MEASURING THE GREEN-core COMPETENCE OF THE ELECTRONICS INDUSTRY

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Abstract

The study is an exploration of the green core competence of semiconductor firms listed with the Semiconductor and Electronics Industries in the Philippines (SEIPI). It aims to explore the positive effects on the green innovation and green image of the Philippine semiconductor and electronics industry. Furthermore, the study is an adaptation and a longitudinal conventional approach of Yu-Shan Chen’s work Driver of Green Innovation and Green Image-Green Core Competence. In a survey of the firms’ top management, results showed that the green core competence of firms is positively correlated only to green images and green process innovation performances. However, the green core competence is negatively correlated to green product innovation. This means that the Philippine electronic companies do not make any effort to positively contribute to the
environment when choosing their products’ materials since they are merely subcontractors of major companies abroad.

The study also found that green core competence, green product innovation performance, green process innovation performance, and green images of small and medium enterprises (SMEs) were all significantly less than those of large enterprises in the Philippine semiconductor and electronics industry. Furthermore, those companies in the introductory and maturity stages of development are highly negatively correlated in terms of green core competence and green product innovation as compared to those companies in the growth stage of their innovation development. This indicates that green product innovation develops at a slower rate than do green process innovation.

**Keywords**: green core competence, green innovation, green image, corporate environmental management
The electronics industry, according to Philippine Business for Education (PBED) President Chito Salazar, is one of the most dynamic industries in the global economy. It is one of man’s necessities today. One can find them in computers, televisions, telecommunications equipment, military hardware, automobiles, and in the aerospace industry. Moreover, the demand for electronic products shows no signs of slowing down. According to the Semiconductor and Electronics Philippines, Inc. (SEIPI), the Philippines in 2004 contributed 10 percent of the world’s supply of semiconductor manufacturing services.

While electronic products comprised only 3 percent of the Philippines’ exports in 1970, it has jumped to 61 percent in 2010 (Figure 1) and will continue to rise as technology continues to advance. In fact, there has been a dramatic shift in the Philippines’ exports from agro-based products to electronic goods through the years.

However, the environmental impact is a growing problem in the Philippines as well as in the world. This relationship

Background of the Study
between environment and advancement in technology is inversely proportional. Meaning, as the technology advances, the environment worsens. Apparently, consumers are now becoming more conscious of the value of the environment due to the effects of global warming. More so, corrective policies in the last several decades have been implemented to remedy such environmental damage.

To eliminate the problems of environmental pollution, the concepts of environmental management (i.e., green management, green marketing, green production and green innovation) are now being pursued. The rise of
international environmental regulations such as the Montreal Convention, Kyoto Protocol, Restriction of the Use of Certain Hazardous Substances (RoHS) in electrical and electronic equipment (EEE), and the Waste Electronics and Electrical Equipment (WEEE) directives, and even the consumers’ increasing environmental consciousness would bring significant impact on businesses in the world (Chen, 2008).

Traditional companies do not really believe in investing in environmental management. They consider environmental management a waste of their time for it allegedly would not contribute at all to a company’s growth. However, several studies now point to pollution as the concrete evidence of inefficient use of resources, and companies that do pioneer in green innovation will enjoy the “first advantage,” which will allow them to ask for a higher price for green products and, at the same time, to improve their corporate images, develop new markets, and gain competitive advantages.

In fact, engagement in environmental management has a great impact on a company’s overall productivity. It helps minimize production waste, increase corporate reputation,
and enhance corporate competitiveness. Previous scholarly works had focused and scrutinized the pertinent issues of core competence, but none had explored core competence in green innovation or environmental management. Thus, this study was commenced to fill this research gap.

This study focused on finding the correct standpoint and evaluation for new concepts of environmental management in compliance with the principles of green innovation and green images. For this reason, this research proposed the novel construct, “green core competence”, developed its research framework, employed an empirical study to verify the research hypotheses, and finally explored the managerial implications of green core competences of firms (Chen, 2008).
Why firms should respond to environmental regulations has been one issue tackled in various studies. A fundamental debate in environmental management is: Should it be corporate social responsibility or corporate social responsiveness?

Today, governments’ policies on environment protection and the existence of both national and international environmental regulations have significantly impacted the operations of companies. So had consumers’ increasing environmental consciousness driven companies to enhance their ability to manage their environment (Hart, 1997; Peattie, 1992).

