

Role of Green Supply Chain Management Strategies in Sustainability: Evidence from Manufacturing Industry of Thailand

Witthaya Mekhum^{*1}

^{*1} *Suan Sunandha Rajabhat University, Bangkok, Thailand*

Corresponding author: E-mail: witthaya.me@ssru.ac.th

Abstract- The study is motivated to estimate role of supply chain management strategies in environmental sustainability. Manufacturing companies of Thailand were selected for the study due to their diverse effect on the environment. Further, role of supply chain management strategies in sustainability has not been thoroughly discussed in developing countries. A questionnaire has been adopted to measure the responses of employees involved in supply chain of manufacturing firm in Bangkok. Structural equation modelling has been adopted to estimate the role of different supply chain management practices in sustainability of environment. The overall results of the study indicate that facility, inventory, information, sourcing, pricing, and transportation have a significant and positive role in sustainability. The interaction of information technology as moderator in the model improves the model strength. Among all of them, inventory management has the highest contribution for sustainability of green initiative in manufacturing enterprises. Effective inventory management tools reduce wastage and protect the environment promptly. Supply chain and inventory procurement managers should develop green supply chain management, remanufacturing, lean production, applications of six-sigma practices, and environmentally friendly package to make sure a safe and protected environment.

Keywords; *Sustainability, Green Supply Chain, Manufacturing, Thailand.*

1. Introduction

Supply chain management has been emerged as an integral part of business strategy to attain competitive advantage [7]. Past research has distinguished the significance of supply chain management in accomplishing an incorporated business efficiency [4]. Recently, a surge in adopting supply chain practices to attain competitive advantage has been witnessed. The main objective of a business firm is to increase the value of company whereas supply management helps to achieve business goals with efficiently using and deploying the business resources. It connects the suppliers and customers by adding values in the business activities [29].

However the major activity of a business is to receive raw material from its suppliers and convert the raw material into product by value addition and sell to customers [8]. A supply chain incorporates every stakeholder that included in satisfying customer demand [7]. Successful supply chain is considered an essential element of business strategy to achieve sustainable competitive advantage. However, there is a need to adopt green supply chain management strategies for sustainable business environment.

The focus on green supply chain management has captured the attention of researchers and environmentalists to maintain environment sustainability. The central objective of green supply chain management is to integrate sustainable environment philosophy in supply chain practices to protect the environment by reduction wastes and pollution. Various organizations involve green supply chain initiatives to get advantages of reduced cost, increase profit, and retain stakeholder values that make sustainable competitive advantage

[16] The manufacturing companies collaborate with logistics service providers, supply chain partners, customers, and suppliers to get effective command over the competitive position of a company.

The manufacturing production in Thailand is growing with the passage of time. However, the manufacturing industries are facing severe issues regarding environmental sustainability [13]. Both consumers and environmental groups have concerned about environmental impact, global warming, and sustainability of products and services in the marketplace. The manufacturing firms are under pressure due to increasing awareness of environmental sustainability [12]. In this regard, the supply chain management drivers are production, inventory, information, transportation, and location. Such drivers develop sustainability goals for manufacturing firms to maximize protective measurement of environment developed [4].

To reduce sources of waste and pollution for overall supply chain, the manufacturing firms initiated to adopt an externally-oriented approach that maximizes the utility of green supply chain initiatives. Such extended responsibility comprises organization downstream and upstream likewise closed-loop supply chain, green supply chain, and product stewardship [12; 19]. Thus, green initiatives and supply chain

management drivers unleash the possibility of sustainability in manufacturing enterprises specifically in Thailand.

The current research study focuses on green initiatives in manufacturing enterprises of Thailand. The Thailand Government enforced environmental regulations and green initiatives to address the scarcity of resources and environmental issues. The study of [8] examines supply chain management drivers that foster the sustainability of the environment and took a proactive approach. The previous literature ponders green supply chain management relationship with organizational performance and strategy [25]. The adoption of green supply chain initiatives protects environment and foster development of efficient supply chain management [28]. This study is significant and unique in nature that inspects a relationship between supply chain management drivers and initiatives of the green supply chain in Thailand. Moreover, a moderating effect of information technology has also been proposed to measure its role in improving effectiveness of SCM strategies towards sustainability. For this reason, a research model proposed whereas various factors of green supply chain adopted among different manufacturing firms in Thailand. In the following section, a rationale for green initiatives in manufacturing enterprises explored to intimate how SCM strategies pursue sustainability goals in the presence of information technology. In second section, relevant literature and conceptualization of supply chain management drivers demonstrated. Further, a set of hypotheses, research methodology and discussion on results has been presented. In the final section, managerial implications of the research findings identified for this study to conclude research parameters in an effective manner.

