements (MSE); Environmental Permits (EP); Hazardous Substances (HS); Wastewater and Solid Waste (WSW); Airborne Emissions (AE); Pollution Prevention (PP); and Product Content (PC) are shown. What becomes immediately evident is that, collectively, the firms scored well (>90%) in the Environmental Management Systems dimension and generally score lower in Law Compliance and lower still the Cleaner Production dimension.

Table 3. Descriptive statistics on environmental dimension and aspects.

Dimension/Aspects	Mean	SD
Environmental Management Systems	**0.914**	**0.150**
MAH	0.952	0.157
EPP	0.917	0.126
MSS	0.932	0.136
MSE	0.855	0.118
Law Compliance	**0.763**	**0.171**
EP	0.893	0.175
HS	0.663	0.132
WSW	0.794	0.092
AE	0.700	0.171
Cleaner Production	**0.583**	**0.254**
PP	0.496	0.214
PC	0.670	0.264

Among the product types considered, storage suppliers had the highest environmental performance with a mean value of 0.847. Next comes "Other" and Final Assembly suppliers with a mean value of 0.806 and 0.793. Power and Memory suppliers showed similar results with mean values of 0.779 and 0.777, respectively. Display suppliers had the lowest level of environmental implementation with a mean value of 0.748.

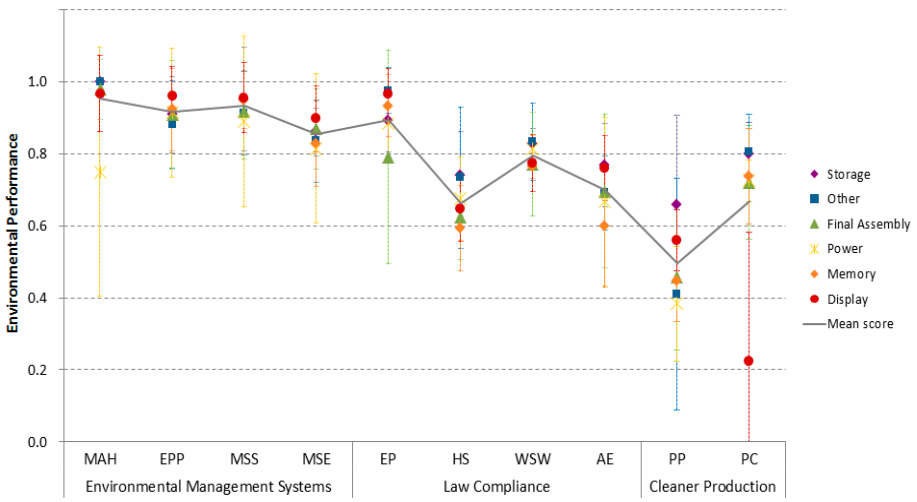

Figure 1. Environmental performance according to product type.

More precise, ANOVA of the data shown in Figure 1 indicate statistically significant differences ($p < 0.05$) among the six supplier types in the three environmental aspects, MAH, PP and PC. The data thus support Hypothesis 1. Our data show a significant difference in overall environmental performance based on product type. It is further supported by the fact that individual environmental aspects showed a statistical difference between Tier 1 suppliers in the computer industry according to the type of product manufactured by that Tier 1 supplier.

Figure 2 shows the results for environmental performance according to geographical area. The environmental aspects are grouped into three dimensions shown along the x-axis. Other Asian regions refer to Japan, Malaysia, Philippines, Singapore, South Korea, and Thailand. The error bars for each data point represent the standard deviation. As in Figure 1, all firms performed best in the Environmental Management Systems dimension, regardless of their location. The mean value of East China, South China and Taiwan is 0.802, 0.783, and 0.752, respectively. Taiwan, China-South, and China-East each showed the poorest performance for some environmental aspects. According to the *post-hoc* analysis, the suppliers in East China perform better than Taiwan in the overall score of the environmental performance. The "Other Asian Regions" generally show similar levels of performance to these, but did score the highest overall, receiving a mean score of 0.841.

