Exploring the Nexus among the Technological Innovation, Supply Chain Integration and Environmental Management Practices in Thai Manufacturing Industry: A Sustainability View

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***Abstract*-The main focus of this paper is on the product stewardship and pollution prevention. RV suggested that the important resource for the competitive advantage is precise inter-enterprise formation through long term partnership of organization. Resource based view suggested that there are three important strategic competences sustainable development, product stewardship and pollution prevention. All the competencies have diverse environmental forces, importantly shape upon dissimilar resources, and having competitive advantages of different resources. The study has used the SEM-PLS to analyze the data collected from the manufacturing firms operating in the Thailand. the results provide the support to the view that the companies with having higher level of SCI from the whole supply chain have the benefit for the implementation of environmental management activities and also access of knowledge sharing with supply chain partners. In addition to the new technology they can implement the innovations in production and can easily met the innovative demands of customers, which eventually leads towards higher innovation performance. EMP's and promotes the technological innovation, which can balance the cost and provide the first-mover benefit. With the deteriorating air quality, water pollution, soil pollution and other environmental issues enterprises are under pressure from government, society and supply chain members for the environmental protection. These findings suggest that precautionary and protective EMP's can promote the technological innovation performance efficiently. Meanwhile EMP's cost should be expanded whereas its advantages may realize in future. The short-term managers are liable to postpone investments in EMP's. the stsuya has used the sustainable management practices to view the issue.**

Keywords: *Supply chain, environment, sustainability, Thailand*

1. Background

A lot of research has been done on corporate environmental management practices (CEMP) all over the world. Due to the negative interpretations of some researchers Implementation of Environmental Management (EM) in firms is difficult because companies think that with the use of environmental management practices (EMP's) they may harm economic interests of company and will decrease competitive supremacy. Although society also can get benefits, if the company bear all the cost of EMP [1]. By practice some companies are not willing for the implementation of EMP and taking risk of strict actions and fines by ignoring the regulations of strict environmental protection. Whereas some researchers have contradict with this research and sates the implementation of EMP's helps not only environment, but also for increase in company's economic performance [2].

By the implementation of comprehensive EMP many companies are getting higher corporate performance (CP) particularly in innovation. Corporate leaders are looking for the fundamental link among CP and CEM [3]. In analytical framework provided by the "Porter Hypothesis" is that government wisely designed the environmental regulation which companies can use for the adoption of EMP, for accelerating the innovations. Which can reduce the cost for EM and made first mover benefit as well [4].

Many empirical studies are available which were tried to explore effect of EM on invention on industrial level by following the "Porter Hypothesis". Though MacDonald, Bahr [5] stated that the impact on firms by environmental regulation may significant, and dissimilarity in vital facet. Therefore, some scholars also examined the association among EMP and technology invention at firms' level, for example implementation of EMP system, clean production, internal policies and green marketing, for the improvement of environmental performance. Companies in Thailand with having higher level of SCI from the whole SC have the benefit for the implementation of environmental management activities and also access of knowledge sharing with SC partners. In addition to the new technology they can implement the innovations in

production and can easily met the innovative demands of customers, which eventually leads towards higher innovation performance. The five major manufacturing industries of Thailand accounts for utmost the 61 percent.

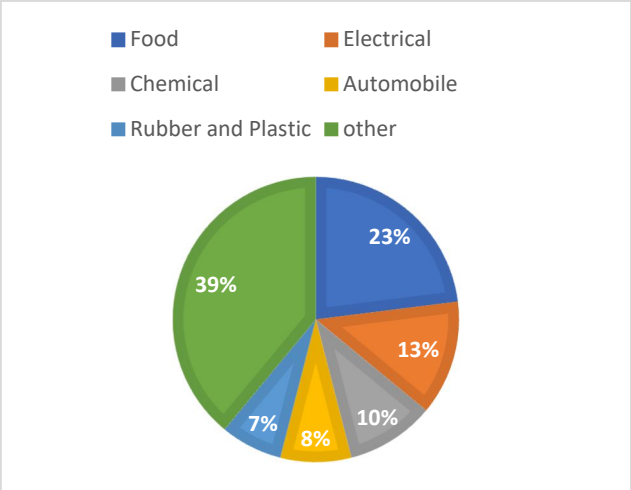

Figure 1. Share of five major industries in total manufacturing of Thailand
Source: National economic and social development board of Thailand

