[UCI]I804:24011-200000241100

2011년 2월
석사학위논문

An Introduction to the Green IT Balanced Scorecard as a Strategic IT Management System and Its Theoretical View

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이 논문을 경영학 석사 학위신청 논문으로 제출함

2010년 10월

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초록

그린 IT 밸런스 스코어카드의 이론적 연구 모델 제시

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본 논문은 그린 IT 기술환경에 대한 기업의 그린 IT 시스템 상황을 측정하는 'Green IT Balanced Scorecard'에 대한 연구로서, 그린 IT 밸런스 스코어카드는 기존의 Balanced Scorecard가 제시하는 모형, 교육, 프로세스, 고객, 그리고 재무적인 관점에 대한틀을 참조하여 새로운 Green IT 밸러스스코어카드를 변형하여 수정된 모델이 될 수 있다. 현재 기업의 주변에서 발생하는 역동적인 기술환경에 대처하면서 지속적 성장과 경쟁력을 확보하기 위해서는 기업은 친환경 저전력의 에너지 사용 및 친환경 고객 욕구를 만족시켜야 되는 상황에 직면하고 있다. 따라서 기업은 기업전략과 IT전략을 시스템믹하게 새롭게 조정하는 하나의 일반적인 Green IT 관리방법이 필요한 시점이다.

본 연구의 목적으로 환경적인 요인을 고려하며 기업의 IT성과와 기업성과를 향상시킬 수 있는 유형과 무형의 자산과 그린 IT 시스템과의 통합에 방법에 대한 개념적인 제시와 개념적 모델을 실증적으로 검증하는 단계로 이루어 질 것이다. 본 연구는 기업의 실무적인 측면과 연구의 이론적인 측면 두 가지 관점을 모두 고려한 그린 IT 활동과 기업 전략과 IT전략과의 연계와 조정을 살펴본 후 이론적인 모델을 제시할 것이며 계속해서 기업단위의 설문조사 방식으로 통계적 프로그램을 사용하여 연구모델을 검증하고자 한다.

I. Introduction

The Strategic Balanced Scorecard (BSC) was first introduced in 1992 by Kaplan and Norton as a measurement tool used to achieve corporate goals in a dynamic environment (Kaplan and Norton, 1996). The basic concept of this balance scorecard was to translate an organization's mission and strategy into a comprehensive set of performance measures that establishes the framework for a strategic measurement and measurement system. This scorecard was created to supplement traditional financial measures with criteria that assessed performance from three additional perspectives: namely, customer, internal business process, and learning and growth perspectives (Kaplan and Norton, 1996). This scorecard also allowed companies to track financial results while simultaneously monitoring their progress in building the capabilities and acquiring the intangible assets they would require for future growth. These intangible assets affect a company's performance by enhancing the internal processes most crucial to the creation of value for customers and stakeholders (Kaplan and Norton, 2004).

The Balanced Scorecard has already been implemented at corporate, strategic business unit, shared service functions, and even individual levels (Epstein and Rejc, 2005). Since the first introduction of BSC, the tool has undergone a significant evolution, driven by a series of external factors (Cram, 2007), including the IT environment. The adoption of a balanced scorecard in IT functions and its processes has been previously conducted by some researchers (e.g. Working Council for CIO, 2003; Martinsons et al., 1999; Van Grembergen, 2000). The IT-balanced scorecard has also been adopted as the foundation of specific IT scorecards such as ERP (e.g. Chand, 2005; Rosemann and Wiese, 1999; Rosemann, 2001). However, until this stage, even though this scorecard has successfully integrated some important IT aspects and aligned them with business strategies, this IT management tool does not include environmental aspects as a component of imperative business drivers. Environmental concerns have become increasingly

important in the business world; however, those concerns are only incompletely reflected in economic transactions (Figge et al., 2002). Therefore, in this paper we have incorporated the environmental aspects of technology into scorecard measurement, as one of the soft factors that may ultimately prove more important than the efficient use of investment capital. We identified our model as the Green IT Balanced Scorecard. In the next sections, we will discuss in a step-by-step manner the development of the Green IT Balanced Scorecard, including the model validation and the Cause and Effect Model, Green IT Metrics, and a range of recommendations for the companies when implementing this scorecard.