According to the ANOVA results for the data shown in Figure 2, there were statistically significant differences in overall environmental performance as well as the Product Content aspect among firms from different geographical areas. The fact that we find nine of ten environmental aspects are not significantly different in our survey sample among different geographic areas. For this practice, we find evidence for only a weak correlation between environmental performance and location for Tier 1 suppliers in the computer industry.

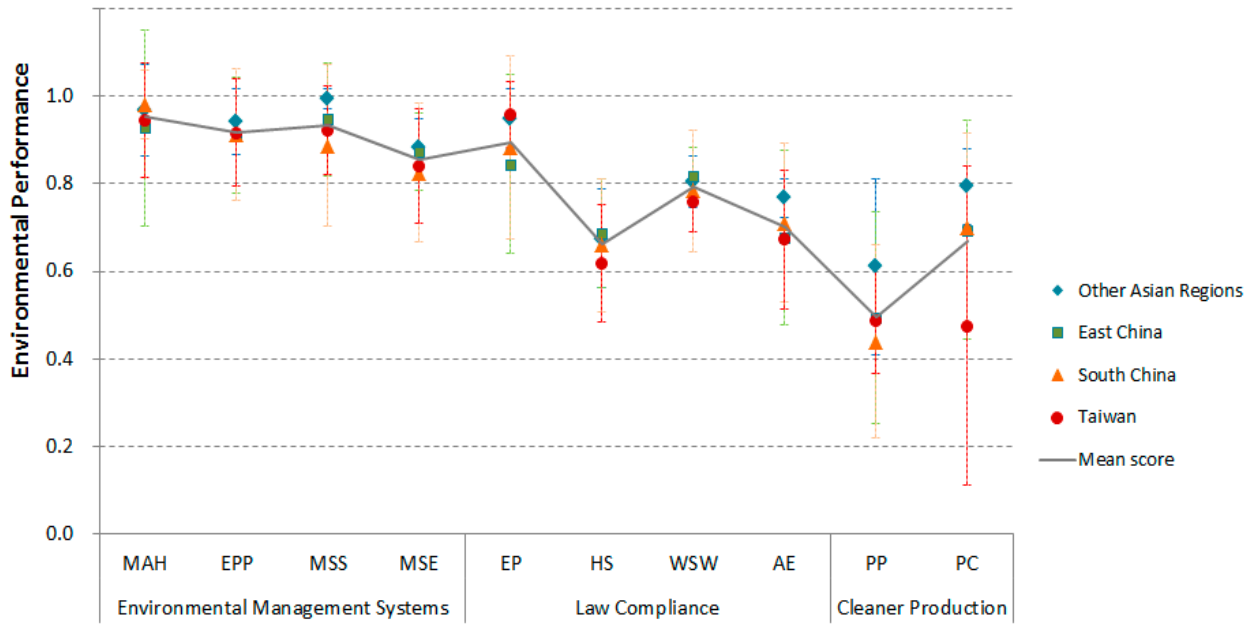

Figure 2. Environmental performance according to geographical area.

Figure 3 shows the results for environmental performance according to the number of employees. The environmental aspects are grouped into three dimensions shown along the x-axis. The error bars for each data point represent the standard deviation. In general, large-sized suppliers had the best

performance, followed by medium-sized firms and then small-sized firms with less than 1000 employees Large manufacturers had the best overall environmental performance with a mean score of 0.808 for all aspects, while small manufacturing suppliers had the poorest performance with a mean score of 0.725. Among all the environmental aspects, Pollution Prevention remained subject to the lowest levels of adoption for all suppliers.

