International Journal of Business and Management Invention
ISSN (Online): 2319 – 8028, ISSN (Print): 2319 – 801X
www.ijbmi.org || Volume 5 Issue 11 || November. 2016 || PP—110-119

Exploring the Role of Greening Drivers, Eco-Design, and Collaboration Capability during the Process of ENPD in Taiwanese Notebook Industry

Lin, Chieh Chiang[1]
[1](*Department of Business Administration, Shih Hsin University, Taiwan)*

Abstract: *Environmental protection is considered imperative for all stakeholders living on the planet. Following the implementation of three directives of European Union, including: Waste Electrical and Electronic Equipment Directive (WEEE), Restriction of Hazardous Substances Directive (RoHS), and Energy Using products (EuP), practitioners are expected to take responsive actions for staying in the EU market and remaining competitive.As a major notebook computer manufacturer in the world, Taiwanese companies are advised to integrated green concepts into the process of new product development (NPD) to alleviate the burden to the earth. The paper aims to explore the role of collaboration capability during the process of ENPD (Environmental New Product Development). Members of product development teams from different companies in notebook industry were interviewed. Documentary analysis, in-depth interview, and content analysis were used to collect and analyze data. The results indicated that practitioners do pay more and more attention to the idea of ENPD; however, the author also found that the concepts of LCA (Life Cycle Assessment) and EMS (Environmental Management System) are still in the early stage that need to be integrated into formal business processes. Supplier management and green procurement are main approaches utilized by companies investigated in the current study. It was also noticed that OEM (Original Equipment Manufacturer) and ODM (Original Design Manufacturer) companies adopted different approaches to become more environmental friendly*

Keywords - *ENPD, Collaboration, Eco-Design, Green Design*

I. Introduction

1. Research Background

The enactment and enforcement of three main Europe Union directives, namely Waste Electrical and Electronic Equipment Directive (WEEE), Restriction of Hazardous Substances Directive (RoHS), and Energy Using Products (EuP) have caused tremendous impact for the IT industry. Proper reactions are required for coping with the trend of environmental protection. Previous studies have indicated the benefits and drivers to be environmentally responsible; it's also well recognized thatcompanies would become more competitive by playing initiative roles. However, the drivers of those green actions remain under investigated [1, 2, 3, 4, 5].

In the past, green is considered as a burden that would add costs without improving business performance [1, 3, 4]. However, the pressure from domestic as well as global competitors revealed the unstoppable trend of being green for IT industries [6]. Therefore, in order to stay competitive and be profitable, companies need to make responsive decisions and shift the focus from cost to environmental protection [2, 7, 8, 9].

The trade-off between social welfare and increased costs makes greening a tough decision for managers; however, as sustainable product development (SPD), environmental new product development (ENPD), ecological-design (eco-design), and green supply chain management (GSCM) become popular issues, it is assured that going green could be a cost-effective choice for companies; actually it is imperative for doing business in some markets in the world. As a fact that a single company could notconduct green activities and remain competitive by its own for mostindustries [10], eco-design and collaborative capability are considered as major approaches for delivering outstanding performance of green activities in the notebook industry [8, 11].In addition, previous literature lacks insights at the team level collaboration that is prevalent for ENPD projects; the current study focuses on team level, collects data, and induces results based on the collected data.

2. Research Objectives

It is well recognized that Taiwanese notebook brand companies and original design manufacturers (ODMs) provide a large number of notebooks in the global market; given the fact that electronic product design stage determines 70 to 80 percentage of cost in the lifecycle and the impact of this cycle on the environment [12, 13], it is assured that focusing on the process of product development would be a fruitful direction. As a main exporter of notebook, Taiwanese companies play an important role in reducing environmental burden on earth.

In other words, if eco-design could be carefully managed, the burden might be alleviated at the early stage of ENPD.

Collaboration among different companies for green is not rare; however, the interaction between collaboration capability and eco-design remains unknown. Previous studies also indicated that people are aware of the importance of collaboration but know little about the process of teaming with other companies for conducting eco-design [14].

Research objectives of the current study are then formulated as follows:

1. to sort out green drivers that might affect ENPD team and eco-design in notebook companies;
2. to understand the effect of green drivers on collaboration capability in notebook companies;
3. to understand the effect of collaboration capability on eco-design in notebook companies.

3. Research Questions

As previous studies paid scare attention to the team level collaboration for ENPD projects [15], the paper collected data from companies in the notebook industry for gaining a better understanding of the following research questions:

1. How do ENPD teams collaborate with others?
2. What does collaboration capability mean to ENPD teams?
3. How does collaboration capability affect eco-design in ENPD projects?