One of two forces driving companies to engage in environmental management is the set of international environmental protection regulations such as the Montreal Convention and Kyoto Protocol. The other force is the environmental consciousness of consumers (Chen, Lai, & Wen, 2006). Environmentalism leads enterprises to pay more attention to corporate environmental management. Here, consumers are more willing to choose green products and even pay relatively high prices for environment-friendly products (Henriques & Sadorsky, 1996).
Hence, companies are forced to carry out environmental protection and recognize the environmental consciousness of consumers (Berry & Rondinelli, 1998; Hart, 1995, 1997). Businesses that adopt the hands-on strategies of environmental management can now highlight the goals of environmental protection to its various departments (Greeno & Robinson, 1992). There is now an obligation to anticipate and plan for environmental issues and to incorporate this thinking into corporate strategies. Therefore, an up-and-coming field of management deals with the natural environment as it affects corporate strategy (Rugman & Verbeke, 1998).

Companies, especially those in manufacturing, are always blamed for the pollution in the world. Such costs them financially as well as in terms of their corporate image. It is here where they now can turn to green innovation to increase their productivity, and consequently make up for their environmental costs. According to Porter and van der Linde, companies that pioneer the green innovation concept will have be the “first-mover” advantage, and thus, can charge relatively high prices for their green products and further obtain competitive advantages.

Firms focused on environmental management can not only avoid violating environmental protection laws, but also enable them to improve their corporate images and develop
new markets. In addition, they can further embody the concept of green products in their product design and packaging. Such would help differentiate their products in the market (Chen et al., 2006; Hart, 1995; Peattie, 1992; Porter & van der Linde, 1995; Shrivastava, 1994, 1995).

Environmental Policies in the Philippines

Various driving forces, both internationally and locally, have been shaping the implementation of environmental management in the Philippines over the years. From a simplistic, regulatory standpoint, the country is making significant improvements in environmental governance by actively soliciting the participation of multi-stakeholders and by crafting enabling mechanisms that support sustainable development principles. An intensified global environmental advocacy and the need to balance the growing environmental concerns with national development and socio-economic agenda were the main factors that influenced a change in people’s perspective. Recent national environmental mandates aspire to promote the twin goals of sustainable use, management and conservation of the country’s natural resources on one end, and protection and enhancement of the environment on the other end.

The next sections discuss the Philippine environmental policies and legislations. Data were taken from an article written by Regina Victoria J. Pascual, a manager of the Energy Development Corporation in Taguig City.
In the early years, environmental protection in the Philippines was not delegated to a single government agency. Instead, environment-related concerns were part of the coverage of several agencies dealing with agriculture, natural resources, health, housing, and public works (EMBUNDP Training Manual, 1996). It was only in 1964 when the National Pollution Control Commission (NPCC) was created to handle air and water pollution control in the country. In 1977, the National Environmental Protection Council (NEPC) was created as the policy-making body on matters related to environment. In 1986, however, major institutional changes were introduced in the government’s structure as a result of a change in its political administration. One of these was the creation of the Environmental Management Bureau (EMB) in 1987, under the Department of Environment and Natural Resources (DENR). The EMB assumed the regulatory functions of both the NEPC and the NPCC (Pascual).
Hypothesis Development

Positive Effect of Firms’ Green Core Competencies on Green Innovation Performance

Firms should build and nurture a group of core competencies, according to Prahalad and Hamel (1990). Core competence is the collective learning in the organization, especially the capacity to coordinate diverse production skills and integrate streams of technologies (Prahalad & Hamel, 1990). Previous studies on core competence have deliberated either on the term’s theoretical concept or its usefulness as a strategic tool for firms (Srivastava, 2005). Because traditional methods of studying competitive advantage are not adequate to explain how firms operate effectively in turbulent and often chaotic environments, a resource-based view focusing on development and application is offered to supplement those inadequate traditional methods, and can form the basis of competitive advantage (Hafeez, Zhang, & Malak, 2002; Lei, Hitt, & Bettis, 1996).