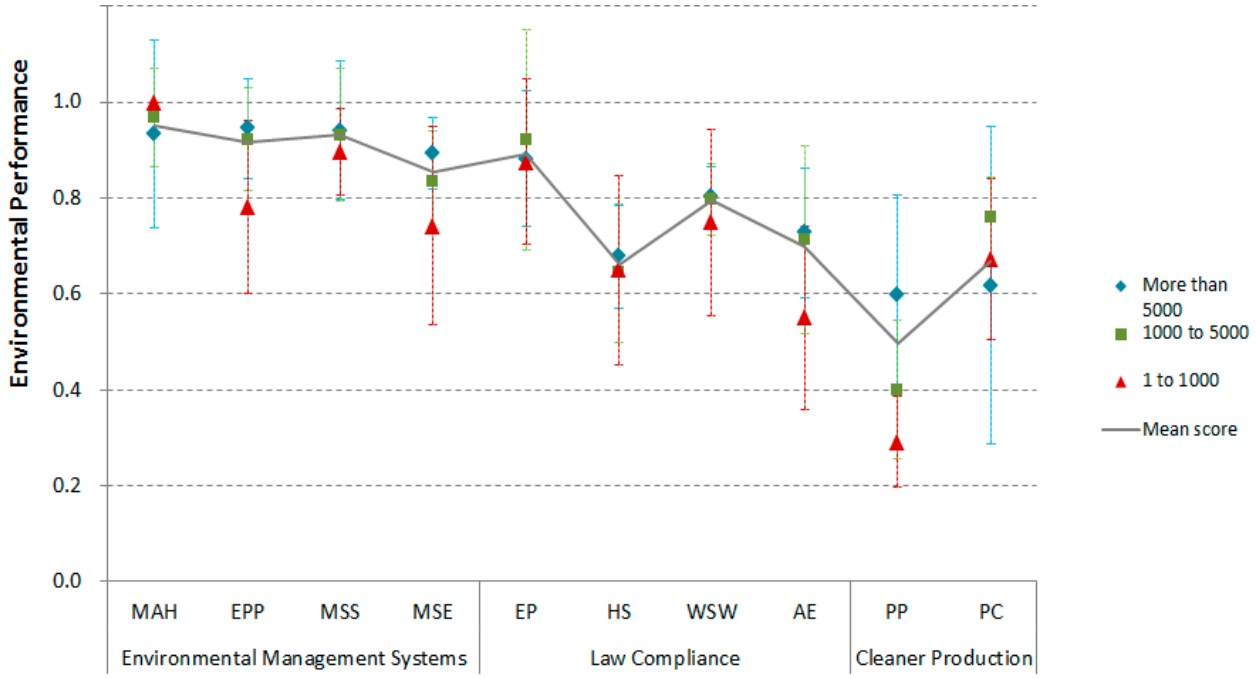

Figure 3. Environmental performance according to number of employees.

The ANOVA results of the data shown in Figure 3 indicate that overall environmental performance differed according to the number of employees in a statistically significant manner. Statistically significant differences in the results were evident for three environmental aspects: Environmental Policies and Procedures, Management System Elements and Pollution Prevention. Hypothesis 3 is thus supported by the fact that environmental performance, as well as several individual environmental aspects, shows a statistical difference between Tier 1 suppliers in the computer industry according to a firm's number of employees.

5. Discussion and Conclusions

Taking advantage of the existence of a standard indicator across Tier 1 suppliers in the computer industry, the EICC, we find that consideration of product type and number of employees offer some indication of expected environmental performance. Our findings also indicate that location alone may not indicate a firm's environmental performance and requires consideration of other firm characteristics to indicate likely levels of environmental performance. This result has implications for managers interested in implementing global Green Supply Chain Management strategies.

Among the criteria for evaluating environmental performance used in this analysis, we find that companies performed best in developing Environmental Management Systems, which tend to measure policy documentation and may or may not reflect actual operational protocols. The result is consistent

with Sullivan's study in large European companies; where the majority of the surveyed companies had a published environmental policy and management [52]. The next best performance across firms comes in the area of Law Compliance, a necessary cost of doing business. The adoption of Cleaner Production strategies is the least successfully realized of the environment dimensions, as it requires investment in technologies not yet proven economically.

Our results confirm that the type of product being manufactured or assembled makes a difference, which is consistent with the result of Zhu and Sarkis that GSCM adoption rates differ in various industries throughout China [53]. Inherent differences among product types can be cause for challenges from a business perspective. For example, storage suppliers demonstrated the highest level of environmental performance across product types. This mature industry reached profitability over the last decades by realizing economies of scale and as a result has become concentrated. Most storage suppliers are large multinational enterprises with years of experience in developing and maintaining environmental management systems. This concentration of large, experienced, firms goes far in explaining their superior overall environmental performance, the highest among product types.