II. Literature Review

Gaining competitive advantage (CA) is one of the most important reasons for environmental protection and collaboration. Traditional resources of CA, however, cannot guarantee profitable results facing intense global competition [16]. The following sections address the importance of and relationships among greening drivers, eco-design, environmental protection, and collaboration capability. Probable linkages among different variables will be provided in the last section.

1. Greening Drivers

Greening actions could be conducted in different forms as greening conveys differentmeanings for different industries. In this current study, greening is considered as environmental protection actions resulting from various drivers indicated in previous studies (see Table 1). These drivers are considered of great importancefor integrating with eco-design and collaboration capability at the team level for improving operational performance.

Table 1 Greening Drivers

Source	Drivers	Level	Industry
Bansal and Roth [17]	Legitimation, ecological responsibility, and competitiveness	Organization	four sectors in United Kingdom and Japan
Vercalsteren [18]	Company (internal): motivation; willingness to innovate; competitiveness; sector. Environment (external): regulation; customers and market; suppliers. Product: position and market; environmental impact of the product.	Tool (quick scan) fororganization	Belgian SMEs in various sectors
Zhu et al. [9]	Regulations, marketing, suppliers, competitors and internal factors	Green supply chain	Chinese power generating, automobile, and electronic/electricalindustries
Chien and Shih [8]	Environmental and financial performance		Taiwanese electrical and electronic industry
Zhu et al. [9]	Manage supplier for risk and performance Manage supply chain for sustainable products		Chinese manufactures
Mair and Jago [2]	Managerial and personal values and attitudes, gaining competitive advantage, cost saving, corporate social responsibility improving image or reputation, complying with regulation, stake holder pressure		Various sectors in different nations
Borchardt et al. [19]	No external factors other than economic or legal	Organization (eco-design)	Footwear industry
Plouffe et al. [7]	Reduction of costs and an increase in revenues	Organization(eco-design)	Manufacturing sector and services sector

Some of the drivers are classified into categories such as legislation, stakeholder pressures, economic opportunities, ethical motives[17], company, environment, and product [18]. Others are discrete but still identifiable; corroborating issues founded in other studies such as performance [8, 9], cost [2, 7], and supplier [5, 9, 18].Unfortunately, as specific greening drivers for notebook industry can't be identified rom previous studies, the current paper takes closely related drivers (i.e., GSCM and eco-design) as primary reference and others as secondary reference. It is also obvious from Table 1 that greening drivers at team level remains unclear; most studies focused on organization level. As eco-design and NPD success share almost the same success factors clustering in motivation and competence [20]; it could be fruitful to focus on motivation and competence to unveil the relationship between successful ENPD and eco-design.

2. Environmental New Product Development (ENPD)

The idea of integrating new product development (NPD) with environmental issues is not new; semantically similar concepts to ENPD could be easily found from the literature. For instance, terms such as "green new product development", "sustainable product development (SPD)", and "eco-products"all share same concepts of caring for the environment.

In the current study, ENPD is defined as "explicitly integrate environmental concerns into the process of product development"; moreover, ENPD also includes the redesign of existing products [21]. Four key differences between NPD and ENPD could be identified from the literature, namely: a broader consideration of customer satisfaction, a focus on physical product life cycles, a focus on design for post-use applications, and an augmented supply chain perspective [21]. Other researcher [22] thought of ENPD as "a first synthesis of theory and practice" and argued that literature about ENPD is a "rather hazy one"; in addition, the author also claimed that the intersection between environmental product development (EPD) and NPD constructs the concept for ENPD [22].

Other scholars identified the underlying dimensions of ENPD from their investigation with 1,000 UK manufacturers [21], including: 1. explicit environmental policy, 2. a high degree of top management support, 3. a high degree of integration of environment coordinator in ENPD process, 4. a high degree of supplier involvement, 5. a high degree of effective groundwork, 6. a high degree of environmental impact databases, 7. a high level of environmental benchmarking, and 8. a high degree of cross-functional coordination. Dimension 1 can be linked with greening drivers while dimension 3, 4, and 8 can be linked with collaboration. Moreover, dimensions 2, 5, 6, and 7 focuson the team level. Beside these important dimensions, three factors of particular importance to the success of ENPD were found from a previous study, including: design specification, project coordination, and management support [23]. All these linkages justify the interaction among ENPD, collaboration, and eco-design discussed in the current study.

3. Terms for Environmental Protection

As the focus of product design transits from "green" to "eco" to "sustainable", a broadening scope in theory and practice could be perceived [24].From the classic and instructive definition derived from UN 1987 documents, sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs;in other words, sustainable development extends the time span of the protection concept. That is, the concept of eco-design is considered as a multi-dimensional term.

