Does the Greening of Supply Chain Have Any Impact on Sustainability and Organizational Performance of Firms in Thai Chemical Industry?

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***Abstract*-The prime objective of the current study is to investigate the determinant of the green supply chain, the impact of the green supply chain on the sustainable performance and lastly the impact of the sustainable performance eon the organizational performance of the Thai chemical firms. The study has employed the survey-based method to answer the research questions as manufacturing managers are surveyed as ultimately, manufacturing managers are responsible for the performance of the organizations for which they work. The SEM-PLS is used to analyze the data collected from the manufacturing managers of Thai chemical firms. The literature provides considerable empirical evidence regarding the linkage of supply chain success with the ERP information mechanism, which helps to share information between the partnering firms. The findings of the study have provided support to the hypotheses results. The consideration of four green constructs in the model explains that cooperation causes largest influence on the environmental performance, next comes the investment recovery and eco-design. However, no significant association was found between cooperation with customers and economic or environmental performance particularly in case of greater customer pressure for adopting environment friendly practices in Thailand.**

Keywords: *Green supply chain, sustainability, Thailand*

1. Background

For the strategic integration and coordination of business process, the SC management is a most important factor. Along with that SC also supports the strategic alignment of company' performance [1, 2]. Purchasing, information system, marketing, manufacturing environmental sustainability (ESUS), and logistic are the business process where the coordination and cooperation is required. The changing customer demands are pushing us to be focused on the competition at SC level. So for gaining competitive advantages it is necessary to be focused on the SC performance of firm and partners [2]. The ESUS is a more a subject of SC than the organization only [3, 4]. The unified efforts of all the SC members is required for the development of environment friendly supply chin

A unified effort is required by all the members for developing products, processes, and services, which are environmentally safe. This is done to avoid any underutilization at the level of partnership (Ferreira & Silva, 2016). Practices of GSCM have been started implemented by the manufacturing firms to respond to the demand of customer for environmentally safe product and services. These products/services are developed using sustainable environmental practices and in reaction to the environmental regulations of government. The ESUS is enhanced by these practices by working in collaboration with the customers and suppliers. The EP improves through execution of GSCM activities. The EP is measured in terms of waste reduction, sold waste, toxic material consumption and air emissions reduction. It is concerned that the efforts of ESUS enhance the profitability and market share or not. The organizational performance is based on the manufacturing managers (Prajogo, 2016). It is required to determine that in what ways organizational performance can be improved by the manufacturing managers. Decisions are made by the local managers, which strengthen the SC on priority and then organizations (Prajogo, 2016). International activities are required by the managers to improve locally. The SC success is mandatory for achieving success at the level of organization (Lemma, Singh, & Kaur, 2015). It is demanded by the government regulatory authorities and customers that the products/services developed should be environmentally friendly. Managers should recognize the practices, which are environmentally safe and implement them across the SC. The water pollution from the Thai chemical industry is shown in the figure 1.