2. Literature review

Supply chain management is the movement of goods from one place to another through different activities and processes. The supply chain activities and processes include suppliers, warehouses, transportation, distribution, purchasing, manufacturing centers, and retail outlets [21]. It encompasses planning as well as management of logistics, sourcing, and procurement of goods and services. The key processes of supply chain include order fulfillment, product development, returns management and customer relationship management. These functions corroborate with the supply chain management. Thus, the major supply chain management drivers include inventory management, transportation, purchasing of product, information, and facilities services. However, such drivers may also pursue for sustainability of the environment. For instance, increased awareness regarding environmental sustainability pressurized the manufacturing firms to adopt green practices [6].

The central focus of supply chain management in terms of sustainability is environmental sustainability. Therefore, all the green initiatives under supply chain management like reverse logistic, green product, green logistics mainly focus to achieve environmental

sustainability [28]. Different examinations uncover that waste management and reusing of products introduced sustainability. A proactive sustainability approach can be adopted by recycling the items throughout the supply chain process. Hence, the ramification of green activities to reinforce sustainability is the best choice. Accordingly, competitive advantage which is the significant element for companies to survive in the competition can be attained through sustainable supply chain management [1].

3. Green Supply Chain Management Drivers

The controlling practices for green supply chain includes recycling, remanufacturing, reverse logistics, reclaim, and refurbish. These practices reflect effective tool of waste minimization. Green initiatives in the supply chain had gained popularity in both practitioners and academics to reduce waste as well as preserve quality of product lifecycle [10; 11; 26]. According to [9], there are certain key drivers for green initiatives in manufacturing enterprises.

3.1. Government Compliance

It is true that the climate is changing that impose a severe impact on the environment. The government regulations are finding standards of production capacities to go green. However, go green does not mean to make a strategy of the supply chain but also focus on cleaning water consumption and alternative source of energy to minimize the impact on environment [23]. In this regard, the Thailand environmental protection agency takes necessary steps to prevent pollution and ensure sustainable practices for the industrial revolution.

3.2. Financial Performance

The financial performance is another key driver for implementing green initiatives. The implementation of green practices for instance customer relationship and cooperation, eco-friendly designs purchase and use of green material, lean practices, six-sigma, just-in-time and continuous improvement will not only impact the environmental sustainability but also improves the operational performance with ultimately affects the financial returns. The companies work with trading partners and share information to match demand and supply accordingly. Therefore, manufacturers became able to achieve visibility in the supply chain.

3.3. Reverse Logistics

The main aim of reverse logistics is to ensure products are returned to producers in order to recondition or recycled [24]. Within reverse logistics, the supply chain process follows the opposite direction. In this regard, reverse logistics denotes a set of planning and execution for the finish or raw material with the aim of recycling and recovering those materials or products [1]. Thus, easy access to information, good warehouse layouts, and standardized reusable containers lead to environmentally sound [14]. Having a reverse logistics process set up, shippers acquire proficient advantages including: Improved reverse supply

chain perceive-ability, expanded profitability, and more noteworthy responsiveness to clients

3.4. Supply Chain Efficiency

The manufacturing firms specifically integrate with the supply chain to reduce lead-time and cost as well. The most common enemy of the environment is the production and manufacturing industries that produce toxic gases and pollute the environment [4]. For this reason, manufacturing enterprises articulate environmental stewardship and ethical sourcing to retain green initiatives of supply chain sustainability [8].

3.5. Corporate Responsibility

The green initiatives of the firm are strongly tied with corporate social responsibility because it is an obligation of the company to manage investors, stakeholders, environment, and society as well. ISO 14000 standard for environmental management system set benchmarks for green initiatives. Both companies and government concerned with sustainability issues but follow standardize environmental compliance to reduce pollution and waste to the environment. The green policy constantly looks for improving green credentials under lean quality initiatives [15].

4. Green initiatives in manufacturing enterprises of Thailand

Green business practices, Green supply chain initiatives, and environmental sustainability have increased attention in Thailand manufacturing industry. The dominated objectives of green initiative within manufacturing firms are to protect the environment. In Thailand, the ecological conditions thought to be an important component while producing goods. The item life cycle inside natural practices incorporate reusing, clean generation, limit the cost of assembling, transfer of items, and eco-plan of creation. The green initiatives accentuates on shut circle tasks, for example, recycling and recuperation with the objectives of cleaner transportation, deploy environmental technology, the supply chain for pollution prevention, and reduce waste [16; 22; 30]. The existing literature acknowledges the value of green initiatives as well as the internal capability of the firm, because internal operations depicts how the firm attain lead-time and reduced cost infrastructure as contented by various researchers [21; 20] but the contemporary role of upstream suppliers remain disrupted [19]. Towards ecological and environmental responsibility, the manufacturing organizations in Thailand are continuing to implement recycling, reuse, and remanufacture used products. It reflects the sustainable role of supply chain management. Various industries in Thailand such as are developing waste handling prohibitions, disposition of electronic waste, and encourage incentive programs for recycling or disposal of goods. According to Paul et al. [23] green product design influence on the environment and some regulations to minimize wastage during the production of goods. Following are

the list of companies that implement environmentally sustainable structure in their manufacturing processes.