3.1 Definitions of Eco-design and Other Similar Terms

Eco-design is the main stream of the design concept for the environment; eco-design is also a critical part of green supply chain management [9, 25, 26]. Eco-design could not only minimize environmental impact throughout the life cycle of product development [20], but also being viewed as "cleaner production or design for the environment". In other words, eco-design is a design process incorporating environmental considerations through eco-design approaches [27]. Other study proposed that eco-design and DfE (Design for the Environment) are synonymous [22]. In short, as environmental considerations were embedded in the process of design, the process could be viewed as eco-design.

3.2 Approaches for Eco-design

A plethora of studies on the benefits of eco-design could be found from the literature. For instance, a recent study indicated that benefits of eco-design could be classified into economic benefits and non-economic benefits [7]. Most case studies of eco-design came from European countries, but the universal perception is that, the main goal of eco-design is to decrease environmental impact or load and to "create sustainable solutions that satisfy human needs and desires" [28]. In addition, six approaches were considered as general ideas for eco-design, including: reuse, recycle, reduce, replace, rethink, and repair [12]. 'Reuse' means to design components of products as reusable ones. 'Recycle' means to choose recyclable materials and design products easily to take apart for recycle in manufacturing process. 'Reduce' means to reduce power and material consumption. 'Replace' means to replace harmful substances with more environment friendly materials. 'Rethink' means to

rethink the product and its functions. 'Repair' means that products are repairable to avoid waste. Other researchers recommended "The Ten Golden Rules" as directions for eco-design, but those rules need to be customized for specific areas [29]. Although some of those approaches are area-specific, they could be seen as guidelines for conducting eco-design and for improving the performance of ENPD. In the following section, previous studies about critical success factors of eco-design will be provided as important reference in the data collection process of the current study.

3.3 Eco-design Success Factors

Numerous studies on eco-design were conducted in the past; the success factors derived from those studies are helpful for exploring effective integration of collaboration and ENPD team in the current study. Table 2 lists the success factors discussed from previous studies.

Table 2 Success Factors of Implementing Eco-design

Source	Success factors of eco-design implementation
Cramer and Stevels [30]	(1) the organization's culture, (2) business conditions such as profitability and market share, (3) the degree of environmental influence exerted by external stakeholders, (4) the available room to maneuver in relation to degrees of freedom for (re)design, and (5) the degree to which environmental issues can be used to gain a competitive edge.
Johansson [20]	management, customer relationships, supplier relationships, development process, competence and motivation
Boks [31]	customization, organization, and communication.

A literature review categorized those factors into six areas [20]; a recent study also provided three categories of eco-design success factors [31]. Based on aforementioned studies, the current study utilized two main categories, namely internal factors and external factors, to analyze collected data. The factors are listed in Table 3.

Table 3 Internal and ExternalEco-design Success Factors

Category	Success Factors
Internal Factors	Management: development process, and motivation
	Organization: motivation, the available room to maneuver in relation to degrees of freedom for (re)design, and the organization's culture
	Capability: customization, communication, and competence
External Factors	Relation: customer relationships, supplier relationships, business conditions such as profitability and market share, and the degree of environmental influence exerted by external stakeholders

The importance of collaboration could be easily identified from the above table. This fact corroborates the importance of integrating collaboration into the process of ENPD; however, the role played by collaboration during the process of ENPD is still in unclear. In the following section, related literature about collaboration will be discussed to further explore possible directions for integrating collaboration into the process of ENPD.

4. Collaboration

Researchers pointed out two important issues for companies to protect the earth: eco-design for reducing environmental impact and collaboration with customers for environmental concerns [9].The importance of collaboration was clearly identified from the literature. A previous study argued that the difference between successful innovation and unsuccessful one lies in the degree of collaboration [32]. As concluded from a recent study [33], "Future advantage (of companies) will go to those that can stimulate and support inter-unit collaboration to leverage their dispersed resources." The concept of collaboration has been existed for decades;the benefits of collaboration were widely accepted as well. However, the literature about collaboration is fragmented [34]. In order to get a whole picture and a better understanding of collaboration, the following sections will be dedicated to decompose the concept of collaboration from different angles.

4.1 Definitions of Collaboration

The term collaboration could be found in different circumstances; however, previous studies provided diverse definitions of collaboration [35]. Moreover, different perspectives were taken to clarify the concept of collaboration, such as process, network, and conflation viewpoints. The process viewpoint considers collaboration as a process involving two or more parties to work together to achieve beneficial outcomes. Other definitions and viewpoints of collaboration are listed in Table 4.

