Positive Influence of Green Supply Chain Operations on Thai Electronic Firms’ Financial Performance

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Abstract

Greening the supply chain is about integrating environmental thinking into the chains and their management activities that include reduction, recycling, reuse, and the substitution of materials. With increased public awareness and strict regulations on environmental and sustainability policy, green supply chain management (GSCM) is becoming increasingly important for many Thai firms, especially those in electronics industry. In this work, correlation between GSCM practices and financial performance of Thai electronics firms was investigated, based on evaluation of the firms’ current operational performance. A survey questionnaire was used as a self-assessment tool designed within the context of Thai electronics industry considering five main areas of supply chain activities (i) procurement, (ii) manufacturing, (iii) transportation and distribution, (iv) reverse logistics, and (v) greening process, based on integration of SCOR Model, SCM Logistics Scorecard, and GSCM concepts. About 50 respondents were collected as part of analysis. Factor analysis was subsequently conducted to identify main influencing factors from the total of 32 assessment items. From extraction based on GSCM concept, the main factors were 1) green manufacturing practice, 2) green logistics practice, and 3) green sourcing. Multiple regression analysis was performed to derive correlation between the extracted factors of GSCM practice and the firms’ financial performance. It was found that both the green manufacturing practice and the green logistics practice were strongly correlated with financial performance, but the green sourcing was not. Cost and complexity appeared to be the major obstacle to implementation of a successful GSCM. More cost effective and easier-to-implement solutions are still needed for future economic and environmental sustainability of the industry.

Keywords: Green supply chain management, Performance measurement, Financial performance, Electronics industry, Factor analysis

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1. Introduction

With increasing environmental awareness as seen from the strict regulations (such as WEEE and RoHS directives) of developed countries, governments, societies and business organizations cannot ignore to reduce environmental risks in the supply chain [1, 2]. These environmental regulations have directly impacted through the supply chain of the electronics manufacturing and related sectors in developing countries including Thailand. The electronics industry is one of the largest manufacturing sectors in Thailand that produce mostly for export goods. It is considered to be the major contributor of Thai economic growth in terms of investment and labor employment. Recognizing the importance of environmental issues, organizations have to adjust and improve the operational performance on the environmental management in correspondence to the environmental standard compliance. At the same time, organizations are also integrating their supply chain processes to minimize costs and maximize customer services under competitive and community pressures [3].

Green supply chain management (GSCM) has become a widely accepted tool to emerge as an approach strategy of enhancing competitive advantages in supply chain management [2 - 4, 9]. The GSCM practices concept is introduced for measurement of a firm’s competence involving management on environmental performance which is based on combination of green thinking such as green procurement, green design, green manufacturing, green logistics, green consumption and green recycling [3, 5 - 8, 10].

In order to maintain the competency of Thai electronics industry in part of expanding the opportunities of market share growth in international trade, making the organization’s function effectively to meet the customer needs completely, creating a good corporate image as corporate social responsibility (CSR) and so on. Thai electronics manufacturing firms must cope with such challenges in more efficient way. Accordingly, the consideration of the GSCM performance is initiated, and implemented by businesses. Result of performance evaluation from GSCM operations can be used to improve both economic and environmental performance of the organization.

Thus, this research aims to evaluate the current GSCM operational performance, as well as identify the influencing factors of adopting GSCM practices on Thai electronics firm’s financial performance. Factor analysis and multiple regression analysis were used for verifying negative or positive economic impacts. This paper is structured as follows. A brief review of literature on GSCM performance is mentioned in section two. The research methodology is described as a section three. Data analysis and result are presented in section four. Conclusions and discussions of finding are given at the final part of the paper.

2. Literature reviews

2.1. GSCM practices

From environmental issues, there is attempt to develop such green practices in every industry. The research on the integration of green supply chains regarding environmentally-friendly aspects [7, 11]. GSCM could be labeled as technique managerial that is gaining increasing interest among researchers and practitioners of operations and supply chain management [12]. The growing of GSCM practices is applying management strategies in supply chain and operational performance to minimize environmental impacts of products [2, 13]. The term of GSCM was defined as a way of initiative improvement, covers supply chain activities from the procurement of raw materials for product design, manufacturing processes to delivery final products and also relates to reverse logistics in reducing sources of wastes [7]. Moreover, this can involve all business partners such as material suppliers, service contractors, distributors and final users to reduce environmental risks from their activities [3]. To improve the supply chain more effectiveness, it is required to assess the performance of GSCM measurement. In general, the performance measurement at the supply chain level can be explained as the managerial process, the efficiency and effectiveness in action quantitatively and/or qualitatively for identifying potential problems, controlling progress and providing possible future operations. [14]. Positive correlation between GSCM practices and manufacturing sustainability has been detected in Malaysian firm [8]. Long-term benefit can be achieved after improving the GSCM performance.
2.2. GSCM performance and its correlations on financial performance