Because of its intense capital requirements and a short product life cycle, the display industry is primarily comprised of large multinational enterprises, firms that generally demonstrate excellent environmental performance. Nonetheless, Product functionality and composition make a difference as well. For example, the display industry has intense material and energy requirements and a long supply chain involving complicated chemical processes along the way. Chemical formulae are frequently proprietary in the industry, making it difficult to identify and manage inputs or recycle product components. This contributes to the display industry's low score in the Product Content aspect, the result of the inherent difficulties in executing material integration in manufacturing, establishing recycling programs, and working with suppliers, all questions on the SAQ.

As a final example, power products are considerably more labor-intensive than other product types, have relatively low capital requirements, and do not generally experience rapid technological innovation. The power industry also obtained the lowest scores of all product types in most Environmental Management Systems aspects. The low score in this dimension indicates the technological constraints for products that accommodate standard electrical voltages 110–220 V. The general lack of technical innovation in this sector perhaps explains this sector's relatively low score in overall environmental performance.

Tier 1 Suppliers in the East Asian computer industry do form distinct clusters and thus should be amenable to direct comparison. For example: 60% of display and memory suppliers were located in Taiwan and 58% of storage suppliers were located in Other Asian Regions in this study. Conversely, some geographical regions were dominated by a particular product type. With regard to the data shown in Figure 2, the majority (70%) of the suppliers from Other Asian Regions were of the Storage product type. However, Christmann and Taylor argued that increasing globalization has made different cultures more similar [54]. Gradually, since suppliers in developing countries are aware of the pressures to implement environmental practices, this will help to further adoption at a higher level, as in development countries. Thus the high environmental performance scores for this region simply reflect the higher scores for the storage product type. As a result we conclude that the two classification schemes, product type and geographic area, may overlap and this result in the weak correlation we find between environmental performance and geographic location. We find more environmental aspects are

significant in our survey sample among different product types and the firm size. In other words, product type and firm size provide better indictors of a supplier firm's environmental performance in this study.

Regarding the correlation between firm size and environmental performance, our findings confirm that, after reaching a certain threshold in the number of employees, Tier 1 supplier firms showed improved environmental performance. While small-sized suppliers pay less attention to overall environmental implementation when compared to both medium- and large-sized suppliers. Though the superior performance for large sized suppliers raises standards for the industry as a whole, smaller firms are motivated to comply with the environmental requirements of their larger partners to maintain their place in the supply chain [49]. This result is supported by the resource-based theory that larger firms often have more financial resources and capabilities to handle environmental issues [55,56]. Yet not all aspects of environmental practice adoption have been found to be related to firm size [57], which is supported by our result.

This study is the first empirical study to date that analyses of quantitative measures based on EICC Code adoption. The original development of the EICC Code was intended to benefit the electronics industry and its suppliers by raising awareness, clarifying expectations, and enabling better assessment of supplier practices [58]. Drawing on the example of standardization in the electronics industry, the results of this research are intended to enable all manufacturers to make better decisions when trying to integrate GSCM practices into their standard operations. From an empirical standpoint, the purchase managers who select suppliers in the computer or electronic industries can benefit from identifying risks from EICC SAQ. Further, supply managers can benefit from understanding their environmental practices level through this study.

This study uses results from survey data describing the level of adoption of the EICC Code of Conduct; it does not verify the SAQ feedback externally. Future studies could sample the accuracy of individual SAQ responses through on-site audits. Other aspects worthy of exploration in future studies include investigation into: The relationship between environmental performance as measured by SAQ and measures of operational performance; The degree of correlation between product type, geographical area, and number of employees and supplier environmental performance in other industries; and Compliance rates for other CSR indicators such as labor rights, ethics, health and safety.

Author Contributions

Ching-Ching Liu designed and conducted this research; Ching-Ching Liu and Iddo Wernick analyzed the data and wrote the paper; Yue-Hwa Yu and Ching-Yuan Chang supervised the research. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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