Table 4 Definitions and Viewpoints of Collaboration

Source	Definition	Viewpoint
Gray [36]	"parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible"	Process viewpoint
Wood and Gray [37]	"a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain"	
Schrage [38]	A process of shared creation by more than one individual possessing complementary skills, which outdoes previous state alone	
Miles et al. [39]	"whereby two or more parties work closely with each other to achieve mutually beneficial outcomes"	
Kolfschoten and de Vreede [40]	a process or a system to achieve goals with people interacting deliberately through technology and communication modes.	Process/ System viewpoint
Pasquero [41]	"loosely coupled, multilayer networks of referent organizations designed to lead stakeholders to take voluntary initiatives toward solving a shared social problem"	Network viewpoint
Huxham [42]	an inter-organizational domain occupying a position between a single organization and the society	Conflation viewpoint
Huxham [43]	"all kinds of inter-organizational relationships"	
Iivonen and Sonnenwald [44]	"human behavior that facilitates the sharing of meaning and completion of activities with respect to a mutually shared superordinate goal and which takes place in a particular social, or work, setting"	

Source: Adapted from [34]

Although different definitions of collaboration could be found from the literature, similar features do exist such as "mutual" [39, 44], "shared" [37, 38, 41, 44], and "complementary" [38]. Based on the process viewpoint and the nature of the notebook industry, the current study considers collaboration as "a process in networks involving more than one party with shared mindsets, complementary skills, and sources of knowledge for achieving mutually beneficial outcomes by conducting different activities and solving a problem."

4.2 Collaboration Barrier

Based on the definition provided in the previous section, two critical issues should be discussed here: collaboration barrier and collaboration capability. Collaboration might take place inside or outside of organizational boundaries; therefore, understanding possible barriers is very important for improving performance of collaboration. Based on an intensive investigation from manufacturing, retail, consumer goods, health care, professional services, financial and high-tech industries, four types of barriers were generalized [33]: 1. unwillingness to seek input and learn from others; 2. inability to seek and find expertise; 3. unwillingness to help; 4. inability to work together and transfer knowledge. These barriers were further simplified into three broad categories, namely: leadership behaviors, shared values and goals, human resources procedures and lateral cross-unit mechanisms. From a survey conducted by Management Roundtable and the Product Development & Management Association to collaborative innovation, the authors concluded four barriers of collaboration, including: physical barriers, organizational barriers, relational barriers, and knowledge barriers [10].

4.3 Collaboration Capability

Collaboration capability was viewed as the capacity and readiness of an organization before collaborating [42]. Information processing, communication, knowledge transfer, intra- and inter-unit coordination, the ability to develop trusting relationships, and negotiation are critical ingredient of collaboration capability [45]. A white paper composed by a consulting company [46] also argued that collaboration capability could represent the orientation and infrastructure of an organization to collaborate under prospective future. A more recent study [16], from another perspective, concluded that collaboration capability is a cross-level concept. The current study considers collaboration capability as "the actor's capability to build and manage network relationships based on mutual trust, communication, and commitment".

5. Underlying Linkages among Eco-design, Collaboration Capability, and Greening Drivers

It is well recognized that continuously providing new products could help companies to secure competitive advantages; facing the declining importance of traditional resources and the surge of environmental issues, eco-design and collaboration might be helpful to protect the market share and increase customer loyalty. In other words, eco-design and collaboration are considered beneficial and import for companies competing in the global market [9, 33]. As ENPD is conducted at the team level for the notebook industry, the current study focus on exploring relationship among the aforementioned concepts at this level. In order to provide environmentally friendly new products and attract existed as well as prospective customers, a proper coordination between eco-design and collaboration is needed [47, 48].Green drivers, act as guidelines or rules for developing new products, also need to be backed up by eco-design and the capability of the company to collaborate with other parties during the process of ENPD. Moreover, as a fact that different kinds of teams are

utilized for developing new products, all concepts described in previous sections converge at the team level, the focus of the current study.

III. Research Method

This study adopted in-depth interview and content analysis for collecting, analyzing, and interpreting data. In the following sections, rationale for choosing notebook industry in Taiwan would firstly be provided followed by details about research design.

1. Why Notebook Industry in Taiwan?

It is well accepted that high tech companies "with higher degree of implementation of green design activities and better implementation of development strategies of new products have better development performance of new products. [49]" As a major manufacture of notebook in the world and the fact that 70 -80 percent of cost in the notebook's product lifecycle and its impact to the environment are determined during the process of product design [12, 13], other studyindicated that Taiwanese original equipment manufacturers (OEM) and original design manufactures (ODM) should adopt green procurement and green manufacturing practices to respond to the green wave and to ensure environmental and financial performances [8]. While previous studies on notebook industry mainly focused on SCM and business models [50, 51, 52];little attention have been paid to discuss green motives, eco-design, and collaboration capability. It is then considered of great importance to figure out the relationships among those concepts for the long term prosperity of the notebook industry.