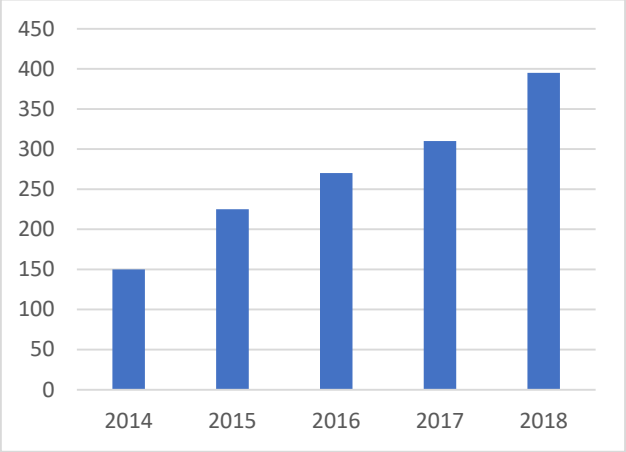

Figure 1. Water pollution by Thai chemical industry
Source: World bank

A unified effort is required by all the members for developing products, processes, and services, which are environmentally safe. This is done to avoid any underutilization at the level of partnership [5]. Practices of GSCM have been started implemented by the manufacturing firms to respond to the demand of customer for environmentally safe product and services. These products/services are developed using sustainable environmental practices and in reaction to the environmental regulations of government. The ESUS is enhanced by these practices by working in collaboration with the customers and suppliers. The environmental performance (EP) improves through execution of GSCM activities. The EP is measured in terms of waste reduction, sold waste, toxic material consumption and air emissions reduction. It is concerned that the efforts of ESUS enhance the profitability and market share or not. The organizational performance is based on the manufacturing managers [2]. It is required to determine that in what ways organizational performance can be improved by the manufacturing managers. Decisions are made by the local managers, which strengthen the SC on priority and then organizations [2]. International activities are required by the managers to improve locally. The SC success is mandatory for achieving success at the level of organization [6]. It is demanded by the government regulatory authorities and customers that the products/services developed should be environmentally friendly. Managers should recognize the practices, which are environmentally safe and implement them across the SC.

2. Literature Review and Hypotheses Development

When the environmentally sustainable practices are adopted by firms as a strategic action, it is easier to establish the capabilities with green information systems. In order to develop, maintain, and sustain the SCs, there is need for information systems[7, 8]. The organizations must develop the green IS for the implementation of environmentally sustainable practices. Moreover, it is required to monitor the process of selling, purchasing and manufacturing for ensuring sustainability in the environment by focusing on the GSCM activities [23]. Interconnectedness is supported through information systems and it can improve the level of commitment and trust among the partners of SC (Ahmed, Khan, Paul, & Kazmi, 2018). Organizations use the information systems for provision of techniques, instruments, and processes to establish collaboration. It was found by Cousins, Lawson [9] and Carvalho and Rabechini Junior (2015) that for implementing the information system in a successful manger, there is need for management support. The practices of GSCM can be implemented (i.e. customer cooperation, eco-design, green purchasing and recovery of investment) after the adoption of environmentally sustainable strategic implication through the support of top management. It is necessary to implement green practices for changing the overall strategies to green. The key driver is the support of top management in the adoption and execution of product innovation through latest activities, programs and technologies (Qureshi, Aziz, & Mian, 2017). In order to ensure excellent in terms of environment, there is need for fully cooperation by the top management. It was found by Jabbour and de Sousa Jabbour (2016) that the implementation of practices of GSCM are positively influenced by the support of management and organizational learning. During the initial designing of product or process, the environmental excellence is initiated. It is necessary for the environmentally sustainable strategy to have commitment of management to ensure that the green approach of life cycle is adopted (Siva et al., 2016; Trachana, Karagiannaki, Zampou, & Pramatari, 2016). Based on the discussion, the following relations have been hypothesized:

H1: The environmental management is in positive relationship with the greening of a SC.

The capability of the information systems of an organization leads to the implementation of practices of GSCM successfully for capturing the related data. The related data or information is used in the process of selling, manufacturing, logistics, and purchasing (Yen, 2018). The information required for decision making can be generated by the data, which results in improved EP of the SC (Yen, 2018). The efforts for environmental management are based on the green IS, which act as a backbone in supporting the internal MS of the firm and reacting to the needs of stakeholders. Information required for customer cooperation is provided by green information systems related to packaging, production, eco-design, and transportation. For SCM, the sharing of information through green IS is crucial for coordination and integration. It was proposed by Panayides (2017) proposed that the level of cooperation is involved in the

logistic integration. It has been argued by researchers based on the case of chemical sector that environmental control standards are important for incorporation across the chemical SC along with other measures of quality control in the IS[10].. Based on a case study of the chemical industry, the required information is provided by the green IS for decision making regarding the eco-design related to consumption of energy, material recovery and recycling and reuse(Saenz et al., 2015). The required information for recovering the investment of the organization in excess of the capital equipment, inventories and scrap is provide by green information systems. Based on the discussion, the following relations have been hypothesized:

H2: The green information system is in positive relationship with the greening of a SC.