This study defined green core competence as the collective learning and capabilities about green innovation and environmental management in an organization (Chen, 2008). Pollution is the concrete representation of the inefficient uses in resources (Porter & van der Linde, 1995), and businesses therefore can increase resource productivity through green innovation to make up for the environmental costs.
This study also referred to green innovation as hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy saving, pollution prevention, waste recycling, green product designs, or corporate environmental management (Chen et al., 2006). The green innovation enhances the performance of environmental management in satisfying the requirements for environmental protection. Moreover, Chen, Lai, and Wen (2006) divided green innovation performance into green product innovation performance and green process innovation performance. This study defined the green product innovation performance as the performance in product innovation that is related to environmental innovation, including the innovation in product that saves energy, prevents pollution, recycles waste, has no toxicity or presents green product designs (Chen et al., 2006). Furthermore, it defined the green process innovation performance as the performance in process innovation that saves energy, prevents pollution, recycles waste, and has no toxicity (Chen et al., 2006).

Talke, Salomo, and Mensel (2006) developed a competency-based model that helps to explain the occurrence of initiatives for innovation and argued that the development of competence can stimulate innovation. On the other hand, Ritter and Gemünden (2003) thought companies needed to develop their competences to increase their innovation success, and firms’ competences had a significant positive impact on their innovation success. Hence, previous studies posited that core competences of firms could drive their innovation as well as further enhance their innovation performance.
However, there is no study exploring the relationship between green core competence and green innovation performance. This study filled this research gap, and asserted how green core competence had a positive effect on green innovation performance. It also referred to Chen et al. (2006) when it divided green innovation performance into green product innovation performance and green process innovation performance. Therefore, this study implied the following hypotheses: (Chen, 2008)

Hypothesis 1 Green core competences of firms are positively associated with their green innovation performance.

Hypothesis 1a Green core competences of firms are positively associated with their green product innovation performance.

Hypothesis 1b Green core competences of firms are positively associated with their green process innovation performance.

Positive Effect of Firms’ Green Innovation Performance on Green Images

Previous studies coming from different scholarly writings confirmed the effects of green innovation performance on green images of firms, either directly or indirectly. For example, Chan (2000) demonstrated that the source country’s green image has a significant positive effect on the effectiveness of advertising, and reminded marketers of the importance of a green image. Corrigan (1996)
pointed out that the Irish export industries had had significant growth ever since the promotion of Ireland as a green European center of quality products and services, which is a positive green image. Hu and Wall (2005) posited that the competitiveness of tourist attractions could be enhanced through sound environmental management practices. Therefore, countries’ environmental management has a positive influence upon their green images. Similarly, green images are also important to companies, especially now that there are this growing consumers’ environmentalism consciousness as well as stringent international environmental protection regulations. As earlier mentioned, companies that are the pioneers of green innovation can have the first-mover advantage, and thus can charge relatively high prices for their green products and further obtain competitive advantages. In addition, enterprises may embody the concept of green products in the design and package of their products to increase their product differentiation. Firms investing efforts in environmental management not only avoid being the target of protests or punishment for violating any environmental rules, but also enable them to improve their corporate images. Therefore,
Hypothesis Development

This study asserted that environmental management of firms has a positive influence upon their green images. However, no research has ever explored the positive influence of firms’ core competences on green innovation or environmental management upon their green images. Thus, this study proposed the following hypothesis (Chen, 2008):

**Hypothesis 2** Green core competences of firms are positively associated with their green images.

**Positive Effect of Firms’ Green Innovation Performance on Green Images**

Chen (2008) defined the green innovation performance as the performance of hardware and software involved in the innovation that a company carries out in relation to green products or processes, including the innovation in technologies that saves energy, prevents pollution, recycles waste, presents green product designs and is covered by a corporate environmental management. As earlier mentioned, Chen further divided green innovation performance into either (1) green product innovation performance; or (2) green process innovation performance. It is this definition that this particular study would refer to all throughout this paper.

This green innovation enhances the performance of environmental management, which then satisfies the requirement of environmental protection. Also, through green innovation, businesses can increase resource productivity to make up for any environmental costs.
involved. Previous studies opined that by adopting proactive corporate environmental management strategies, companies might not only avoid environmentalist protests or penalties, but also help businesses develop new market opportunities and increase competitive advantage. Because of their first-mover advantage, firms that pioneer in some new green products can set higher prices. Likewise, those that embody the concept of green products in their design and packaging increase their product differentiation advantages. Therefore, this study asserted that firms’ environmental management positively influence their having a ‘green’ corporate image. It implied the following hypotheses (Chen, 2008):

**Hypothesis 3a** Green product innovation performance of firms is positively associated with their green images.

**Hypothesis 3b** Green process innovation performance of firms is positively associated with their green images.
Objective of the Study

The study aimed to explore the positive effects of green core competences on the green innovations and green images of the semiconductor and electronics in the Philippines. It also set to know the stance of these companies regarding the green practices.