II. Literature Review

A. The Development of the IT Balanced-Scorecard

Since its early stages, the IT balanced scorecard has received a great deal of attention from IT researchers and IT practitioners. One of the best-known versions of the IT balanced scorecard is the one developed by Van Grembergen and colleagues (1998, 2000). This scorecardproposed four perspectives: the User Orientation perspective represents the user evaluation of IT; the Operational Excellence perspective represents the IT processes employed to develop and deliver the applications; the Future Orientation perspective represents the human and technology resources needed by IT to deliver its services, and the Business Contribution perspective captures the business value of the IT investment (Van Grembergen, 2000). The working council for Chief Information Officers (2003) conducted an extensive review of IT scorecards and found that the most advanced scorecards shared in common the following six structural attributes: simplicity of presentation, explicit links to IT strategy, broad executive commitment, enterprise-standard metrics definitions, drill-down capability and available context, and individual manager compensation should be linked to scorecard performance. Additionally, these progressive scorecard practitioners track metrics in five key categories: financial performance, project performance, operational performance, talent management, and user satisfaction, as well as two additional metric categories--information security and enterprise initiatives.

Moreover, Martinsons et al. (1999) proposed four perspectives: (1) user orientation with a mission to deliver value-added products and services to end users, (2) business value with a mission to contribute to the value of the business, (3) internal process with a mission to deliver IT products and services in an efficient and effective manner, and (4) future readiness with a mission to deliver continuous improvement and prepare for future challenges. They proposed three key balanced

scorecard principles: cause and effect relationship, sufficient performance drivers, and linkage to financial measures. They also demonstrated that cause-and-effect relationships can involve one or more of those four perspectives. Rosemann and Wiese (1999) adopted a system-level balance scorecard approach. They employed a modified balanced scorecard approach to evaluate the implementation of ERP software and to assess the continuous operation of the ERP installation. Additionally, Brewton (2003) provided an illustration of a balanced CRM scorecard. He projected four perspectives: financial, customer, process, and staff. Fairchild (2002) attempted to devise a Balanced Knowledge Management Scorecard by viewing the scorecard from two different perspectives. The first approach involved the Knowledge Centric Organizational perspective, and the second adopted a resource management-based approach. The details of the development of IT balanced scorecards during this decade can be observed in Table 1 below.

<Table 1> IT Balanced Scorecard

Author(s)	Objective	Perspectives
Van Grembergen (2000) Van Grembergen et al. (2003)	IT Balanced Scorecard	User orientation
		Business contribution
		Operational excellence
		Future orientation
The working council for Chief Information Officers (2003)	IT Balanced Scorecard	Financial performance
		Project performance
		Operational performance
		Talent management
		User satisfaction
		Information security (additional metric)

		Enterprise initiatives (additional metric)
Martinsons et al. (1999)	IT Balanced Scorecard	User orientation
		Business value
		Internal process
		Future readiness
Hagood and Friedman (2002)	HRIS Balanced Scorecard	Customer perspective
		Internal process perspective
		Resource (financial) perspective
		Learning and growth perspective
Rosemann and Wiese (1999)	ERP Balanced Scorecard	Financial
		Customer
		Internal process
		Innovation and learning
		Project perspective
Brewton (2004)	CRM Balanced Scorecard	Financial
		Customer
		Process
		Staff
Fairchild (2002)	KM Balanced Scorecard (Knowledge Centric Organization approach)	Human capital
		Intellectual capital
		Structural capital
		Social capital

Fairchild (2002)	KM Balanced Scorecard (Resource Management based approach)	Employees
		Customers
		Processes
		Technology
Van Grembergen and De Haes (2005)	IT Governance Scorecard	Corporate contribution
		Stakeholders
		Operational excellence
		Future orientation

The drivers of IT BSC are divided into three categories: (1) demonstration of IT value: IT BSC assist to demonstrate the IT value by providing a straightforward method of reporting on a range of IT metrics, enabling the value of IT to be quantified for the business stakeholders; (2) IT governance: A structure of relationships and processes to direct and control the enterprise in order to achieve the enterprise's goals by adding value while balancing risk versus return over IT and its processes (COBIT, 2000); and (3) cost cutting and efficiency: using IT BSC, it is possible to track both the efficiency of IT activities and the efficacy of contributions to organizational goals (Cram, 2007). According to the study of Epstein and Rejc (2005), an IT performance measurement and management system must necessarily focus on the causal relationships and linkages within the organization and the actions managers can take to improve both customer and corporate profitability. In this paper, we adopted Van Grembergen's scorecard since this model integrates the outcome measures and performance drivers systematically and establishes the cause and effect relationship fairly effectively.