2. Research Design

This study utilized in-depth interview for collecting data; qualitative content analysis was then used for data analysis and interpretation. Based on PSI/AIDSMark Social Marketing Research Tool Kit 2004, in-depth interview performs well when objectives are to explore relatively unknown behaviors (eco-design and collaboration), to explore how and why of behaviors (eco-design and collaboration), and to improve the process of the behavior (collaboration). Qualitative content analysis was used because opinions provided by interviewees should be analyzed through qualitative approaches. The current study adopted the features of general qualitative research analysis and chose the most appropriate approach, summative content analysis for interpreting transcripts of the interview.

Content analysis was defined as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns [53]." The following steps were used for the current study: 1. preparation of raw data files; 2. close reading of texts; 3. creation of categories; 4. overlapping codes and uncoded text; 5. continuing revision and refinement of category system [54].

IV. Results

Four interviewees from three notebook corporations were invited to participate the current study; three coders from related field contributed to the process of analyzing collected data (details about the interviewees is provided in Table 5). With 0.52 of inter-rater agreement and 0.76 of reliability, the coders analyzed the manuscripts in a word-by-word fashion for issues mentioned above. Related sentences were collected as themes and then sorted into primary and secondary categories based on the literature; new categories founded from the manuscripts were established. In order to reach inter-subjectivity, the process of coding aims to be clear, easy, and objective. The final number of themes was 264. After selecting themes, these themes were categorized into primary and secondary categories based on literature review; new categories were also added. The preliminary categories include greening driver, collaboration capability, and eco-design.

Table 5 Information about the Interviewee

Information	Interviewee A	Interviewee B	Interviewee C	Interviewee D
Type of the company	Notebook Brand & ODM corporation	Notebook Brand & ODM corporation	ODM corporation	ODM corporation
Position in the ENPD team	Chief Procurement Officer	Component engineer director	Human- computer interaction director	Green engineer
Working experience	15 years	11 years	6 years	1 year

Table 6 Primary and Secondary Categories

Primary categories (1)(2)(3)	Secondary categories
Greening driver (1)	Regulation (A), marketing (B), competitor (C), internal factor (D), cost (E), performance (F), product (G), and supplier (H)
Collaboration capability (2)	Communication (A), mutual trust (B), and commitment (C)
Eco-design (3)	Reduce (A), rethink (B), recycle (C), repair (D), replace (E), and reuse (F)

Table 6 lists primary categories and secondary categories selected by the coders. If a sentence stated by the interviewee is considered insightful enough to fit a specific category, the sentence would be selected and classified into specific category respectively. For instance, interviewee A stated:

"Thus we should conform with the regulations of EU, and the regulations are actually of global regulation now."

This sentence would be coded as 1A because regulation (A) is mentioned; regulation (A) also belongs to greening driver (1), therefore the theme was coded as 1A. The coders followed this guideline to analyze the transcripts; in the end 264 themes were identified and categorized.

1. **Greening Drivers**

For the 264 themes, greening drivers occur 83 times. The most common driver is regulation (1A) which is mentioned by the interviewees for 38 times; the second common driver is supplier (1H). Although brand corporation and ODM corporation consider green as an important issue, the drivers for conducting related activities are different. For example, interviewee A stated that:

"Let me put it in this way, that components can only enter the supply chain when they comply with related regulations. Several tests need to be done before the provider could be considered as an official supplier."

The above quotations not only indicated the role of suppliers but also the role of component providers. Another example from interviewee D stated as follows:

"Sometimes the customer will clearly describe his needs because he is the owner of the products. He must know what regulations to comply with."

The above sentence could not be easily classified into a specific category, but the importance of customer was mentioned in the literature [18]. In other words, requests from customers might be considered important driver for ODM corporation to be green.Based on the results of analyzing transcripts, RoHS is the most important regulation; Halogen free is a new trend. Form the literature, cost is thought to be an important driver, but the word cost did not appear from the interviews. This fact might imply that greening in notebook industry in Taiwan still have a long way to go at ENPD team level as companiesmainly conduct greening activities by mandatory regulations.

2. Collaboration Capability

Sentences categorized into collaboration capability counts 57 times. Communication is considered an issue with high priority. As interviewee A stated:

"Later we continued to cooperate and kept communicating with each other because he had his own RD as we did." Another quotation from interviewee D stated as follows:

"The role we played is to coordinate each function to complete the task."