EMP have influenced on innovation process of firm and product invention. The current study has a limited scope in this field for influencing the EMP on technological inventions. So it is important to discover instrument for the promotion of technological innovation (TI) in EMP. By comparing the previous EMP's which were focused only on pollutant control end-of-pipe treatment and throughout the production process, current EMP's moved the attention towards the prevention of Environmental impact for all the stages of lifecycle of the product. In every stage operating cost, the sharing of resources and advantages of EM with SCP can make contribution for the properties of EMP. As per the theory of resource-based view, Process cooperation of SCP which also known as SC integration (SCI), for exchanging the knowledge and information can create inter-firm network, which can help out for encouragement of mutual learning , resource sharing and combined problem solving among customers and supplier [6]. Therefor it is beneficial to inspect the communications impacts of EMP and SCI.

How TI performance (TIP) can be affected by EMP? Is there any effect of SCI on this Relationship? How and why? This paper will find the answers of these the main questions. How TIP can be affected by EMP? Is there any effect of SCI on this Relationship? How and why? This paper will find the answers of these the main questions.

2. Literature Review

2.1 Resource-Based View (RBV)

Delery and Roumpi [7], developed the theory of resource-based view which states that performance and competitive strategy of a firm depends on its occasional and unique organizational resources. Many other researchers also develop the theory with integration of RBV, environmental issues, social network theory and relational theory. (NRBV) natural resource-based view [8] and relational view (RV) [9] the two branches of literature.

NRBV suggested that there are three important strategic competences sustainable development, product stewardship and pollution prevention. All the competencies have diverse environmental forces, importantly shape upon dissimilar resources, and having competitive advantages of different resources. The main focus of this paper is on the product stewardship and pollution prevention. RV suggested that the important resource for the competitive advantage is precise inter-enterprise formation through long term partnership of organization. In short life cycle practical and product knowledge are created by EMP, are important for CP and competitiveness. There are some critical antecedent variables of other advantage resources and TI as well. By following the collaborative view SCI may produce a network for exchanging the knowledge and information. This network will help out SCP learning about the new occasions and solving problems is also one type of corporate advantage resources.

2.2 Hypothesis

Environmental management included with life cycle knowledge and practical knowledge according to the RBV, which might affect TIP. In current years the focus of attention in a company is the association between TIP and volunteer (EMP's). Chavez, Yu [10] stated that in the process of EMP enterprises can make dialogue with different stake holders, and operational abilities can be produced by using the positive strategies of environmental management like the ability of making continuous improvements and ability to control technological changes easily.

Based on empirical research Müller, Kiel [11] stated that by EMP accompany can decrease the bad environmental effect and consumption of resources and through organizational learning encourage the product innovation environmental process innovation as well. Dangelico [12] found that volunteer EMP have positive and significant effect on process and product innovation's different understandings about EMP are here. Mårtensson and Westerberg [13] stated that for dealing with environmental issues a complete system can be provided by the environmental management. Environmental issues are associated with organizational activity from

production process, waste disposal, raw material inputs and packaging. So EMP are mixture of organizational actions aims to reduce the consumption of resources and improvement in waste disposal. EMP' includes manufacturing, product design and waste management.

For the implementation of EMP three different motivations are there for the enterprises.

(1) Environmental regulation: the company can avoid penalties considered legitimate by meeting the requirements of environmental regulation.