5. Supply Chain Management Strategies

5.1. Facility Management

The facilities could be effectively managed to unleash the potential of green initiatives in the manufacturing enterprise. However, effective supply chain management planning decrease cost and faster services in facilities. The facilities management creates values for internal customers. Furthermore, the long-term facility management builds strategic relationship between provisions and business needs of facilities [5]. The actual meaning of facility is physical placement of finished goods, work in process material, and raw material in store rooms and warehouses. In this regard, more efficient or more responsive facility management required to get better and quicker access to products near to the customer [17]. Thus, warehousing facilities near to distributor location minimize cost, time, and fewer resources utilize. In this way, the green initiatives can be achieved. This research contended that:

H1: Facility management has a significant role in supply chain management sustainability.

5.2. Inventory Management

The larger inventory incurred huge cost to store finish goods and disseminate into the marketplace. The manufacturing companies hire professionals to procure required inventory and ensure effective collaboration with suppliers to minimize stock levels [24]. For this reason, Vendor Management Inventory (VMI), Just-in-Time, and lean manufacturing considered to achieve supply chain sustainability goals. Moreover, four approaches for inventory can be purposeful if they applied at right time with the right place. Such approaches include reverse inventory consignment, inventory speculation, inventory consignment, and inventory postponement [15]. The manufacturing organizations can adopt any one of inventory approach to forecasting in customer demand, bargaining power of organizations, and supply line comparative to its supplier that inspect in the research of [2]. Hence, this research hypothesizes that:

H2: Inventory management has a significant role in supply chain sustainability.

5.3. Transportation Management

A better transportation approach for manufacturing company is necessary to reach the destination in a timely manner. A Joint route planning can be achieved by outsourcing transportation function. The manufacturing firms contract with third parties to provide transportation services to remain focus on production and sustainability goals. A smart transportation management system required to meet delivery requirements. This model includes smart infrastructure, smart vehicle, and smart freight as well

[27].

H3: Transportation management has a significant role in supply chain sustainability.

5.4. Sourcing of Raw Material

The green sourcing of raw material helps the companies to address the goals of sustainability. Green outsourcing has positive relationship with supply chain management. There are four key strategies adopted by manufacturing firms to get the optimal level of operations. Focus, scaling without mass, disruptive innovation, and strategic repositioning resolve sourcing issues [9]. The manufacturers adopt green sourcing option with key sourcing strategy to speed-up business operations in a sustainable manner.

H4: Sourcing has a significant role in supply chain sustainability.

5.6. Pricing Strategy

Strategy mix pricing and linear pricing approach aligns with the correct pricing, whereas both customer and supplier can be satisfied. The company objectives aligned with pricing strategy to remain sustainable in the business operations. Geographical pricing, markup pricing, and bundling can be beneficial to facilitate effective supply chain management [9].

H5: Pricing has a significant role in supply chain sustainability.

5.7. Role of Information Technology

The process of exchange of information between customer and supplier give desirable information to meet the effectiveness of supply chain management. Thus, a continuous conversation with customer helps to develop strategy and maximize the goals of green initiatives [28]. When all stakeholders have symmetric information then there will be less chances of uncertainty. A business information system developed inside the organization to forecast supply and demand and ensure firm sustainability. Use of information technology in supply chain management to control the flow of information for timely decision making brings the transparency in the overall system [16]. Hence, It permits the manufacturing organizations to have better command over item stream and data stream over the supply chain which helps to monitor the green activities for sustainability. Keeping in view the above discussion this research contented that:

H6: Information Technology plays a significant role in improving the effectiveness of supply chain management strategies for sustainability.

6. Research Methodology

The current study adopted quantitative research approach to find the answer of the problem raised in this research. Structured questionnaire was developed to collect responses from selected respondents. All the manufacturing companies in Bangkok were selected in the study sample. The data was collected through survey questionnaire and that questionnaire adapted from [18].