Scope and Delimitation of the Study

This study had covered companies in the Philippines that are members of the Semiconductor and Electronics Industries Philippines Inc. (SEIPI). It focused on the green core competence, green product innovation performance, green process innovation performance and green image of companies.

Note that this study took all efforts to refrain from disclosing important data gathered from companies that had expressed their wish for confidentiality.
Research Framework of the Study

Sampling Design

Data gathered from respondents were tabulated and interpreted. Researchers used the marginal error of 5 percent as the basis and adopted the Sloven’s formula.

The sample size was obtained by using Sloven’s Formula:

\[ n = \frac{N}{1 + N(e^2)} \]

Where:
- \( n \) - sample size
- \( N \) - total number of population
- \( e \) - desired number of error (percentage allowance for non-precision)

The researcher considered a 10 percent allowance for precision since it is the most commonly used in the industry when doing a descriptive research.

The researcher’s total number of population (\( N \)) is 100, representing the number of regular members of the Semiconductor and Electronics Philippines, Inc (SEIPI)). By using the Sloven’s formula, the resulting sample size (\( n \)) is 80.
This study integrated the literature on environmental management and corporate strategy into a new managerial framework from the core competence perspective. As mentioned in the earlier part of the study, although many previous studies explored the issue of core competence, no research had explored core competences of firms on green innovation or environmental management. This study aimed to fill this research gap, and proposed a novel construct: the green core competence. It explored the positive effects of firms’ green core competence on their green innovation performances and green images.

Figure 2. Research Framework

The two consequences of the research framework in this study are green innovation performance and green image, while the antecedent is green core competence. Besides, this study also wanted to explore how green innovation had partial mediation effect between green core competences and green images of firms. Therefore, green innovation was not only a consequence, but also a partial mediator in the research framework. In addition, this study referred to Chen et al. (2006) when it talked about dividing green innovation performance into green product innovation performance and green process innovation performance. This study proposed three hypotheses, and showed the research framework in Figure 2 (Chen, 2008).
Data Collection and the Sample

This study’s unit of analysis was the business level. It employed an empirical study, which collected data from semiconductors and electronics industry companies that are members of SEIPI (an organization of various semiconductors and electronics industries in the Philippines) as of July 2012. It targeted both Original Electronics Manufacturing (OEM) and Subcontractors. The OEMs are companies that are responsible for innovation of their own brand for distribution in the market. Subcontractors, on the other hand, are manufacturing companies wherein products from OEMs are being subcontracted in the form of sub-assembly or whole assembly. The target respondent is shown below in an inverted pyramid form.

![Figure 3. Target Respondents](image)

All Semiconductor and Electronic Industries in the Philippines
All Members of Semiconductor and Electronics Industries in the Philippines Inc.
All Regular Members of SEIPI
All CEO's, President, Chairman, R&D Managers who are members of SEIPI

Source: SEIPI
Respondents of the questionnaires were either the corporate executive officers (CEOs) or the managers of environmental protection, marketing, or R&D departments in the Philippines’ semiconductor and electronics companies (Figure 3). To improve the valid survey response rate, this research emailed each company sampled to explain in writing such study’s objectives and the questionnaire’s content, as well as to confirm the names and job titles of the respondents. Respondents were asked to return the completed questionnaires within three weeks through mail.

Seven-point Likert-type questions were used in all constructs with 1 representing strongly disagree and 7 for strongly agree in this study. A total of 80 questionnaires were sent to the respondents. There were 56 valid questionnaires, and the effective response rate was 70 percent. Below is a diagram of survey results (Figure 4).

Figure 4. Survey Results Breakdown
Source: The Author
Definition and Measurement of the Constructs

The questionnaire consists of five parts. The first part are descriptive data on companies (including the number of employees, year founded, industry sector, etc.); the second part measures green core competences of firms. The third section is the measurement of green product innovation performance while the fourth part is on green process innovation performance. The fifth section is the measurement of green image. The definitions and measurements of the constructs were further defined as follows (Chen, 2008):

- **Green core competence**

  This study defined green core competence as the collective learning and capabilities of an organization’s green innovation and environmental management. It argued that a company’s environmental competitiveness is derived from its green core competences and green core products (the tangible results of green core competences). The green core competence proposed in this study ought to meet three requirements:

  1. It provides potential access to meet a wide variety of environmental needs of markets;

  2. It makes environmental contributions to customer benefits; and

  3. It is difficult for competitors to imitate.

  The measurement of green core competence included five items:
(1) The environmental capabilities, technologies, or know-how of the firm are rare in the marketplace;

(2) The environmental capabilities, technologies, or know-how of the firm are less imitable by competitors;

(3) The environmental capabilities, technologies, or know-how of the firm are difficult to be substituted;

(4) The environmental capabilities, technologies, or know-how of the firm provide potential access to meet a wide variety of environmental needs of markets;

(5) The environmental capabilities, technologies, or know-how of the firm have environmental contributions to customer benefits (Prahalad & Hamel, 1990; Chen, 2008).

**Green product innovation performance**

This study adopted Chen et al. (2006)’s definition of green innovation as hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy saving, pollution prevention, waste recycling, green product designs, or corporate environmental management. Moreover, Chen divided green innovation performance into (1) green product innovation performance; and (2) green process innovation performance. This study adopted Chen’s
definition of green product innovation performance as the performance in product innovation that is related to environmental innovation, including the innovation in a product that involves energy saving, pollution prevention, waste recycling, non-toxicity, or green product designs. Green product innovation performance is measured in four areas:

(1) The company chooses the product materials with the least amount of pollution in the conduct of the product development or design;

(2) The company chooses the materials of the product that consume the least amount of energy and resources in the conduct of its development or design;

(3) The company uses the fewest amount of materials in the conduct of the product development or design;

(4) The company would circumspectly deliberate on whether the product is easy to recycle, reuse, and decompose during the conduct of the product development or design (Chen, 2008)

• Green process innovation performance

As per the definition of Chen et al. (2006), green process innovation performance is the performance in process innovation that is related to energy saving, pollution prevention, waste recycling, or non-toxicity. The measurement of such concept included four items:
(1) The manufacturing process of the company effectively reduces the emission of hazardous substances or waste;

(2) The manufacturing process of the company recycles waste and emission that allow them to be treated and re-used;

(3) The manufacturing process of the company reduces the consumption of water, electricity, coal or oil;

(4) The manufacturing process of the company reduces the use of raw materials (Chen, 2008).

- **Green image**

  Previous studies measured the corporate image according to the dimensions of reputation and credibility (Lapierre, 1998; Martinez & Pina, 2005). Likewise, this study measured the green image according to the dimensions of green reputation and green credibility. Referring to Weiss, Anderson, and MacInnis (1999), this study measured green reputation through the terms “regarded”, “professional”, “successful”, “well established,” and “stable.” In addition, this study referred to Keller and Aaker (1992) to measure “green credibility,” which covered the items “trustworthiness,” “dependability,” and “concern for
customers.” Hence, this study measured a corporate image based on Martinez and Pina’s (2005) definitions.

The measurement of the green image included eight items:

(1) The company is regarded as the best benchmark of environmental management;

(2) The company is professional about environmental management;

(3) The company is successful about environmental management;

(4) The company is well-established about environmental management;

(5) The reputation of the company on environmental management is stable;

(6) The company is trustworthy about environmental management;

(7) The company is dependable about environmental management;

(8) The company has concern for customers regarding environmental management (Chen, 2008).
• **Stages of development**

According to Zhai (2007), a previous study of more than 100 manufacturing small and medium enterprises (SMEs) from “high technology” industries showed that there are four stages in their life-cycle model: start-up, expansion, maturity, and diversification. As a supplement to that study, this new research on the Philippines electronic industry also considered the effect of an electronics company’s developmental stage to the relationship of the said constructs.

This study’s team gave another set of questionnaire to the previous respondents to determine the developmental stage that the involved companies currently belong. Companies that answer letter (a) are still in the introduction or start-up stage; (b) is in the growth stage; (c) is in the maturity stage; and (d) is in the decline or diversification stage.
Empirical Results

Table 1 shows the descriptive statistics of the four main constructs of this study. Table 2 includes the descriptive statistics of the four main constructs of the companies in the introductory stage of development of their green core competence while Table 3 shows the descriptive statistics of the companies in the growth stage. In addition, Table 4 provides the descriptive statistics of the constructs of companies in the maturity stage of green core competency development.