It has been argued that GSCM is a strategic imperative, which depends on the demand of customers for products being environmentally safe. Moreover, it is also required that the products are developed through sustainable processes and the overall mechanism improves the sustainability of environment. The influence of environmental practices adopted by Xerox; Ltd. across the SC was analyzed at different stages of life cycle of product through use of performance matrix of environment. It was found by Mitra and Datta (2014) that there is a positive association between the improvement of economic and EP with the use of SC practices, which are green in nature. According to Yen (2018), the EP improves with the support of close relations and collaboration established with the key suppliers.

The chances of green multiplier effect were described by Yen (2018), which came by extending the practices of green purchasing from immediate to second or third tier of suppliers. it was argued by Ferreira and Silva (2016) that the supply policies and green purchasing enhance the EP of a firm. The EP improves through use of practices, which are green in nature. Difference factors influencing the process of implementation of green SCs were studied by Jabbour and de Sousa Jabbour (2016) and it was found that the performance of green SCs is enhanced by green design.

The environmental influence of a product is reduced through eco-design without the creation of a negative trade-off with the criteria of any other design including the functionality and cost. The EP is positively and directly influenced with the development of eco-friendly design as the designers focus on the reduction of the environmental influences related to the design. The focus of GSCMP is on the reduction of waste production associated with the sustainable environmental practices. The costs are reduced through the minimization of waste, which improve the overall ECNPR. A relation has been shown between ECNPR and green SCs by Mitra and Datta (2014). Moreover, the researchers found that the firm achieves competitiveness and ECNPR through use of practices, which are green and sustainable. The influence of the achieving environmental awards was studied by Ferreira and Silva (2016) on the prices of stock. It was found that firms with high stock value and valuation are given such recognition. It has been argued that the ECNPR improves with the implementation of GSCMP. Based on the discussion, the following relations have been hypothesized:

H3: The greening of the SC is in positive relationship with the ENVP

H4: The greening of the SC is in a positive relationship with ECNPR.

H5: The greening of the SC is in positive relationship with the OPOR

The economic as well as EP improves through the cost saving aspect of the EP. This leads to the achievement of operational efficiency of the firm. Cost savings are generated through economic, environmental, and OPOR. It shows the ability of a firm to fulfill the needs of its customers through developing sustainable and environmentally friendly products/services. The overall marketing and financial organizational performance improve with the cost of social, economic, operational, EP and their marketing implications. Moreover, the adoption of green initiatives is influenced by the regulations imposed by the government with reference to environment and the demands of customers (Yen, 2018). The influence of environmental regulations on the competitiveness of a firm is not clear in literature. The influence of costs related to control of pollution was quantified by Wilson (2013) in economy of United States. It was estimated that the abatement of pollution could account almost 10 percent of the total product cost of products/services. The benefits related to development of safe and clean environment were not assessed by the researchers. It is considered that the competitive edge can be lost by the firms because of increase in the cost of implementing sustainable practices. It was concluded by Mazzanti and Rizzo (2017) that the proposition of competitiveness damaged by environmental regulations is not supported by much studies. There is need for more empirical investigation to analyze the influence of environmental legislation of firm's competitiveness. The earlier literature regarding GSCM is focused on the anecdotal evidence and theoretical discussions. Moreover, several researchers have worked on the development of measurement scales of ESUS (Laari et al., 2016; Malviya, Kant, & Gupta, 2018). The question related to the benefits of implementing ESUS was raised by Verrier, Rose, and Caillaud (2016). The researchers were not able to find a strong relation between the financial, environmental, and sustainable practices. There is need for more investigation. The current research is not conclusive but gives some direction for future research (Mitra & Datta, 2014). The

following research hypothesis has been formulated based on the literature review:

H6: The ENVP is in positive relationship with the OP

H7: The ECNPR is in positive relationship with the OP

H8: The OPOR is in positive relationship with the OP

3. Methodology

This section involves data analysis and the discussion about the obtained results. In this study we used PLS-SEM as a statistical technique, since it is capable of estimating both linear and multiple regression analysis, without any errors. In addition, it is an advance technique which provide robust results. PLS-SEM does not require large sample size and can simultaneously estimate the multiple structural modeling. The purpose of using PLS-SEM is to predict the relationship between the constructs. Since it is a quantitative research therefore, a questionnaire is developed to collect the responses. The current research is cross-sectional in nature, which analyzes the responses of a specific population subset, based on their observation at a specific period of time. An email questionnaire is also generated for collecting responses from respondents that are unreachable. Afterwards, the questionnaires were sent to each of the 359 Thai manufacturing managers to collect information required for the statistical testing. The data normality test is performed to check if the data fits well for the modeling. An ideal sample size range is 130-250, since data abnormality issues arise in small sample size.

4. Data Analysis

SEM-PLS is a multivariate statistical procedure which involve factor and regression analysis and allows to examine the relation among measured and the latent constructs, i.e. measurement model (MM) and relation among a set of latent constructs, i.e. structural model. Thus, Shao, Feng [11] and Phillips, Barnes [12] stated that PLS path modeling can simultaneously determine the structural and the MM. This simultaneous estimation of both models makes it a robust statistical technique. The partial least square structural equation modeling carries out in two steps, in its first step it undertakes the inner model estimation also known as MM, whereas in the second step, it estimates outer or the structural model. The MM for this research can be determined by assessing the different criterions, In order to affirm the effectiveness of MM and if all the variables of the model are well observed, we used the (CFA). Therefore, all the elements of MM are separately analyzed through structural, formative, and reflective modeling. A factor loading of above 0.70 is obtained for all the items of the model.

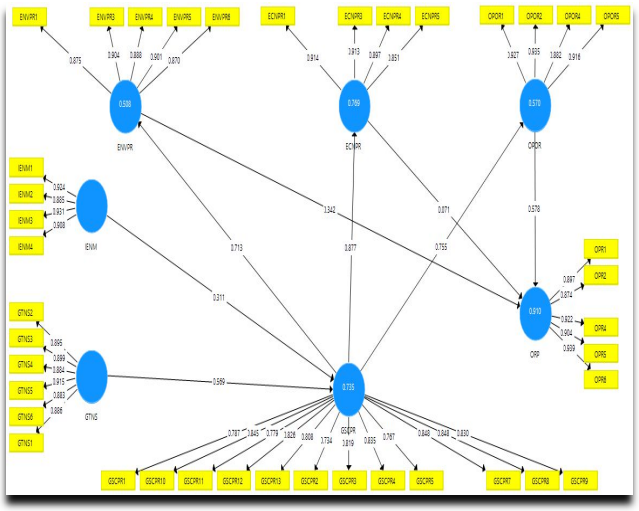

Figure 2. MM

Statistical findings of the measure indicate consistent outcomes in terms of internal consistency, reliability and convergent validity. However, we excluded those items from the model which have lower item loadings.

Table 1. Outer loading

	ECNPR	ENVPR	GSCPR	GTNS	IENM	OPOR	ORP
ECNPR1	0.914						
ECNPR3	0.913						
ECNPR4	0.897						
ECNPR5	0.851						
ENVPR1		0.875					
ENVPR3		0.904					
ENVPR4		0.888					
ENVPR5		0.901					
ENVPR6		0.870					
GSCPR1			0.787				
GSCPR10			0.845				
GSCPR11			0.779				
GSCPR12			0.826				
GSCPR13			0.808				
GSCPR2			0.734				
GSCPR3			0.819				
GSCPR4			0.835				
GSCPR5			0.767				
GSCPR7			0.848				
GSCPR8			0.848				
GSCPR9			0.830				
GTNS2				0.895			
GTNS3				0.899			
GTNS4				0.884			
GTNS5				0.915			
GTNS6				0.883			
IENM1					0.924		