The supply chain sustainability can be determined by supply chain management strategies. Hence, we include all five supply chain management strategies to measure its role in suitability. All responses were collected on a five-point Likert scale. The unit of analysis for the current study was employees working in manufacturing enterprises in Thailand were considered to investigate the sustainability of supply chain management strategies. The data had been collected from supply chain managers, procurement managers, inventory management staff, and warehouse managers. In this way, it was easy to examine the supply chain activities in various manufacturing enterprises. Simple random sampling technique was adopted to select managers randomly from manufacturing enterprises. In total 320 employees were contacted for the data collection and 303 questionnaires were found complete in all respect and selected for further data analysis. The response rate is 94.68% which was sufficient and adequate to ensure generalizability of study results.

Table 1. Descriptive Statistics

Varia	Mean	S	K
Sustainability	4.11	-1.61	-1.371
Facility	4.52	-1.873	-1.535
Transportatio	4.12	-1.974	-1.435
Inventory	4.74	-1.583	-0.974
Sourcing	4.33	-1.566	-0.933
Pricing	3.99	-1.483	-0.844
Information Technology	3.01	-1.438	-0.982

The reliability analysis was also applied to determine the internal consistency of respondents. The Cronbach's alpha was calculated for every variable. The values of Cronbach's alpha represent that all variables are in acceptable range of more than 0.7.

Table 2. Reliability Analysis of Construct

Variables	Cr	No
Sustainabilit	0.811	13
Facility	0.873	15
Transportat	0.901	24
Inventory	0.847	15
Sourcing	0.912	10
Pricing	0.844	10
Information	0.873	16

The validity analysis was taken to determine the constructive and convergent validity of instrument. The loading value of each variance and variable were analyzed and calculated. All variables loading values are under 0.7, whereas squared loading value is greater than 0.5.

Table 3. Validity Analysis of Construct

Variables	Compo site Reliabil ity (CR)	Average Variance Extracted (AVE)
Sustainability	0.841	0.810
Facility	0.955	0.842
Transportatio	0.841	0.744
Inventory	0.947	0.887
Sourcing	0.811	0.784
Pricing	0.843	0.810
Information	0.945	0.819

The construct validity of instrument has been analyzed through calculation of square root of average variance extracted. Thus, the square root of AVE is greater than scale of variables and it is acceptable.

Table 4. Convergent Validity of Construct

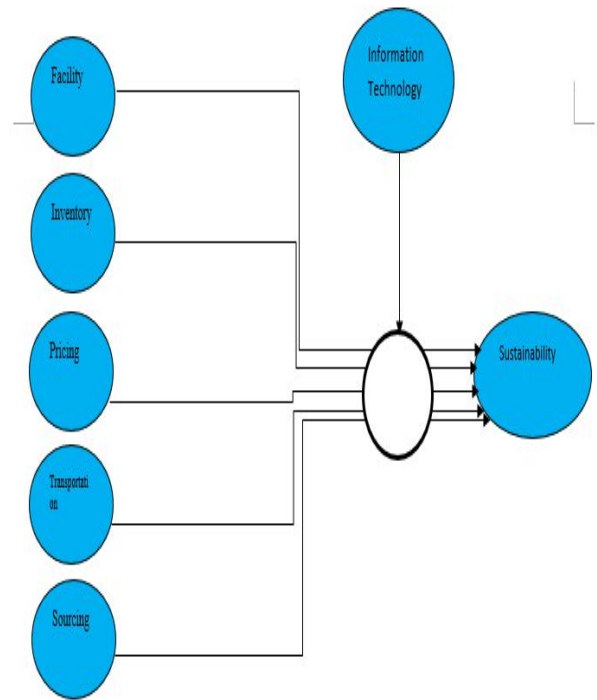
Variables	Squa	AVE
Sustainability	0.900	0.810
Facility	0.917	0.842
Transportation	0.862	0.744
Inventory	0.941	0.887
Sourcing	0.885	0.784
Pricing	0.900	0.810
Information Technology	0.904	0.819

Research Findings and Discussion

The descriptive statistics has presented in the table 1. The supply chain management strategies have used as a measurement of supply chain sustainability as well as execution of green initiatives. The minimum, maximum, and mean values have been calculated to give an overview of responses. It has been noted that inventory has the highest value of mean as compared to all other variables. Furthermore, the kurtosis and skewness were calculated to investigate the normality of data. All variables lie under the standardized value for kurtosis and skewness.