The GSCM performance is one application-focused area of the performance measurement that has been receiving increasing attention in the literature of various industries. The overall goal of GSCM practices is to improve environmental performance of the supply chain and industry as a whole with balancing financial performance [3]. With an example of food company researched by Ala-Harja and Helo, successful green supply chain operations can improve the logistics efficiency leading to cost saving in transportation process [15]. Three main decisions includes (1) supply chain structure (2) logistics media and (3) planning and timing structures are proposed with expected emission impact and related cost. Apart from food industry, Sharma [22] attempted to adopt the GSCM practices in the electrical and electronics industry in India. It becomes distinguish from this study that successful implementation of GSCM has major impact on firm’s environment performance and gain long-term potential savings, however, some negative effect has been identified among economic performance regarding increased investment and costs during the initial stage of GSCM implementation.

Regarding Thai computer parts’ manufacturer, effective and efficient GSCM are found to be obtained through strong collaboration among important stakeholders [19]. Improving GSCM through, for example, promoting eco-design, controlling hazardous substances, set rules of disposing, propagate GSCM knowledge, expand product lifespan are introduced. However, the correlation between those practices and firm’s financial performance are remain doubtful.

From previous researches, there are several samples of GSCM implementation and its linkage to other performance, such as, operational performance, environmental performance, cost performance etc. Nonetheless, limited research has attempted to investigate relationship between GSCM performance and actual firm financial performance, such as, ROA, Inventory turnover ratio, Operating cost ratio, Net profit margin, Asset turnover ratio, etc. This paper examines the impact of the GSCM factors on selected financial ratio where electronics industries in Thailand are chosen as case study. The result maybe vary from industry to industry but similar approach can be replicated to investigate result from different business.

3. Methodology

3.1. Data collection

Data collection of this study focused on sampling companies in the Thailand electronics industry. By using a survey questionnaire as a self-assessment of a five-point Likert scale designed within the context of Thai electronics industry, 5 main areas of supply chain activities, including procurement, manufacturing, transportation and distribution, reverse logistics, and eco-friendly, were considered based on integrating SCOR Model, SCM Logistics Scorecard, and GSCM concept. In this paper, assessment items of Thai electronics industry’s performance measurement from existing questionnaires [17, 18] was applied, totalling 32 assessment items.

3.2. Factor analysis and multiple regression analysis

Factor Analysis (FA) method was used for the analysis of GSCM operational performance. An exploratory factor analysis was conducted to derive groupings of GSCM practices, using the maximum likelihood method followed by a varimax rotation for the factor extraction. The Kaiser criterion (eigenvalues>1) was employed in conjunction with an evaluation of scree plots. The empirical of factor analysis demonstrated the correlations among GSCM attributes in term of the relatively factors in order to summarize a significantly factor. Multiple regression analysis was also conducted for verifying operational performance of green supply chain adoptions which negatively or positively impact on financial performance. Results are presented in the following section.
4. Data Analysis and Discussion

A total of 50 valid and usable manufacturer responses were received for data analysis. The data attributed of total score are given in Table 1. And the result are shown in term of Cronbach’s coefficient alpha for 32 assessment items at 0.901 which these results indicate high reliability of the GSCM Operational Performance Measurement as a data collection tool for this research. For the evaluation of the number of questionnaire’s confidence, Taro Yamane’s method will be used as a tool. The result revealed that the confidence value of the number of questionnaire is approximately 90% which is slightly lower than the standard criteria. In addition Kaiser-Meyer-Olkin (KMO) at 0.600 which these results indicate high appropriate for factor analysis and Bartlett’s Test of Sphericity by significant at 0.000 these results indicate factors were correlation matrix are given in Table 2. After delivering questionnaire, a GSCM Operational Performance Measurement survey is the research instrument and invitations to complete this survey were sent out by email, interviews, and letter. There are 225 factories which involve with electronics industry in Thailand and they are also members of electronics industry council of Thailand. The total response to questionnaires is 50 factories which equivalents to 22.22 % of total amount. Mostly of respondents are from 2nd-Tier Suppliers & 1st-Tier Suppliers (Components and Modules).