(2) Economic interests: Apart of reducing the bad effects of organizational activities on environment EMP also provide the economic benefits by creating the recycling revenue, achievement of first-mover advantage, boosting in sales, improvement in product quality and enhancement in social reputation.

(3) Competitive advantage: for attaining the competitive advantage EMP are one of the strategic alternates.

For instance, re-design, of the product, using technology of clean production, improvement of production technology, reduction in cost of production and improvement in resource utilization may bring the opportunities for business and competitive advantages. For winning the gratitude from customers and public green consumption, green marketing and environment-friendly products are valuable. By implementation of green management for establishment of green image may reduce the effect of competitors which are only working on implementation of environmental management. Likewise, Lycett, Bodewes [14] also stated that EMP such as eco-design, environmental management recycling investment have positive effect on TI. The life cycle and practical knowledge included in EMP's may enhance TIP. So, we have purposed the following hypothesis:

H1: EMP has significant impact on the TIP

TI and supply chin both have focus on methods of production, commercialized and organizational processes. SCs are dedicated for the creation of value for the final customers. Members of SCs are not the fundamental source of TI but also the important sources of knowledge and ideas, joint problem-solving and mutual trust among members, Information sharing, and accentuation of SCI can increase direct nd indirect interaction among SCP and enterprises.

This can take a different and new viewpoint and also help for generating the new ideas with diverse substitutes important for innovation. Engels [15] stated that in product innovation projects at early stage with the involvement of suppliers, expensive design changes latter can be avoided. Participation of supplier's TI have a positively significant impact on innovative performance and product innovation.

Participation of customers in the development projects of new product may help for acquiring demand information, due to which enterprises can make improvement in customer satisfaction and produce higher quality products with low cost of production. The vital forerunner for crucial and cooperative innovation to product design is customer demand. Customer engagement in innovation also have positive contribution in innovation performance and quality performance.

According to RV the broadcasted network resources of SCI are that type of resources for corporate advantage which are rich in knowledge and information. on one side in SC network (SCN) may quickly share the knowledge of inter-enterprises, whereas on the other side in SC problem-solving of inter-enterprises mutual learning may facilitated by the network.

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The literature of last two years demonstrates that researchers have started research with the full approach of SC for analyzing the impact of SCI on the innovation. Bellamy, Ghosh [16] stated that collaborative knowledge and SCN integration can improve the quality of the product and the main resource of business innovation. Lycett, Bodewes [14] also stated that in the manufacturing firms of Malaysia there is a positive and significant impact of SCI on innovation performance. So, we have purposed the following hypothesis:

H2: SCI has significant impact on the TIP

For the enterprises SCN's are becoming the most important way for sharing of knowledge, as business management transforming from closed-end management to open end management. The effect of SCI on knowledge sharing is as: At first enterprises must not trust only on scarce resources for the development but should obtain advance knowledge from external resources as well. In SC SCI provide appropriate opportunities to the firms for acquiring the advance knowledge. Secondly the closeness among the supply chain partners may arose the more knowledge sharing. Thirdly with the proper use of inter-organization "relationship" the quality of knowledge acquisition, cohesion and resource exchange can be increased, therefore improvement in transferring the practical knowledge exchanging the competences. SCI provide good chances of friendly communication and facilitate consensus building and make contribution for sharing the effective use of practical knowledge. Lycett, Bodewes [14] also stated that for the enterprises SCN is the main source of resources and knowledge. So, we have purposed the following hypothesis:

H3: SCI has significant impact on the SCKS

According to the theory of KM for the creativity of knowledge resources and re-integration are the stem for enterprise innovation. Allal-Chérif and Makhlouf [17] have stated that for innovation knowledge is the main factor, knowledge cannot be created by organization itself only if the staff which is the knowledge wealth discuss, share and analyze, the organization will be able for revolutionization. Knowledge sharing in an organization can decrease the quandary of limited resources of knowledge and decrease the development cost, and progress in application of innovation. It is easy for the SC partners to adopt the advance technology timely and achieve the latest innovations which are important for TI by knowledge sharing in Enterprises.