III. Conceptual Model

A. What is the Green IT Balanced Scorecard?

Currently, many organizations have an opportunity to tackle with sustainable development while improving their productivity, reducing costs, and enhancing benefits. However, their lack of environmental skills has resulted in many forms of waste, unused resources, energy inefficiency, and pollution (Watson et al., 2010). Although many companies have previously implemented specific environmental or social management systems in the past decade, as can be seen in Table 1 (p.5-6), these systems have only rarely been integrated into the general management system of the firm. As a consequence, in many cases, these systems are not linked to the economic contributions of the environmental management system (Laurinkevičiūtė, 2008). In order to address this issue, several authors have previously suggested applying the balanced scorecard approach to sustainability (e.g. Bieker, 2003; Elkington 1997; Figge et al., 2002; Johnson, 1998) in order to ascertain that environmental concerns are thoroughly considered in the decisions and activities of the other sectors (Laurinkevičiūtė, 2008).

On the other hand, undoubtedly, a growing environmental consciousness, including investments in environmental technologies, carries with it a source of business risk, particularly to brand, reputation, and shareholder value (Sigma, 2006). Therefore, a measurement on a balanced scorecard should consist of a linked set of objectives and measurements that are consistent and mutually reinforcing (Kaplan and Norton, 1997). Although various approaches to the IT balanced-scorecard have been adopted, IT researchers and practitioners should be aware of their applicability to measurements of environmental technology alignment. The adoption of Green IT could differ from other IT adoption approaches due to the importance of ethical and eco-sustainability considerations in the decision-making process (Molla, 2009). IT adoption is generally motivated by the potential economic benefits associated with

the use of a technology, whereas Green IT practices may be motivated by concern for the environment, even if economic benefits might not prove tangible in the short-term (Molla, 2009). Therefore, continuing in this vein, the Green IT balanced scorecard can be viewed as "a nomological management tool to systematically align IT strategy with business strategy from environmental sustainability perspective in order to achieve competitive advantage".

Kaplan and Norton (1997) also asserted that a balanced scorecard must contain the appropriate mixture of outcome measures (lagging indicators) and performance drivers (leading indicators). Performance drivers provide early indicators as to whether or not the strategy is being successfully implemented, whereas outcome measures help to show whether operational improvements have been successfully translated into financial performance. The scorecard should strongly emphasize financial outcomes. Additionally, the scorecard should include measurements critical to the success of the unit's established strategy. The needs, demands, goals, objectives, and/or structures of one component should be consistent with the needs, demands, goals, objectives, and/or structure of another component (Oh and Pinsonneault, 2007). Thus, the measures that appear on the scorecard should be integrated thoroughly into the cause-and-effect relationship that describes the trajectory of the strategy. Because the balanced scorecard is a technique for the implementation of strategy, the prerequisite for the companies before they implement a Green IT balanced scorecard approach is described as:"they have committed to environmental responsibility". The objectives of the Green IT balanced scorecard are as follows: (1) to measure technology performance by effectively integrating environmental aspects, (2) to investigate both tangible and intangible assets of Green IT investment, and (3) to align IT performance and business performance, and transform the results into competitive advantage.

B. 2 Basic Pillars

Our Green IT BSC model is comprised of two distinct pillars: environmental

aspects of technology and competitive advantages of Green IT implementation. These two factors are responsible for the relative significance of sustainable IT vision in the business environment. They also constitute a foundation for the formulation of further metrics scorecards.

1. Environmental Aspect of Technology

A number of previous studies have demonstrated that environmental aspects are strategically relevant as a driver of performance (e.g. Aragon-Correa and Rubio-Lopez., 2007; Carmona-Moreno et al., 2004; Cohen et al., 1995; Cordeiro and Sarkis, 1997; Edwards, 1998; Gilley et al., 2000; Hamilton, 1995; Hart and Ahuja, 1996; Klassen and McLaughlin, 1996; Klassen and Whybark, 1999; Link and Naveh, 2006; Russo and Fouts, 1997; Sharma and Vredenburg, 1998; Wagner et al., 2002; Wagner, 2005). However, in fact, environmental issues are complex and difficult to manage, since they are components of social and natural systems (Roome, 1992). Therefore, because IT performs an integral function in almost all aspects of business, and because each stage of the IT lifecycle from manufacturing tousage and disposal can pose environmental damages (Elliot and Binney, 2008),it is necessary to include IT as one of the aspects of "environmental sustainability" (Molla et al., 2009).