Table 1. All Stages

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Green core competence</td>
<td>4.9429</td>
<td>0.9562</td>
<td>4.00</td>
<td>6.29</td>
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<td>Green product innovation performance</td>
<td>5.9286</td>
<td>0.2474</td>
<td>5.57</td>
<td>6.14</td>
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<td>Green process innovation performance</td>
<td>5.8929</td>
<td>0.2704</td>
<td>5.71</td>
<td>6.29</td>
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<tr>
<td>Green image</td>
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<td>0.4234</td>
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<td>6.43</td>
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Source: The Author

Table 2. Introduction Stage

<table>
<thead>
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<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
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<td>7.00</td>
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<td>Green product innovation performance</td>
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<td>Green process innovation performance</td>
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<td>3.00</td>
<td>7.00</td>
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<tr>
<td>Green image</td>
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<td>0.512068811</td>
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Source: The Author
### Table 3. Growth Stage

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<td>Green product innovation</td>
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<td>Green process innovation</td>
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<td>Green image</td>
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<td>0.709317203</td>
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Source: The Author

### Table 4. Maturity Stage

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<tr>
<td>Green image</td>
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Source: The Author

### Table 5. The Cronbach’s α coefficients of the constructs

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<td>4</td>
<td>0.7136</td>
<td>Acceptable</td>
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<tr>
<td>performance</td>
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<td></td>
<td></td>
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<tr>
<td>Green process innovation</td>
<td>4</td>
<td>0.7719</td>
<td>Acceptable</td>
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<tr>
<td>performance</td>
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<td></td>
<td></td>
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<tr>
<td>Green image</td>
<td>8</td>
<td>0.7680</td>
<td>Acceptable</td>
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</table>

Source: The Author
Table 5 shows the Cronbach’s alpha (α) of coefficients. Cronbach’s α is a coefficient of reliability. It is commonly used as a measure of the internal consistency or reliability (Allen, 2002). The value of alpha (α) ranges from negative infinity to 1; however, only positive values of α make sense. Table 6 presents the accepted rule of thumb for describing internal consistency.

Table 6. Cronbach’s α Acceptable Rule of Thumb

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>Internal Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>α≥0.9</td>
<td>Excellent</td>
</tr>
<tr>
<td>0.8≤α&lt;0.9</td>
<td>Good</td>
</tr>
<tr>
<td>0.7≤α&lt;0.8</td>
<td>Acceptable</td>
</tr>
<tr>
<td>0.6≤α&lt;0.7</td>
<td>Questionable</td>
</tr>
<tr>
<td>0.6≤α&lt;0.6</td>
<td>Poor</td>
</tr>
<tr>
<td>α&lt;0.5</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

Source: The Author

The minimum requirement of α is 0.7 to be acceptable. It can be observed that the Cronbach’s α coefficient of green core competence is 0.8240; that of green product innovation performance is 0.7136; that of green process innovation performance is 0.7719 and that of green image is 0.7680. Since a on all the four constructs is more than 0.7, the measurement of this study is accepted in reliability.
Table 7. Correlation Coefficients Between the Constructs

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Core Competence</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Product Innovation Performance</td>
<td>-0.518246661</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Process Innovation Performance</td>
<td>0.892338786</td>
<td>-0.6987207</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Green Image</td>
<td>0.855170546</td>
<td>-0.22400619</td>
<td>0.67336592</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: The Author

Table 7 presents the correlation coefficients among the constructs. It shows that green core competences of firms had negative correlations with green product innovation performance at -0.5182. Green core competences of firms on green process innovation and green image, on the other hand, is positively correlated at 0.8923 and 0.8551 respectively. This means that the major contributors to green core competence of firms in the electronics industry are green process innovation and green image. Companies do not hinge much on the performance of their products to environmental innovation (i.e., product innovation pertaining to energy savings, pollution prevention; waste recycling, and non-toxicity). This is because these Philippine companies are only subcontractors of major companies overseas.
Table 8. Correlation Coefficients Between the Constructs for Companies in the Introduction Stage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Core Competence</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Product Innovation</td>
<td>-0.950318448</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation Performance</td>
<td>-0.968272012</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Process Innovation</td>
<td>0.997955035</td>
<td>-0.968272012</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Innovation Performance</td>
<td>0.859250029</td>
<td>-0.65732437</td>
<td>0.824794318</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: The Author

Table 8 provides the correlation coefficients among the constructs for start-up electronics companies. Apparently, start-up companies’ green product innovation performance and green core competence are inversely proportional to each other. However, green core competence is directly proportional to green process innovation performance and green image. This result implies that electronics companies at their infancy stage with little collective learning and capabilities about green innovation and environmental management still have room to improve their green product innovation performance, including product innovations on energy savings, pollution prevention, waste-recycling, or green product designs since these kind of innovations are being embraced by the Filipino society now. Moreover, more companies nowadays are being introduced to technologies that are both affordable and ecological. Finally, start-up companies with a high green core competence have a good reputation and image when it comes to environmental management.