For attaining the sustainable competitive advantage "TI is an imperative way in enterprises, and a main topic of concentration for enterprises and Chinese government. Eurostat TI is based o the new knowledge of technology which includes TI process and product innovation which is new for enterprises and may apply to production and market (new process enterprises should apply new process and bring new products in the market)".

Researchers may have studied only the of TI because TIP is of multidimensional structure. But it doesn't have any uniform index of measurement. Grigoriou and Rothaermel [18] stated that from the number of patents by putting onward the valuation of TIP, patent certification and R&D investments. Additionally, Chen and Chen (2006) stated that valuation of TIP fully based on measure indexes: new product development cost and spread, sale of innovative products, innovated projects success rate, new product sales rate and contribution in the growth of industrial standards.

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H4: SCKS has significant impact on the TIP

SCI is not a precursor of TIP only but can be a condition which will effect of EMP on TIP. Olson [20] and Rasche and Seidl [21] has stated that inter-organizational cooperation apparatuses and organizational learning are linked with the association among innovation and environmental management. SCI predestined cooperation and trust, easy communication between SC members which have direct effect on inter-organizational learning and collaborative network of SC.

According to the theory of RBV and RV, knowledge sharing, cooperation between SC partners and organizational learning may promoted though the broadcasted network of SCI. therefore the firm which are having the advanced level of SCI may gain more practical knowledge and life cycle knowledge of the product from the EMP's. and for technical innovation the application of this knowledge has more collaborative and inter-organizational learning opportunities. So, for the exploration of association among TI and EMP's we should not ignore SCI as it is main supplementary factor. O have proposed the following hypothesis:

H5: SCI moderates the relationship between EMP and TIP

3. Methodology

For the analysis this study has use the Structural Equation Modelling (SEM)due to the many reasons. For the linear and multiple regression analysis the SEM have equal capabilities. Which assumes that all the variables assessed without any error. Although multiple regression and factor analysis are involved in SEM but it more effective ways of estimation of instruments having many separate equations of multiple regression and evaluates them parallel [22].

For the collection of samples adopted the cluster sampling technique. Ullah [23], was present the five-technique approach is used for the calculation of sample size in our study. Estimation of population is the first step. We have followed the table of Noh and Yusuf [24] for estimation sample size of the population. Total population size is 310 SEM can test many relationships at a time, so it is known most powerful and commonly used tool [25].

Though in the past many scholars had much emphasis on AMOS which is a co-variance-based approach. But for the CB-SEM approach PLS-SEM is good alternate which have exclusive methodological features. SEM is the most suitable methodology due to the many reasons as among the existing techniques it is the finest one. Rather it provides the advanced and robust solutions for the problems of researchers which we may not get from multiple regression. According to Hair, Hult [25] when the only purpose for using structural modelling is obtaining the prediction and explanation of constructs then PLS approach is more beneficial. PLS technique is in terms of sample size is demand less and assumes to be the more flexible. It can handle multiple structural modeling.

4. Data analysis

There are the two steps of SEM outer model assessment which is also known as structural model and inner model assessment known as measurement model. Different criterions are followed for measuring the model variance, validity and reliability in structural models. By nature,

items are dynamic so there is strong correlation is expected among the variables combined for the formation of constructs.