IENM2		0.885				
IENM3		0.931				
IENM4		0.908				
OPOR1			0.927			
OPOR2			0.935			
OPOR4			0.882			
OPOR5			0.916			
OPR1					0.897	
OPR2					0.874	
OPR4					0.922	
OPR5					0.904	
OPR6					0.939	
GTNS1	0.886					

Reliability and Validity

We used SmartPLS software for analyzing the data obtained through survey. SmartPLS examines the path modeling in PLS [13]. Afterwards, we estimated measurement or inner model for analyzing the possible structural association between measured and the latent variables. It also determines the direct as well as indirect association between the measured constructs. Subsequently, a composite reliability test is carried out to assess reliability of latent variables involved in MM [14]. The composite reliability (CR) values turned out to be above 0.70 for all the variables of the model, which is consistent with the threshold level. In addition, internal consistency of latent variables is also analyzed by carrying out Cronbach alpha test, whose value must be above 0.70 to be acceptable [15]. The result of Cronbach alpha test for each construct exhibit $\alpha > 0.70$. In view of [13] and Bouwman, Daetwyler [15] researchers generally use AVE as a powerful measure for determining convergent validity. Therefore, convergent validity for this model is achieved as AVE>0.50, i.e. ranging from 0.511-0.725.

Table 2. Reliability

S	Cronbach's Alpha	rho_A	CR	AVE
ECNPR	0.916	0.921	0.941	0.799
ENVPR	0.933	0.935	0.949	0.788
GSCPR	0.953	0.953	0.958	0.658
GTNS	0.950	0.950	0.960	0.799
IENM	0.933	0.935	0.952	0.832
OPOR	0.935	0.937	0.954	0.837
ORP	0.946	0.947	0.959	0.823

The next step is determining the discriminant validity. Assessing a model's discriminant validity explains its uniqueness from other latent variables [13, 16]. A Tzempelikos and Gounaris [17] criterion is considered to observe the discriminant validity of measured constructs, however, it must exhibit value which is greater in comparison to correlations among other latent constructs. Table 3 presents the AVE square root values.

Table 3. Discriminant Validity

	ECNPR	ENVPR	GSCPR	GTNS	IENM	OPOR	ORP
ECNPR	0.894						
ENVPR	0.647	0.888					
GSCPR	0.877	0.713	0.811				
GTNS	0.769	0.615	0.846	0.894			
IENM	0.779	0.607	0.817	0.890	0.912		
OPOR	0.799	0.728	0.755	0.785	0.791	0.915	
ORP	0.795	0.723	0.765	0.786	0.789	0.744	0.907

The next step is the assessment of R^2 measure or coefficient of determination to observe the predictive relevance of underlying model [13, 16]. R^2 measure is another criteria which predominantly observes the predictive power of endogenous or dependent variable [18]. It is defined as the proportion of variance in endogenous variable which can be explained through one or more exogenous variables. R^2 can take any value between 0-1. An R^2 equal to 1 indicates that set of independent variables can completely predict the variation in dependent variables, whereas an R^2 of 0 indicates that variation in exogenous variable is not predictable by independent variables.

Table 4. R-Square

	R Square
ECNPR	0.769
ENVPR	0.508
GSCPR	0.735
OPOR	0.570
ORP	0.910

Structural Model

Using first order construct, we estimated the hypothesized model. However, this model is estimated to determine the nature of association among the latent constructs. In addition, path coefficients are also observed to make decisions about the proposed set of hypotheses. Afterwards, the MM is altered to structural model with a purpose of observing any linkage among exogenous and endogenous constructs. The table shows the acceptance of all direct hypotheses, since they have shown significant outcomes. Meanwhile, by performing a bootstrapping procedure, significance of path-coefficients is observed, with 5000 bootstrap observations and 359 cases.