**Empirical Results**
Table 9. Correlation Coefficients Between the Constructs for Companies in the Growth Stage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Core Competence</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Product Innovation Performance</td>
<td>-0.341541967</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Process Innovation Performance</td>
<td>0.871259249</td>
<td>-0.665008889</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Green Image</td>
<td>0.93567401</td>
<td>-0.227588288</td>
<td>0.723096582</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: The Author

On the other hand, Table 9 shows that in the growth stage, the correlation of coefficients of green product innovation performance to green core competence is still negatively correlated although lesser when compared to the introduction stage and maturity stage. This means that as companies enter the growth stage, their volume of sales increases due to the high demand for the product. Since volume increases, companies in these stages try to sustain the growth by improving the product, preferring raw materials that are sturdy and environmentally friendly. Companies choose the materials that produce the least amount of pollution during its development or design. However, this does not mean that all companies are doing these improvements because, as a whole, the green product innovation performance is negatively correlated to green core competence. This will be further discussed in the latter part of the study.
Table 10. Correlation Coefficients Between the Constructs for Companies in the Maturity Stage

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Core Competence</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Product Innovation Performance</td>
<td>-0.638393901</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Process Innovation Performance</td>
<td>0.774113</td>
<td>-0.749707203</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Green Image</td>
<td>0.826574352</td>
<td>-0.484041939</td>
<td>0.633758339</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: The Author

For electronics companies in their maturity stage, the relationship of the constructs to each other is also similar as those of companies in the introduction stage (See Table 10). Thus, long-established companies have strengthened their commitment to sustainability as the benefits become more apparent. Just as natural resources are becoming scarce and costly, companies are increasingly environmentally conscious to engage customers on a more meaningful level. One company (name withheld), for example, plans to abandon its investment in dirty energy sources in exchange for the renewable energy that will power the future.
The Results of Regression Analysis

Table 11. Empirical Results of Regression Analysis

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Model I</th>
<th>Model II</th>
<th>Model III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Core Competence</td>
<td><strong>-0.5182</strong></td>
<td><strong>0.8923</strong></td>
<td><strong>0.8552</strong></td>
</tr>
<tr>
<td>Green Innovation Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Product Innovation Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Process Innovation Performance</td>
<td><em>-0.2240</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Image</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.2686</td>
<td>0.7963</td>
<td>0.7313</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.2550</td>
<td>0.7925</td>
<td>0.7263</td>
</tr>
<tr>
<td>N</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>F</td>
<td>19.8289</td>
<td>211.0548</td>
<td>146.9801</td>
</tr>
</tbody>
</table>

Note: *p<0.05, **p<0.01
Source: The Author

Results of the regression analysis in this study are shown in Table XI. In Model I, the green core competence and green product innovation performance of firms are negatively correlated with each other. Meanwhile, the green process innovation performance in Model II is positively correlated to green core competence. Therefore, only Hypothesis 1a is not supported in this study. In Model III, results show that only green product innovation performance is negatively correlated with green core competence, whereas the green core competence on green process innovation performance positively correlates with the green image of a firm.
In other words, Philippine electronic companies do not consider making environmental contributions when they choose the materials for their products. Moreover, their environmental technologies were not about designing a product that would consume the least amount of energy and pollution. The main reason behind this result is that Philippine companies are merely subcontractors of major electronic companies overseas and therefore do not have the authority to make changes in their product design.

On the other hand, since there is a growing trend toward environmental management systems, the said Philippine companies seek to set the best benchmark on environmental management systems by improving and providing unique environmental technologies in their process, such as reducing effectively the emission of hazardous substance or waste during their manufacturing process.

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The Results of Regression Analysis
Conclusions and Implications

This study summarizes the literature on environment management and corporate strategy into a new managerial framework from a core competence perspective. The study was adapted from the researches made by Yu-Shan Chen, author of *The Driver of Green Innovation and Green Image-Green Core Competences*. It attempted to draw a correlation between green core competence and green image as well as green innovation performance in the Philippines. Moreover, as an additional supplement, the study also discussed the stages of development of the industry as a factor in the relationship of the said constructs.