Further structural equation model is applied to analyze the contribution of supply chain management strategies in sustainability. Figure 1 illustrate the path diagram and corresponding variables. The statistics of structural model is presented in Table5. Here we develop two models naming model 1 and model 2. Model 1 corresponds the independent variables and dependent variable sustainability to measure the relationship or contribution of green supply chain practices in achieving sustainability. It is noted that all the SCM strategies have a positive and significant effect on suitability. Further, model 2 is used o capture the effect of moderator variable i.e. use of information technology in supply chain management. The moderation effect is present in the model if the R2 changes significantly [3]. We noted that while observing the change in the value of R2, it changes from 0.712 to 0.793. this shows that the interaction on moderator term strengthen the

model. Hence, it is confirmed that use of information technology plays a significant role in improving the affect supply chain management practices in improving the sustainability goals. The result shows that beta coefficient for transportation accounts for 0.39. The beta coefficient of pricing has the lowest contribution for sustainability (0.33). Conversely, inventory has the highest beta value in the model (0.47). While sourcing and facility has the 2nd and 3rd highest values respectively (0.45, 0.43). The Table 5 illustrates that all the results are statistically significant.

**Figure 1.** Structure Diagram**Table 5.** Regression Results

Model	Variables	Coefficient	R ²	ΔR ²	p-value
Model-1	Transportation	0.37	0.712	0.81	0.00
	Sourcing	0.44			0.002
	Pricing	0.31			0.31
	Inventory	0.45			0.00
	Facility	0.41			0.00
Model-2	Transportation	0.39	0.793	0.81	0.00
	Sourcing	0.45			0.00
	Pricing	0.33			0.019
	Inventory	0.47			0.00
	Facility	0.43			0.022
	Information Technology	0.32			

This study aims to examine the green initiative sustainability in manufacturing enterprises. The role of SCM practices on sustainability was measured. The results of the study proved that drivers of the supply chain have a significant impact on supply chain sustainability to remain environment protected. Close facility location to distribution, effective replenishment of inventory, easy of information to suppliers and customers, transportation management with short routing logistics, green sourcing,

and suitable pricing approach lead to sustainability of supply chain activities [21; 14]. The study indicates that manufacturing enterprises interest in inventory management because it influences market position. The findings of inventory management have consistent with literature findings because effective management of inventory reduces waste and ensure prompt response of recycling that confines in [17]. The paper suggests that manufacturing companies should focus on green drivers of the supply chain to enhance manufacturing capacities and satisfy potential stakeholders.

Moreover, the other drivers such as facility, information, and sourcing have positive relationship with the sustainability of green initiative. Therefore, it should be known that sustainability can only be derived from focus on supply chain drivers [28]. It has been notified from research results that drivers of supply chain have positive influences in the sustainability of manufacturing firms of Thailand [4]. Therefore, supply chain managers and procurement managers should understand the importance of green initiatives such as reverse logistics; reduce carbon footprints, recycling of disposed of goods, and lean manufacturing. The improvement in manufacturing capabilities will increase production capacities of Thailand and ensure preventive measurement to protect environment [15].

7. Conclusion and Recommendations

The sustainability of green initiatives in manufacturing firms of Thailand is growing with the passage of time. The persistence of the current study is to provide a brief overview of supply chain management drivers and their contribution to sustainability. It indicates that the sustainability of supply chain management reduces the ecological impact on manufacturing enterprises. Much research has conducted on drivers or motivators to seek how improvement in supply chain activities drives sustainability and protects the environment. For this reason, green manufacturing, reverse logistics, lean manufacturing, recycling, and green operations can lead excellence within a role of supply chain management. A manufacturing enterprise supply chain needs a balance between responsiveness and efficiency of organization competitive strategy. The whole study concluded the drivers of supply chain management included facility, inventory, information, transportation, sourcing, and pricing contributes in environment sustainability. Such drivers are closely related to sustainability and have greater impact on organizational performance. Research findings suggested that drivers of supply chain unleash the goals of green initiatives to go green effectively with the protective environment. Further, use of information technology is very important in enhancing the significance of supply chain management practices to achieve suitability.

The manufacturing companies should look forward to sustainability goals and protect the environment. Therefore, green initiatives within supply chain management should be opted to retain environmental sustainability in an effective manner. The green

supply chain activities include recycling, Just-in-time inventory system, remanufacturing, lean production, applications of six-sigma practices, and environmental compliance embedded with product end-of-life practices, total quality environmental management, green procurement, environmentally friendly package, green design, and effective transportation routing. The manufacturing industries in Thailand are moving into advanced era of expansion that strongly needs sustainability in the manufacturing concern. The study described strong motivation towards green manufacturing and green sourcing. Such aspects consider superior green initiatives to protect and safe environment. Finally, the manufacturing companies in Thailand should adopt green operations and lean manufacturing tools to foster business processes as well as save the environmental practices.

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