To represent technology within an environmental context, some researchers have coined terms such as "environmental technology" or "sustainability technology", whereas others reference concepts such as "green technology (IT)" or "green computing". The definitions also vary considerably. Hedwig et al. (2009) defined Green IT as all activities and efforts that incorporate ecologically friendly technologies and processes into the entire lifecycle of information and communication technology, where the sustainable operation of a data center performs a central role in this domain, focusing on the reduction of energy consumption during the operation of the data center. Shrivastava (1995) previously defined "environmental technologies" as "production equipment, method and

procedures, product designs, and product delivery mechanisms that conserve energy and natural resources, minimize the environmental load of human activities, and protect the natural environment."They include both hardware (pollution control equipment, cleaner production technologies, etc.) and operating method (e.g. waste management practices, conservation oriented work environment). From the practitioner's perspective, Green IT has been associated principally with technologies and initiatives designed to reduce the power, cooling, and real estate expenses associated with ICT operations (Molla 2009). Molla (2009) conceptualized Green IT theory from these various definitions,and defined Green IT as "as an organization's ability to systematically apply environmental sustainability criteria (such as pollution prevention,product stewardship, use of clean technologies) to the design, production, sourcing, use, and disposal of the IT technical infrastructure as well as within the human and managerial components of the IT infrastructure".

Green IT issues include climate change, greenhouse gases and CO2 emission, energy usage, material usage, and electronic wastes. The Green IT offering addresses the information technology function/industry, which plays a role in reducing the environmental burdens incurred by IT and also in providing advanced technology and solutions to environmental problems (Lash and Wellington, 2007). It also affects the environment during the entirety of its life-cycle, from its production, throughout its use, to its ultimate disposal (Murugesan, 2008). As the ultimate objective of this technology is to provide a win-win solution for both the company and the environment, we defined Green IT as relating to any computer-based tools (hardware, software, equipments), mechanisms, structures, guidelines, and methodologies as the results of environmental breakthrough at each stage of the technology's life-cycle, including use, design, manufacture, and reuse, refurbish, and disposal of technology in environmentally sound manners (to deliver sustainable values for business, environment, and society, and at the same time, improve the quality of life). We identified this environmental aspect of technology as one of the basic pillars of our Green IT BSC, as this factor helps to enhance companies' performance in some regards.

2. Green IT and Competitive Advantage

Currently, organizations are attempting to transform themselves for future competition based on information and intangible assets, which have become increasingly important in the global economy (Herath et al. 2010). The previous literature has highlighted several benefits arising from the integration of environmental sustainability issues into business operations, such as increased efficiency in the use of resources, return on investments, increased sales, the development of new markets, improved corporate image, product differentiation, and enhanced competitive advantage (Albino et al., 2009). Environmental technologies have been purported to function as a potential strategic resource, because they affect the value chain at a number of points. These technologies are capable of providing firms with unique and inimitable advantages at each stage of the value chain (Shrivastava, 1995).

Porter and Van Der Linde (1995) previously demonstrated that companies may achieve competitive benefits if they address the environmental impacts via innovation offsets. These innovation offsets are broadly divided into process offsets and product offsets. Product offsets occur in cases in which environmental regulation generates not just less pollution, but also creates better performing or higher quality products, safer products, lower product costs, products with higher resale or scrap value (due to ease of recycling or disassembly) or lower product disposal costs for the user. These process offsets might deliver a variety of benefits, including:

- Materials savings resulting from more complete processing, substitution, reuse, or recycling of production inputs
- Increases in process yields
- Less downtime through more careful monitoring and maintenance
- Better utilization of byproducts
- Conversion of waste into valuable forms
- Lower energy consumption during the production process

■ Reduced material storage and handling costs

■ Savings from safer workplace conditions

■ Eliminates activity costs involved in discharges or waste handling, transportation, and disposal

■ Improvement in the product as a byproduct of process changes

Process offsets occur in cases in which environmental regulations not only lead to reduced pollution, but also result in higher resource productivity (Porter and Van der Linde, 1995). The benefits can be gained in the following forms:

■ Higher quality, more consistent products

■ Lower product costs and packaging costs

■ More efficient use of byproducts

■ Safer products

■ Lower net costs of product disposal for customers

■ Higher product resale and scrap value

Environmental technologies integrate environmental considerations into many aspects of business operations, thereby affecting the competitive landscape in most sectors of the economy (Shrivastava, 1995). By considering these possible benefits, environmental technologies should be aligned to harmonize technologies and businesses with the natural environment (Shrivastava, 1995). Thus, we determined that green IT facilitates different forms of competitive advantage in three dimensions of technology: infrastructure, usage, and strategic. Infrastructure value refers to the nature of hardware and software platforms, annual enhancements to these platforms, the nature of network and data architectures, and the corporate standards for the procurement and deployment of IT assets (Sambamurthy and Zmud, 1999). The usage value refers to the IT characteristics that address the prioritization, planning, budgeting, and day-to-day delivery of operations and services, whereas strategic value refers to the manner in which the companies use their IT capabilities to generate knowledge (Sambamurthy and Zmud, 1999). We summarized the possible competitive advantages achievable though Green IT adoption (Shrivastava, 1995) into three value dimensions (Table 2). However, it should be noted herein that different environmental management practices may

result in different types of competitive advantage (Christman, 2000).

<Table 2> Competitive Advantages of Green IT

Dimensions of Value	Description of Benefits
Infrastructure	■ Reduction of liabilities Green technologies may address long-term issues such as risks of resource depletion, product liabilities, pollution, and waste. ■ Social and health benefits Green technologies benefit the ecosystem and the environment of communities in which companies operate.
Usage/operational	■ Cost reduction Green technologies offer the opportunity to drive down operating costs by exploiting ecological efficiencies ■ Revenue enhancement Green technology createspossibilities for revenue enhancement, because it allows the companies to enter the growing market for environmental products and technologies and may expand the market segment, particularly to green customers. ■ Quality improvement Green technologies reinforce the environmental management philosophy. Moreover, technology assessment allows quality concerns to be incorporated in the very early stages of selecting product and production technologies.

Strategic	■ Supplier ties Manufacturing for the environment and design for disassembly actively involves suppliers in corporate decision-making, in turn strengthening supplier ties ■ Competitive edge Competitive advantage accrues directly from cost reductions and revenue improvements resulting from environmental technologies. Environmental technologies also offer companies the potential to create unique and inimitable strategies. ■ Public image Green technologies are good for public relations and corporate image. ■ Regulation compliance Green technology solutions allow companies to comply with the environmental regulations and establish a firmer footing with regard to environment environmental and product liabilities. ■ Competitive landscape Green technologies allow firms to remain competitive in global markets, reduce costs and production times, and enhance strategic flexibility.

(Adapted from Shrivastava 1995)

C. IT Governance and IT Balanced-Scorecard

IT governance is a component of corporate governance and is tasked with providing the organizational structures that enable the creation of business value through IT, the assurance that the corporate resources have been allocated to the right projects, and the existence of adequate IT control mechanisms (Van Grembergen, 2000). IT governance provides the structure linking IT processes, IT resources, and information to enterprise strategies and objectives (COBIT, 2000). Among the various definitions of IT governance, we adopted the definition of IT governance developed by Van Grembergen (2000) and Weill (2004), as these definitions encompass the IT governance aspects from a strategic viewpoint. Van Grembergen (2000) defined this as "the organizational capacity to control the formulation and implementation of IT strategy and guide to proper direction for the purpose of achieving competitive advantages for the corporation". Weill (2004) defined IT governance as "the framework for decision rights and accountabilities to encourage desirable behavior in the use of IT". According to the relevant literature, IT governance includes IT-business alignment, decision-making process, and competitive advantages, and we defined IT governance as "the organizational ability to provide a systematic framework for decision-making process during the formulation and implementation of IT strategy as a direction to achieve competitive advantages for the corporation".