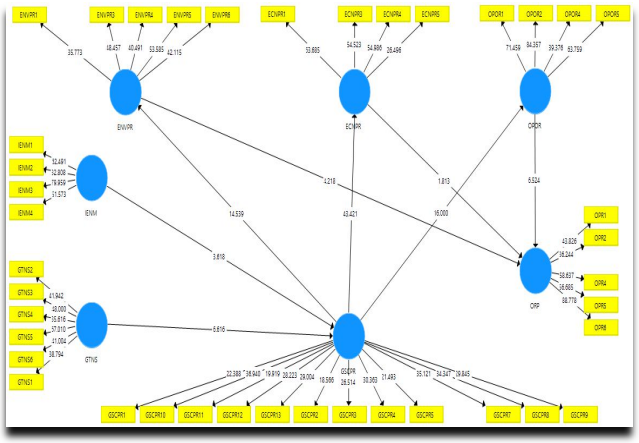

Figure 3, Structural Model

Table 5. The antecedents of greening of a SC

	(O)	(M)	(STDEV)	(|O/STDEV|)	P Values
GTNS -> GSCPR	0.569	0.561	0.086	6.616	0.000
IENM -> GSCPR	0.311	0.319	0.086	3.618	0.000

Table 6. Greening of a SC and sustainable performance

	(O)	(M)	(STDEV)	(|O/STDEV|)	P Values
GSCPR -> ECNPR	0.877	0.877	0.020	43.421	0.000
GSCPR -> ENVPR	0.713	0.714	0.049	14.539	0.000
GSCPR -> OPOR	0.755	0.756	0.047	16.000	0.000

Table 7. Sustainable performance and organizational performance

	(O)	(M)	(STDEV)	(|O/STDEV|)	P Values
ECNPR -> ORP	0.071	0.071	0.039	1.813	0.035
ENVPR -> ORP	0.342	0.346	0.081	4.218	0.000
OPOR -> ORP	0.578	0.573	0.089	6.524	0.000

Finally, after estimating the magnitude of R^2 as predictive accuracy measure, we then calculate the Stone-Geisser's Q^2 as a predictive relevance criterion. According to Henseler, Hubona [16] the inner model is expected to provide evidence regarding the predictive relevance of latent constructs.

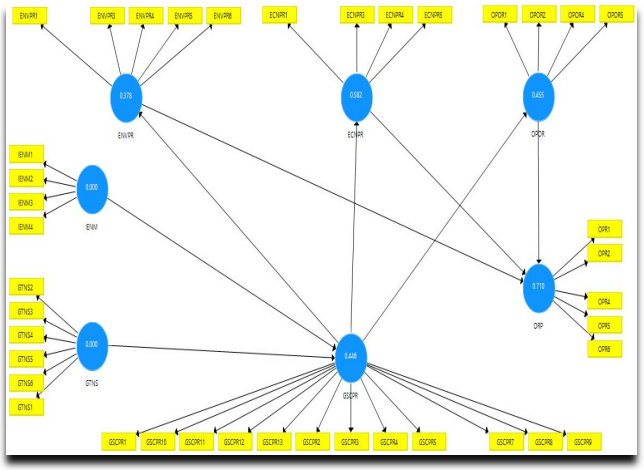

Figure 4. Q-square

Although, in PLS path-modeling, generally a blindfolding procedure is performed by researchers to gain a cross-validated measure for the latent constructs. It is usually used for measuring the goodness of fit [12]. Hair Jr, Hult [18] suggested that researchers should use certain measures while observing the models' predictive relevance.