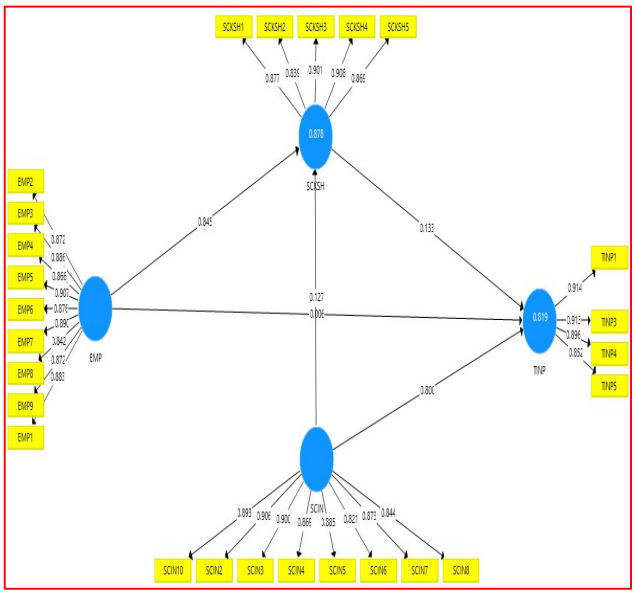

Figure 2. Measurement Model

This study used the confirmatory factor analysis for confirming the validity of the measurement model such as variables of models are observed finely. Many researchers have suggested reliability of individual items can be measured with the determination of loadings for each item [22, 26, 27]. As per the recommendation of Hair, Sarstedt [22] threshold is 0.70 and the values below that level are omitted. In current study the value for cross loading and outer loading evicted to be the same. the presence of correlation between the constructs analyzed by the cross loadings so this study has examined the discriminant validity among variables and their constructs.

Table 1. Outer Loadings

	EMP	SCIN	SCKSH	TINP
EMP2	0.872			
EMP3	0.886			
EMP4	0.866			
EMP5	0.907			
EMP6	0.876			
EMP7	0.890			
EMP8	0.842			
EMP9	0.872			
SCIN10		0.893		
SCIN2		0.906		
SCIN3		0.900		
SCIN4		0.869		
SCIN5		0.885		
SCIN6		0.821		
SCIN7		0.873		
SCIN8		0.844		
SCKSH1			0.877	
SCKSH2			0.839	
SCKSH3			0.901	
SCKSH4			0.908	
SCKSH5			0.869	
TINP1				0.914
TINP3				0.913
TINP4				0.896
TINP5				0.852
EMP1	0.883			

The suitable way for the assessment of internal consistency reliability is composite reliability in PLS path model [28]. We may interpret as Cronbach 's α. The value of composite reliability must be greater than 0.7 [29]. The information about composite reliability for each variable is presented in Table 2. Which shows that value of composite reliability of all the variables ranges from 0.844 to 0.985 which is greater than the benchmark of 0.70. the results show acceptable internal consistent reliability for the measures used in current study.

Table 2. Reliability

	Cronbach's Alpha	rho_A	CR	AVE
EMP	0.963	0.963	0.968	0.770
SCIN	0.956	0.957	0.963	0.765
SCKSH	0.926	0.927	0.944	0.773
TINP	0.916	0.921	0.941	0.799

We have use the Fornell-Larcker criterion of discriminant validity, for the determination of validity [30]. It is an influential measure and used in many researches. discriminant validity, which is a influential measure and has been widely used by the researchers in studies. Discriminant validity measures the relationship among the constructs of reflective variables. In general, the variables involved in the model it operationalizes them. So, this study incorporating this as a threshold for assessment of discriminant validity. Expected value for the reliability index is 0.70 or above.

Table 3. Fornell-Larcker criterion of discriminant validity,

	EMP	SCIN	SCKSH	TINP
EMP	0.877			
SCIN	0.796	0.875		
SCKSH	0.833	0.714	0.879	
TINP	0.787	0.700	0.710	0.894

Table 4. Heterotrait-Monotrait Ratio (HTMT)

	EMP	SCIN	SCKSH	TINP
EMP	1			
SCIN	0.724	1		
SCKSH	0.706	0.758	1	
TINP	0.728	0.734	0.769	1

The valuation of Validity and reliability are included in measurement model, and the current study also examine structural model by getting into the structural paths among moderating, dependent and independent variables. The exclusive nature of SEM-PLS is different from the other techniques because of its unique nature. So, It examine all the constructed variables simultaneously.it analyzes the indirect and direct impact of variables in case of structural model. Structural model is show below.