The empirical results of this study showed that green core competences of firms had positive effects only on green image and green process innovation performance. The relationship of green product innovation to green core competence is negatively correlated. This means that Philippine electronic companies do not consider making positive environmental contributions when choosing the materials for their products. Moreover, their environmental technologies were not about designing a product that would consume the
least amount of energy and pollution. Such investment of Philippine electronic companies on green core competence with respect to green product innovation performance could have benefited the country but remains a pipe dream. This is because these Philippine companies are simply subcontractors of big companies abroad.

Empirical results also show that at the introductory and maturity stages of development, firms’ green product innovation has a relatively high negative correlation to green core competence as compared to the results at the growth stage of development. This would mean that companies in the introductory and maturity stages of development are more concerned with green process innovation than product innovation, or that the rate of product innovation is proceeding at a slower rate than that of process innovation.

Table 12. Difference Between Large Enterprises and SMEs

<table>
<thead>
<tr>
<th></th>
<th>Mean of Large Enterprises (E)</th>
<th>Mean of SMEs (F)</th>
<th>E-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Core Competence</td>
<td>5.02</td>
<td>4.91</td>
<td>0.11</td>
</tr>
<tr>
<td>Green Product Innovation</td>
<td>6.01</td>
<td>5.93</td>
<td>0.08</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Process Innovation</td>
<td>5.91</td>
<td>5.85</td>
<td>0.06</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Image</td>
<td>6.19</td>
<td>6.17</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Note: the measurement of the questionnaire items in this study was with “seven-point Likert scale from 1 to 7” rating from strongly disagreement to strongly agreement. The sample size of the study was 56, including 38 large enterprises and 18 SMEs.

Source: The Author
Table 12 shows that scores on green core competence, green product innovation performance, green process innovation performance, and green images of SMEs were all significantly less than those of large enterprises in the information and electronics industry in the Philippines. According to the Department of Trade and Industry (DTI), the way to classify enterprises as either micro, small, medium or large may be either by asset size or by the number of employees. In the survey, the researchers asked the R&Ds, general manager, CEOs, presidents, and chairmen about the number of employees in their organization. Table 13 summarizes the employee size per enterprise category.

Table 13. Classification of MSMEs by Employee Size

<table>
<thead>
<tr>
<th>Type of Enterprise</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro</td>
<td>1-9 employees</td>
</tr>
<tr>
<td>Small</td>
<td>10-99 employees</td>
</tr>
<tr>
<td>Medium</td>
<td>100-199 employees</td>
</tr>
<tr>
<td>Large</td>
<td>more than 200 employees</td>
</tr>
</tbody>
</table>

Note: As defined under small and Medium Enterprise Development (SMED) Council Resolution No. 01 Series of 2003 dated 16 January 2003
Source: Department of Trade and Industry (DTI)

Therefore, Table 13 has indicated two implications: First, the bigger firms in the electronics industry in the Philippines are more at an advantage in their green core competence because of their available resources for green
product and process innovation development. Second, that it is imperative for SMEs in the electronics industry of the Philippines to develop and to create their green core competences in green product innovation performance, green process innovation performance, and green images.

This study focuses only on the electronics industry. Further studies can also focus on other industries or countries. This study has also verified and observed the dynamic change of green core competence in the development of the electronics industry in the Philippines through a longitudinal study. Future studies can still expand on this longitudinal study to determine the differences in the green core competencies at different developmental stages of the electronics industry in the Philippines.

Conclusions and Implications
References


References


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References
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Mr. Chan was recently a guest professor at the Taiz University Delft, an affiliate of Delft University of Technology, The Netherlands. He has taught operations research at the Master in Engineering and Management Program of the same university.

He obtained masters degrees in industrial engineering, major in operations research, and business administration at De La Salle University. He completed Bachelor of Science in Chemical Engineering at the Mapua Institute of Technology. He is also a holder of an international and advanced certificates in purchasing and supply chain management, accredited by the International Trade Centre affiliated by UNCTAD in Geneva, Switzerland. He is a certified professional industrial engineer bestowed by the Industrial Engineering Certification Board of the Philippine Institute of Industrial Engineers, as well as a COTECNA-certified Green Belt of Six Sigma Program.

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