The objectives of IT governance are as follows: (1) IT is aligned with business, enables business success, and maximizes benefits; (2) IT resources are utilized responsibly; (3) IT-related risks are appropriately managed (COBIT, 2000). The most critical element of IT governance is the alignment of IT with the business, which leads to the creation of business value (De Haes and Van Grembergen, 2004). According to De Haes and Van Grembergen (2008), IT governance can be set up using a variety of structures, processes, and relational mechanisms. In this case, the relevant structures include structural devices and mechanisms for connecting and enabling horizontal, or liaison, contacts between business and IT

management functions. Processes refer to the 'formalization and institutionalization of strategic IT decision-making or IT monitoring procedures (e.g. IT balanced scorecard), and relational mechanisms refer to the active participation in, and collaborative relationships among corporate executives, IT management, and business management. With regard to environment, in the past year, many organizations have integrated environmental management systems into their IT mechanisms. Thus, when companies perceive the need to address the climate change issue in their business strategy, they also must implement a strategy aimed at balancing the social, environmental, and economic needs of both the company and the society at large (Epstein and Roy, 2001). This integration with the environmental management system will prevent adverse environmental effects and improve environmental performance by institutionalizing a variety of environmental programs and practices such as the initiation of environment-associated performance measures and the development of green technologies, processes, and products (Saha and Darnton, 2005).

D. Technology Performance and Environmental Perspective

We begin by discussing performance measurements, specifically by addressing the interrelationship between technology and environmental sustainability. The World Commission of Environmental and Development definessustainability as "economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs".

Hart (1995) noted previously that the concept of the environment in management theory emphasizes political, economic, social and technological aspects, but frequently neglects the natural environment. Rasanen et al. (1994) also showed that the greening of industry can involve any fundamental change in the managerial logic of action. Moreover, Garrod and Chadwick (1996) determined that some firms have adopted environmental management tools only to the extent that such a strategy will enable the firms to pursue more effectively their profit-centered

approach. Also, while the companies decided to invest in environmental technology to comply with government regulations, they also need to spend and allocate their budget into a range of cost (Jaffe et al., 1995), such as: governmental administration of environmental costs (statutes and regulations, monitoring, and enforcement), private sector compliance expenditures (capital and operating), other direct costs (legal and other transactional, shifted management focus, disrupted production), negative costs (natural resource inputs, worker health, and innovation stimulation), general equilibrium effects (product substitution, discouraged investment, retarded innovation), transaction costs (unemployment, obsolete capital), and social impacts (loss of middle-class jobs, economic security impacts).

To improve performance, top-level management has recognized that it is necessary to better understand the drivers of both costs and revenues and the actions they can take to affect them (Epstein and Roy, 2001). Several questions that must be addressed before investing in environmental technology are:

1. How can top management get their investment on environmental technologies to return some business value to them?

2. How does top management ensure that investments in environmental technologies are the right decision, not only to comply with government regulations, but also to achieve and transform those investments into competitive advantage?

3. How does top management control the firm's environmental technology investments?

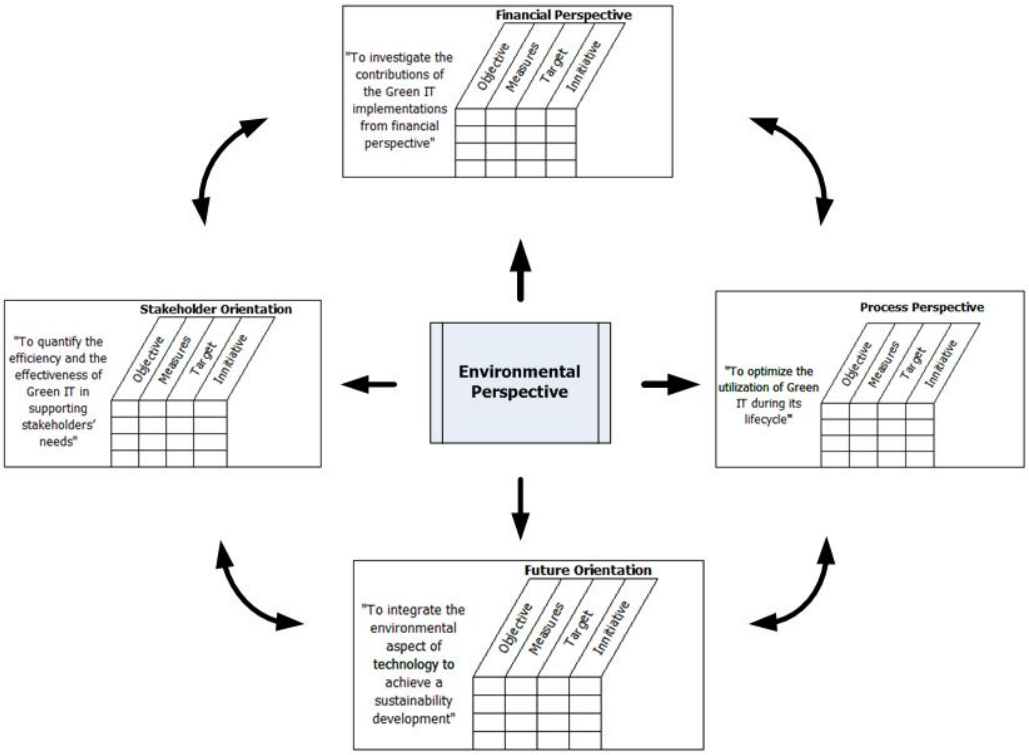
Certainly, the effort to invest in environmental technology and the decision to include environmental aspects into companies' strategies requires fundamental changes from the perspective of IT governance. In comparison to strategic BSC and IT BSC, Green IT BSC emphasizes the environmental aspects of IT along with the financial perspective, stakeholder orientation, future orientation, and operational excellence (Table 3).