Table 8. Q-square

	SSO	SSE	Q^2 (=1-SSE/SSO)
ECNPR	868.000	362.480	0.582
ENVPR	1,085.000	675.137	0.378
GSCPR	2,604.000	1,442.839	0.446
GTNS	1,302.000	1,302.000	
IENM	868.000	868.000	
OPOR	868.000	473.335	0.455
ORP	1,085.000	314.367	0.710

5. Discussion and conclusion

The current research proposed and analyzed a detailed GSCMP model. In case when a theory does not support the set of individual hypotheses, the general model is applicable. The strength and significance of positive linkage between one-stage and two-stage GSCMP signify the importance of implementing staged practices. The results obtained from these practices are straightforward, having little or no doubt. The model suggests that firms should take ESUS as strategic imperative, which clearly explains that top SC management strives to integrate ESUS in the mission statement of organization, as an important constituent and develop and deliver environmentally friendly products and services across the organization.

The literature provides considerable empirical evidence regarding the linkage of SC success with the ERP information mechanism, which helps to share information between the partnering firms. ESUS is crucial at SC level [19]. Therefore, organizations must establish information

systems which coordinate with customers and suppliers to integrate initiatives for ESUS. Achieving ESUS through direct or indirect adoption of green information systems or internal environmental management practices influence the stage-2 GRSCMP. With the expansion in organizational strategy to integrate ESUS, an ERP system of an organization should also be expanded, for monitoring environment-related outcomes and efforts made with the customer and supplier cooperation.

The stage-2 GSCMP provide vague outcomes in terms of economic and EP, particularly in case of eco-design related outcomes. The purpose of eco-deign is to minimize the environmental impact of products, without the occurrence of any negative transaction with other designs, i.e. functionality and costs [20]. Eco-design is reportedly found to have positive relation with EP and is negatively related to ECNPR. This indicates that eco-design failed to achieve intended and desirable aim, which may occur due to further improvement and development of eco-design methodologies.

This significant effect on ECNPR and insignificant effect on EP by green purchasing is quite surprising. However, similar results were obtained by Taylor and Vachon [21] in case of Chinese firms operating in a competitive market. In a study by Taylor and Vachon [21], the managers in the manufacturing sector have completed the measurement scales through emphasizing upon size of the plant. Green purchasing poses an environmental impact on the supplier instead of the manufacturer and positively influence the manufacturer's ECNPR. For the manufacturers, implementation of green purchasing is comparatively less expensive as compared to other GRSCMP i.e. eco-design.

Furthermore, customer cooperation directly influences EP and indirectly influence the ECNPR. Rather, customer cooperation influences ECNPR by indirectly affecting the EP. The consideration of four green constructs in the model explains that cooperation causes largest influence on the EP, next comes the investment recovery and eco-design. However, no significant association was found between cooperation with customers and economic or EP, particularly in case of greater customer pressure for adopting environment-friendly practices in Thai.

The study proposed that the level of cooperation involve in the flow of materials and information across the SC is involved in the logistic integration. It has been argued by researchers based on the case of chemical sector that environmental control standards are important for incorporation across the chemical SC along with other measures of quality control in the IS[10].Based on a case study of the chemical industry, the required information is provided by the green IS for decision making regarding the eco-design related to consumption of energy, material recovery and recycling and reuse(Saenz et al., 2015.

The results obtained for this research provide varied outcomes may be because of differences in samples. The sample for current research is a diverse Thai manufacturer's group, whereas previous studies [21] have used sample from a focused group involving manufacturers from China. According to Zhang, Tse [22], choosing a diverse group from another country confirms the effectiveness of measurement scales' effectiveness across countries and manufacturers. Such that, the Thai manufacturers tend to be market-oriented and more responsive towards environment-based customer demand. Zhang, Tse [22] observed that Chinese organizations have started to adopt market orientation only recently, to surpass the intense market competition. It also justifies the outcome obtained regarding US sample. It has been argued by researchers based on the case of chemical sector that environmental control standards are important for incorporation across the chemical SC along with other measures of quality control in the IS. Based on a case study of the chemical industry, the required information is provided by the green IS for decision making regarding the eco-design related to consumption of energy, material recovery and recycling and reuse.

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