"It (conducting green related activities) requires many departments to cooperate for accomplishing the task; communication among different departments is inevitable." In addition, the second theme cited from interviewee D points out a very interesting fact that collaboration in practice may not be perceived as collaboration but as cooperation. The importance of mutual trust (B) could be found from interviewee D:

"After building up a long term relationship, we could have mutual trust with our customers. It would be much easier to cooperate with those customers because we have tacit understanding of each other."

it is easy to understand that,from the above quotations, communication could be seen as the most important indicator of collaboration capability. External collaboration and internal collaboration are both vital for the success of greening activities.

3. Eco-design

As mentioned above, eco-design is a relatively new topic; therefore, it is not surprising that eco-design did not show up from the interview. Most of the six approaches proposed in previous studies were not mentioned by the interviewees; only replace, reduce, and reuse were mentioned for a couple of times during the interview.

V. Conclusion, Implication, Limition, And Future Directions

Through in-depth interviews, the current study collected data to figure out the relationships among green drivers, eco-design, and collaboration capability in Taiwanese notebook industry at the team level; qualitative content analysis was utilized to probe and analyze the transcripts by three coders. Conclusion, implication, limitation and future directions for academia as well as practitioners on issues concerning environmental protection, greening driver, collaboration, and eco-design are provided in the following sections.

1. Conclusions

The results indicate that RoHS is the most important driver for companies participated in the current study; the second important driver is the demands from the supplier. Brand companies mainly follow RoHS to select suppliers and component providers; ODM corporations, on the other hand, just responded to the requests

from their customers. EuP is not commonly seen and known by the interviewees except for interviewee D (the green engineer). Communication is the most important element for collaboration, internal and external as well.

The current study also found that approaches for eco-design proposed by previous studies were not very popular in practical settings. The results indicated that, currently, practitioners focus on the usage of restricted substances such as, lead (Pb), mercury (Hg), cadmium, hexavalent chromium (Cr6+), polybrominatedbyphenyls (PBB), and polybrominateddiphenyl either (PBDE) and ignore other possible solutions for eco-design.

2. Research Implication

Implications for practitioners could be classified into three categories: green driver, collaboration, and eco-design.

(1). Greening driver:

From the results, brand companies should more actively utilize eco-design to respond to the green wave, to reduce the impact on the environment, and to gain sustainable competitive advantage through collaboration with partners from the supply chain. In addition, in order to secure the shipment and sales in different regions, members in the ENPD team should extensively search for related regulations or directives for establishing the reputation of environmental friendly.

(2). **Collaboration**:

Communication is by no means the most important element for successful collaboration; directors and all the members in ENPD teams should cultivate the ability of smoothly communicate with others inside or outside of the company to make sure the information could effectively and efficiently transfer to other parties.

(3). Eco-design:

Unfortunately, six eco-design ways are not well and fully considered by the participants; managers are advised to promote those approaches to all members of ENPD teams.

3. Limitation

Some limitations deserve to be mentioned for the current study. First of all, the focus of the current study is the ENPD team in notebook industry; therefore, results as well as implications might not be suitable for other levels or companies in other industries.Secondly, although the authors tried to be as objective as possible during the data collection as well as data analyzing processes, subjectively interpretation could not be completely avoided. Moreover, the process of in-depth interviews could not be fully controlled by the interviewer; data and results derived from the current study should be used with caution.Finally, the opinions and statements provided by the interviewees could not represent their respective companies. However, the results from the current study do provide some insights about the current state of the notebook industry in Taiwan.

4. Future Direction

From previous studies and the results of current study, it could be argued that, the greening drivers, collaboration, and eco-design are vital for the success of any greening related activities. However, elements of each topic deserve further investigation. Comparing companies with/without government subsidizations might generate more information about the greening drivers; companies from other industries might also help provide more generalized insight of those topics. In addition, collecting data from partners in the same supply chain might also help discover the essence of collaboration.

Acknowledgements

The author would like to express his gratitude to Mr. Hung Guan Wen and two anonymous colleagues for their kindly help during the process of data collection and data analysis. The current study would not stand a chance to be finished without the cooperation of the interviewees; thanks for their time sharing with us.

References

[1] J. J. Bacallan, Greening the Supply Chain,*Business and Environment*, 6,2000, 11-12.

[2] J. Mairand L. Jago,The Development of a Conceptual Model of Greening in the Business Events Tourism Sector,*Journal of Sustainable Tourism*,18, 2010,77-94.

[3] M. E.Porterand C. van der Linde,Green and Competitive: Ending the Stalemate,*Harvard Business Review*, 73,1995, 120-134.

[4] M. E. Porterand C. van der Linde,Toward a New Conception of the Environment-Competitiveness Relationship, *Journal of Economic Perspectives*, 9,1995, 97-118.

[5] Q.Zhuand J. Sarkis, An Inter-Sectoral Comparison of Green Supply Chain Management in China: Drivers and Practices,*Journal of Cleaner Production*, 14, 2006, 472-486.