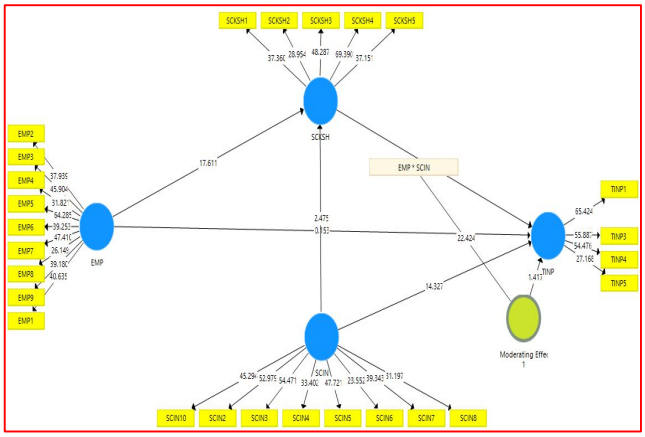

Figure 3. Structural Model

Moderation level is assessed for the investigation of indirect effect of variables on moderator. Furthermore, bootstrap analysis is used for specifying the significance of association on sample of 1000observations.the level of significance for p-value is less than 0.05. All the hypothesis having p-value less than 0.05 which indicates the acceptance of hypothesis. For the both hypotheses the significant values of p and t shows the moderation results. P values are less than 0.05 whereas t-test values are also more than 1.96 which indicates the acceptance of all hypotheses.

Table 5. Direct results

	(O)	(M)	STDEV	T Statistics	P Values
EMP -> SCKSH	0.845	0.838	0.048	17.611	**0.000**
EMP -> TINP	0.129	0.139	0.050	2.590	**0.005**
Moderating Effect 1 -> TINP	0.032	0.034	0.023	1.417	**0.078**
SCIN -> SCKSH	0.127	0.133	0.051	2.475	**0.007**
SCIN -> TINP	0.825	0.817	0.048	17.054	**0.000**
SCKSH -> TINP	0.134	0.141	0.109	1.229	**0.110**

Table 6: Mediation

	(O)	(M)	STDEV	T Statistics	P Values
EMP -> SCKSH -> TINP	0.113	0.118	0.092	4.054	**0.000**

The value of R^2 describes the predictive power for endogenous variables in structural modelling. The insignificant of coefficients for the path coefficients indicate the values close to 0. In current study the value of R^2 lies from 0-1 values close to 1 indicate greater predictive accuracy and so on. The value of 0.25 indicates weak predictive power, 0.50 indicates moderate predictive power while the value of 0.75 indicates substantial predictive power.

Table 7. R-square

	R Square
SCKSH	0.878
TINP	0.819

Hair, Sarstedt [22] suggested that for using the PLS-SEM for the evaluation of model's quality researchers must apply measures for the indication of model's predictive relevance. This study using blindfolding procedures relay on Stone-Geisser's test of predictive relevance. In PLS -SEM for the assessment of goodness of fit usually use this test modeling [26].

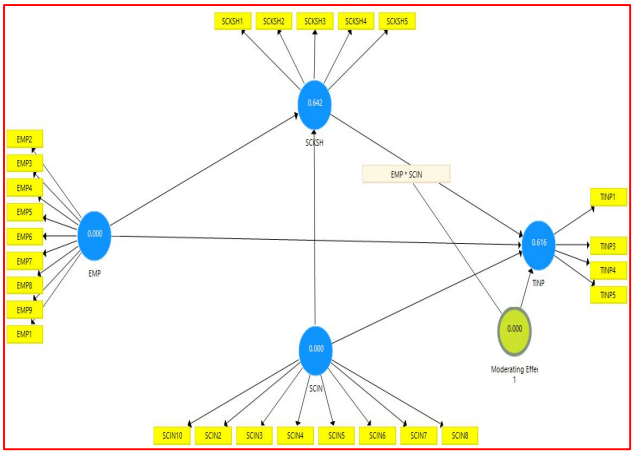

Figure 4: Q-square

For the assessment of blindfolding procedure to endogenous latent variables which have reflecting model of measurement.