The results of decisive areas comparison on GSCM Operational Performance Measurement score as shown in Table 3 and Fig. 1. (a) and (b) The radar chart represent average score total 32 sub-items collected from initial comparison of 5 decisive areas which included procurement, manufacturing, transportation and distribution, reverse logistics and eco-friendly. These are average scores of process management by GSCM self-assessment of respondents. For areas of procurement, manufacturing, and transportation & distribution are mainly concentrated in supply chain. Other decisive areas, reverse logistics and eco-friendly focused on environmental aspects. Among the operational firm’s performance of GSCM adoptions within assessment of 5 main areas, the manufacturing, reverse logistics and eco-friendly area obtained the top score respectively. This result indicated that electronics and electrics industries in Thailand pay attention on improving internal process to be environmental friendly instead of focusing on inbound or outbound trading partner.

| Table 1. Data attributes of total score from Thai electronics firms. | Value |
|---|---|
| Items | |
| Demography of respondents | |
| 3rd-Tier Suppliers (Semiconductor and Wafer Fabrication) | 4% |
| 2nd-Tier Suppliers & 1st-Tier Suppliers (Components and Modules) | 56% |
| Hard disk drive (HDD) | 22% |
| Finished goods manufacturer | 18% |
| Demography of respondents | |
| Mean | 119.26 |
| Median | 119 |
| Mode | 122 |
| Standard Deviation | 15.69 |
| Variance | 241.19 |
| Minimum | 86 |
| Maximum | 150 |
| N=50 | |

| Table 2. Data attributes of KMO and Bartlett’s Test. | |
|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | 0.600 |
| Bartlett's Test of Sphericity | |
| Approx. Chi-Square | 1028.753 |
| Df | 496.0 |
| Sig. | 0.000 |
Table 3. Average scores of 5 decisive areas in Thai electronics firms.

| Decisive area                        | Average | S.D.  | Min.  | Max.  |
|--------------------------------------|---------|-------|-------|-------|
| 1) Procurement                       | 3.516   | 1.013 | 2.460 | 4.140 |
| 2) Manufacturing                     | 3.943   | 0.919 | 3.160 | 4.460 |
| 3) Transportation and distribution   | 3.285   | 1.141 | 3.040 | 3.440 |
| 4) Reverse logistics                 | 3.905   | 0.926 | 3.180 | 4.340 |
| 5) Eco-friendly                      | 3.903   | 0.923 | 3.220 | 4.600 |

4.1. Factor analysis results

The results show that three component factors by result from the first factor signified that 11 sub-items were extracted with the variance rate of 36.411% and result from the second component factor signified that thirteen sub-items were extracted with the variance rate of 12.318% and result from the third component factor signified that eight sub-items were extracted with the variance rate of 6.786%, as shown in Table 4. The key three extracted factors of GSCM practices were labeled as new series, namely 1) green manufacturing technology practice, 2) green logistics practice and 3) green sourcing strategy.

**Factor 1: Green Manufacturing Technology Practice**, which is the most important aspect for electronics industry in Thailand. This factor affects operating achievement based on green supply chain. In this factor, it will concern about component in setting systematic manufacturing and technology in order to reduce the waste production or fulfill its highest capability. Plus, factories should regard and develop all steps to be friendly to environment. And so on.

**Factor 2: Green Logistics Practice**, which is lesser important aspect than factor 1 for electronics industry in Thailand. In this factor, reverse logistic will concentrate on properly receive raw material back from customers or manufacturing process due to hazardous and durable wastes control. Electronics industry products are related to metal, lead, iron, colorant and chemicals which are persistent and threat to environment. In order to improve the procedure in green supply chain management, eco design should be involved in every step of activities inside the factories. And so on.