[6] P. J.Daugherty, R. G. Richey, A. S. Roath, S. Min, H. Chen, A. D. Arndt and S. E. Genchev, Is Collaboration Paying Off for Firms?*Business Horizons*, 49,2006, 61-70.

[7] S.Plouffe, P. Lanoie, C. Bernemanand M. F. Vernier, Economic Benefits Tied to Eco-design,*Journal of Cleaner Production*, 19, 2011,573-579.

[8] M. K. Chienand L. H. Shih, An Empirical Study of the Implementation of Green Supply Chain Management Practices in the Electrical and Electronic Industry and Their Relation to Organizational Performances,*International Journal of Environmental Science and Technology*, 4,2007, 383-394.

[9] Q.Zhu, J. Sarkisand K. H. Lai, Confirmation of a Measurement Model for Green Supply Chain Management Practices Implementation, *International Journal of Production Economics*, 111,2008, 261-273.

[10] M. Swink, Building Collaborative Innovation Capacity,*Research-Technology Management*, 49,2006, 37-47.

[11] F. Testaand F. Iraldo, Shadows and Lights of GSCM (Green Supply Chain Management): Determinants and Effects of These Practices Based on a Multi-National Study,*Journal of Cleaner Production*, 18,2010, 953-962.

[12] P. H.Ho,Eco-Way: The Design and Management for Electronic Products,*Quality Magazine*, 45,2009, 24-32.

[13] R.Rothwell,Success Industrial Innovation: Critical Success Factors for the 1990s,*Research Policy*,22, 1992, 221-240.

[14] S. Y.Chiang, C. C. Wei, T. H. Chiang and W. L. Chen, How Can Electronics Industries Become Green Manufacturers in Taiwan and Japan, *Clean Technologies and Environmental Policy*,13,2011, 37-47.

[15] C. A.Grote, R. M. Jones, G. N. Blount, J. Goodyear and M. Shayler, An Approach to the EuP Directive and the Application of the Economic Eco-design for Complex Products,*International Journal of Production Research*, 45,2007, 4099-4117.

[16] K.Blomqvistand J. Levy, Collaboration Capability - A Focal Concept in Knowledge Creation and Collaborative Innovation in Networks,*International Journal of Management Concepts and Philosophy*, 2,2006, 31-48.

[17] P. Bansal and K. Roth, Why Companies Go Green: A Model of Ecological Responsiveness, *The Academy of Management Journal*,43,2000, 717-736.

[18] A. Vercalsteren, Integrating the Eco-design Concept in Small and Medium-Size Enterprises: Experiences in the Flemish Region of Belgium,*Environmental Management and Health*, 12,2001, 347-355.

[19] M.Borchardt, M. Wendt, G. M. Pereira and M. A. Sellitto, Redesign of a Component Based on Eco-design Practices: Environmental Impact and Cost Reduction Achievements,*Journal of Cleaner Production*,19,2011, 49-57.

[20] G. Johansson, Success Factors for Integration of Eco-design in Product Development: A Review of State of the Art, *Environmental Management and Health*, 13,2002, 98-107.

[21] D. Pujari, G. Wright and P. Ken, Green and Competitive: Influences on Environmental New Product Development Performance,*Journal of Business Research*, 56,2003, 657-671.

[22] L. Berchicci, *Innovation for sustainability: Green entrepreneurship in personal mobility*(London: Rutledge, 2009).

[23] L. Berchicciand W. Bodewes, Bridging Environmental Issues with New Product Development, *Business Strategy and the Environment*,14,2005, 272-285.

[24] H. Baumann, F. Boons and A. Bragd, Mapping the Green Product Development Feld: Engineering, Policy and Business Perspectives,*Journal of Cleaner Production*,10,2002, 409-425.

[25] C. W. Hsu and A. H. Hu, Green Supply Chain Management in the Electronic Industry,*International Journal of Environmental Science and Technology*, 5,2008, 205-216.

[26] S. K. Srivastava, Green Supply-Chain Management: A State-of-the-Art Literature Review,*International Journal of Management Reviews*, 9,2007, 53-80.

[27] I. Ben-Gal, R. Katz and Y. Buckhin, Robust Eco-design: A New Application for Air Quality Engineering, *IIE Transactions*, 40,2008, 907-918.

[28] R. Karlssonand C. Luttropp, EcoDesign: What's Happening? An Overview of the Subject Area of EcoDesign and of the Papers in This Special Issue,*Journal of Cleaner Production*, 14,2006, 1291-1298.

[29] C. Luttroppand J. Lagerstedt, EcoDesign and The Ten Golden Rules: Generic Advice for Merging Environmental Aspects into Product Development, *Journal of Cleaner Production*,14,2006, 1396-1408.