Table 8: Q-square

	SSO	SSE	Q^2 (=1-SSE/SSO)
EMP	1,953.000	1,953.000	
Moderating Effect 1	217.000	217.000	
SCIN	1,736.000	1,736.000	
SCKSH	1,085.000	388.150	0.642
TINP	868.000	333.052	0.616

5. Results and discussion

At first the result shows positive impact on TIP by EMP's, which shows consistency with the past studies Lycett, Bodewes [14] and Dangelico [12]. As compare o the past studies only on environmental innovation and limited with the one or two EMP our results provide comprehensive framework for the impact of systematical EMP on TI. EMP's promotes innovation, create product life cycle knowledge, and practical knowledge which are important for all the innovation activities.

The results are complementary to "Porter hypothesis "and according to NRBV of the RBV, from EMP's viewpoint at level of firm. Secondly the value of SCI is indicated in the empirical results. Which shows the SCI

may improve the effect EMP's on TIP and also have positive impact of TIP.

SCI play an important role for creating a network for knowledge sharing between the SC partners. Companies with having higher level of SCI from the whole SC have the benefit for the implementation of environmental management activities and also access of knowledge sharing with SC partners. In addition to the new technology they can implement the innovations in production and can easily met the innovative demands of customers, which eventually leads towards higher innovation performance. Meanwhile the enterprises having lower SCI face problems in attaining the complete knowledge of product life cycle. Therefore, the have lack of important knowledge can't support TI. In every stage operating cost, the sharing of resources and advantages of EM with SCP can make contribution for the properties of EMP. As per the theory of resource-based view, Process cooperation of SCP which also known as SC integration (SCI), for exchanging the knowledge and information can create inter-firm network, which can help out for encouragement of mutual learning, resource sharing and combined problem solving among customers and supplier

Thirdly also found that SCI have direct impact on SC knowledge sharing, which have a positive effect on TI. which is supported by past findings from Oh and Syn [31] and Idda, Munk [32]. The firm can share the knowledge easily with the closeness of SC partners. Firms can get more chances for sharing their knowledge and ideas with the interaction of SC partners, and the network of SCI can provide platforms and channel for knowledge sharing. Subsequently the basis of innovation is knowledge sharing and no form can get all the knowledge itself so the knowledge sharing in SC became highly important for innovation.

5.1 Managerial Implications

The manger s of enterprises must realize that environmental improvement may leaded by the EMP's and promotes the TI, which can balance the cost and provide the first-mover benefit. With the deteriorating air quality, water pollution, soil pollution and other environmental issues enterprises are under pressure from government, society and SC members for the environmental protection. Though many enterprises still don have knowledge for the adoption of EMP's efficiently [33].

This study also suggested that precautionary and protective EMP's can promote the TIP efficiently. Meanwhile EMP's cost should be expanded whereas its advantages may realize in future. The short-term managers are liable to postpone investments in EMP's. Second, for sharing of knowledge with SC partners and learning, enterprises must give priority to SCI. with the building of networking for sharing of information ,benefits and risk enterprises can speed up for SCI. Specifically they must make collaborations with knowledge sharing and environmental management partners for instance organizing meetings for exchanging the experience, eco-technology, database of product life cycle knowledge and establishment of teams for collective innovation.

Thirdly by combing the "Three-in-One" SCI, environmental management and SC knowledge sharing will have a positive impact on innovation and will provide beneficial competencies for performance and competitive strategies as well. This study also suggest that managers can streamline functional departments on knowledge management, environmental management and SC management. For instance, by empowering one manager for taking the responsibility or they can place three functions in one department

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