**Factor 3: Green Sourcing Strategy**, which is the least important for electronics industry in Thailand. In this factor, all details in manufacturing process will be regarded beneficial to procurement will focus on raw material acquirement and packaging which can recycling or reuse in reprocess.
| Assessment Items                                                                 | Factor Loading |
|--------------------------------------------------------------------------------|----------------|
| 1-1. The purchased products are friendly to environment and environmental harmful |                |
| products are avoided.                                                          | .334           |
| 1-2. The purchased raw material can be reused or recycled.                      | .103           |
| 1-3. The purchased raw material are produced from excess and environmental      | -.201          |
| friendly.                                                                      | .284           |
| 1-4. Consideration for procurement and selection of raw materials based on cost,|                |
| quality, and environmental impacts.                                            | .373           |
| 1-5. The concern on environmental management of provider.                       | .267           |
| 1-6. The concern of carbon dioxide releasing of provider.                       | -.115          |
| 1-7. The computer network is used instead of papers in marketing between vendor|                |
| and factory (Paperless).                                                       | .616           |
| 1-8. The distance between vendor and factory is minimized in order to reduce    | -.050          |
| pollution and cost.                                                            | .512           |
| 1-9. The provider has received ISO 9000 and ISO 14000.                          | .131           |
| 2-1. Corporate strategy regarding renewable energy and its importance to support|                |
| in manufacturing.                                                             | .284           |
| 2-2. Reducing carbon dioxide emission in manufacturing process.                 | -.041          |
| 2-3. Strategic planning the preventive maintenance of machines.                | .822           |
| 2-4. The pollution reducing system in producing process is operated            | .519           |
| 2-5. The clean manufacturing technologies are applied                           | .596           |
| 2-6. Control and emission pollution of heavy metals into water resource        | .502           |
| 2-7. Reducing energy consumption cost.                                         | .585           |
| 2-8. Cooperate with employee regarding energy preservation for cost saving     | .361           |
| 3-1. The factory is concerned about the fuel consumption in distribution        | -.004          |
| includes measuring the carbon dioxide emission.                                | .439           |
| 3-2. The delivering vehicles are well checked and maintenance plan are         | -.082          |
| available.                                                                     | .698           |
| 3-3. The full truck load system is applied to increase the effectiveness of    | -.211          |
| product delivering.                                                            | .585           |
| 3-4. The delivering routes are determined to safe the fuel and reduce the      | -.079          |
| pollution.                                                                     | .831           |
| 4-1. The waste for production can be reused or recycled.                        | .820           |
| 4-2. The used products from customers are recycled.                             | .163           |
| 4-3. The used packaging are reused.                                             | .159           |
| 4-4. Strategic planning for optimizing waste treatment and disposal system     | .737           |
| based on legal procedure.                                                      | -.041          |
| 5-1. Control and decreasing the consumption of hazardous and toxic substance   | .631           |
| in raw materials.                                                              | .211           |
| 5-2. The environmental friendly products are designed.                         | .304           |
| 5-3. The wasted water generated from whole facilities are neutralized and     | .385           |
| reused.                                                                       | .473           |
| 5-4. The wastes from all manufacturing failure are well managed.               | .449           |
| 5-5. Promoting and improvement of occupational health and safety in the        | .698           |
| workplace.                                                                    | .055           |
| 5-6. The thought of environment responsibility is implanted to employee.       | .412           |
| 5-7. Communication with customer in order to make them realize the importance  | .326           |
| of environmental friendly products.                                             | .336           |

| Initial Eigenvalues | 11.652 | 3.942 | 2.170 |
|---------------------|--------|-------|-------|
| Variance (%)        | 36.411 | 12.318| 6.780 |
| Cumulative (%)      | 36.411 | 48.729| 55.509|
| Cronbach’s Alpha    | 0.956  | 0.933 | 0.932 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Among the operational firm’s performance of GSCM adoption within assessment of 5 main areas, the manufacturing area was the highest score in term of its association with environmental performance, whereas the transportation and distribution was the lowest score. Beside the factor extraction results of significant GSCM factors were determined by factor analysis, namely 1) green manufacturing technology practice, 2) green logistics practice, and 3) green sourcing strategy. In addition, this paper also found that green manufacturing technology practice and the green logistics practice have significant relationship with financial performance, especially result with only efficiency operating cost ratio per revenue, among electronics industry in Thailand. In contrast, green sourcing strategy had not significant influential on financial performance. The regression analysis each performance indicator shown on the chart below as result shown in Fig. 2.

![Fig. 2. Influence of adopting GSCM practices on firm’s financial performance of Thai electronics industry](image)

\(X = \text{Green Manufacturing Technology Practice}, Y = \text{Green Logistics Practice}, \text{and} Z = \text{Efficiency Operating Cost Ratio}\)

As the result, it indicated that even if firms focused implementing only the green manufacturing technology practice, their relationships to financial performance gives rise to operating cost will be increased which the possible reasons might be from the high initial cost of technology system [20]. Thereby, they need to add include the implement of green logistics practice to help moderate cost saving.

5. Conclusions

The overview of current operational performance among Thai electronics industry was carried out. Mostly, they paid attention to promote GSCM operational performance in manufacturing areas to fulfill consumers’ requirement and compliance regulations. However, their operational performance practice may not be as clearly effective in profiting financial performance. It was suggested that firms should implement continuously the green practice for balancing better their financial performance. These main factors if considered seriously for GSCM sustainable implementation will also solve other sub factors. This will definitely lead to enhanced performance and long-term benefits for the company. In addition, obstacles to the GSCM development (such as fear of large investments, cost and the lack of knowledge etc.) can be avoided, even if Thai electronics firms understand the GSCM concept and proper GSCM implementation. With the right knowledge, they can gain the better operational performance and great advantages in the future for both economic and environmental performance [10, 21].
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