[30] J. Cramerand A. Stevels, *Sustainable solutions*(London: Greenleaf Publishing, 2001).

[31] C. Boks, The Softside of Ecodesign,*Journal of Cleaner Production*, 14, 2006, 1346-1356.

[32] K. Ramani, D. Ramanujan, W. Z. Bernstein, F. Zhao, J. Sutherland, C. Handwerker, J. K. Choi, H. Kim and D. Thurston, Integrated Sustainable Life Cycle Design: A Review,*Journal of Mechanical Design*, 132, 2010, 091004-1-091004-15.

[33] M. T. Hansenand N. Nohria, How to Build Collaborative Advantage,*MIT Sloan Management Review*, 46,2004, 21-30.

[34] T. Rura-Polleyand S. Clegg, Managing Collaborative Quality: A Challenging Innovation,*Creativity and Innovation Management*, 8, 1999,37-47.

[35] N. Hara, P. Solomon, S. L. Kim and D. H. Sonnenwald, An Emerging View of Scientific Collaboration: Scientists' Perspectives on Collaboration and Factors that Impact Collaboration,*Journal of the American Society for Information Science and Technology*, 54, 2003, 952-965.

[36] B. Gray,*Collaborating: Finding common ground for multiparty problems*(San Francisco, CA: Jossey-Bass, 1989).

[37] D. J. Woodand B. Gray, Toward a Comprehensive Theory of Collaboration,*The Journal of Applied Behavioral Science*, 27,1991, 139-162.

[38] M. Schrage, *Nomore teams! Mastering the dynamics of creative collaboration*(New York, NY: Currency and Doubleday, 1995).

[39] R. E. Miles, G. Miles and C. C. Snow, Collaborative Entrepreneurship: A Business Model for Continuous Innovation,*Organizational Dynamics*, 35,2006, 1-11.

[40] G. L. Kolfschotenand G. J. de Vreede, A Design Approach for Collaboration Processes: A Multimethod Design Science Study in Collaboration Engineering,*Journal of Management Information Systems*, 26,2009, 225-256.

[41] K. Pasquero, Supraorganizational Collaboration: The Canadian Environmental Experiment,*Journal of Applied Behavioral Science*, 27,1991, 37-64.

[42] C. Huxham, Pursuing Collaborative Advantage, *Journal of the Operational Research Society*, 44,1993, 599-611.

[43] C. Huxham, *Creating collaborative advantage*(London: Sage Publications, 1996).

[44] M. Livonenand D. H. Sonnenwald, The use of technology in international collaboration: Two case studies," in D.H. Kraft (Ed.), Proceedings of the 63rd American Society for Information Science Meeting(Medford, NJ: Learned Information, 2000) 78-92.

[45] B. B. Tyler, The Complementarity of Cooperative and Technological Competencies: A Resource-Based Perspective,*Journal of English Technology Management*, 18, 2001, 1-27.

[46] A Frost & Sullivan White Paper Sponsored by Verizon Business and Microsoft, "Meetings Around the World: The Impact of Collaboration on BusinessPerformance", Retrieved World Wide Web,http://newscenter.verizon.com/kit/collaboration/MAW_WP.pdf

[47] G. Avila, Product Development for RoHs and WEEE Compliance,*Printed Circuit Design and Manufacture*, 23,2006, 28-31.

[48] M. Walls, Extended Producer Responsibility and Product Design: Economic Theory and Selected Case Studies,*Resources for the Future*,2006, 1-47.

[49] Y. C. Chung and C. H. Tsai, The Effect of Green Design Activities on New Product Strategies and Performance: An Empirical Study among High-tech Companies,*International Journal of Management*,24,2007, 276-288.

[50] C. M. Feng and C. H. Chern, Key Factors Used by Manufacturers to Analyze Supply-Chain Operational Models: An Empirical Study among Notebook Computer Firms, *International Journal of Management*,25,2008, 740-755.
[51] C. M. Feng and C. H. Chern, The Development of a Supply Chain Model for the Computer Notebook Industry,*International Journal of Management*, 26,2009, 197-212.
[52] I. S. Yung, H. W. Lee and H. H. Lai, Competitive Advantages Created by a Cluster Collaboration Network for Supplier Management in notebook PC Production,*Total Quality Management & Business Excellence*, 20,2009, 763-775.
[53] H. F. Hsieh and S. E. Shannon, Three Approaches to Qualitative Content Analysis,*Qualitative Health Research*, 15,2005, 1277-1288.
[54] D. R. Thomas, *Qualitative data analysis: Using a general inductive approach*(New Zealand: Health Research Methods Advisory Service, Department of Community Health University of Auckland, 2000).