<Table 3> Comparison of Strategic BSC, IT BSC, and Green IT BSC

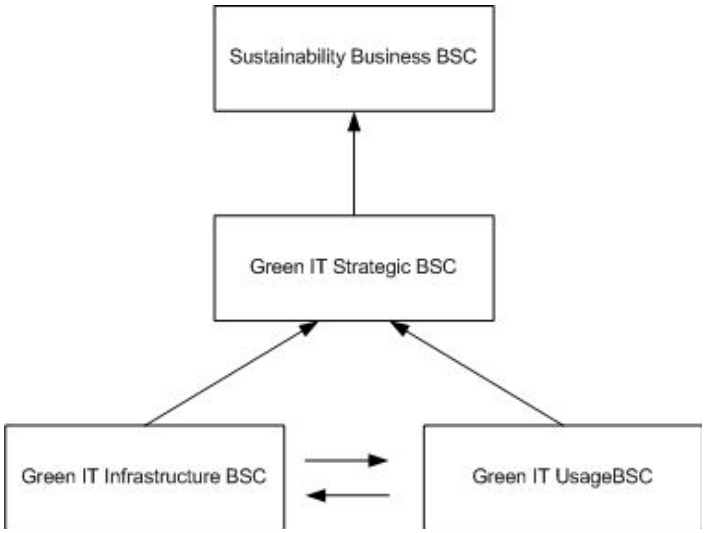
Balanced Scorecard for Strategic Management (Kaplan and Norton 1996)	**Balanced scorecard for strategic IT management (Van Grembergen 2000)**	**Green IT Balanced scorecard**
Financial perspective Mission: To succeed financially, how should we appear to our shareholders?	Business contribution Mission: to obtain a reasonable business contribution of IT investment	Financial Perspective Mission: to investigate the contributions of the Green IT implementations from financial perspective
Customer perspective Mission: To achieve our vision, how should we appear to our customer?	User orientation Mission: to be preferred supplier of information system	Stakeholder Orientation Mission: to quantify theefficiency and the effectiveness of Green IT in supporting stakeholders' needs
Learning and Growth Mission: To achieve our vision, how will we sustain our ability to change and improve?	Future Orientation Mission: to develop opportunity to answer future challenge	Future Orientation Mission: to integrate the environmental aspect of technology to achieve a sustainability development
Internal business process Mission: To satisfy our shareholders and customers, at what business processes must we excel?	Operational Excellence Mission: to deliver effective and efficient IT application and services	Process Perspective Mission: to optimize the utilization of Green IT during its lifecycle

We need to acknowledge that linking measurements to strategy is at the heart of the success of the scorecard development process (Kaplan and Norton, 1993). The adoption of the original IT balanced scorecard to measure the benefits generated from emerging environmental aspects into companies' strategies may help companies to attain competitive advantage (See Figure 1).

As a technological assessment, our Green IT scorecard evaluates environmental risks, the impacts of specific projects and facilities, the potential for effluents, releases, and hazardous wastes, and the product life cycle costs of technology (Shrivastava 1995). Additionally, similarly to other BSCs, each perspective must be translated into corresponding metrics and measures for the evaluation of the current situation. The relationship between the IT scorecard and the sustainable business scorecard is shown in Figure 2. Although we adopted the cascade concept of IT BSC, the flow- process of its formulation is relatively different. Unlike the traditional balanced scorecard cascade (Van Grembergen, 2000), we conceptualized the "sustainability scorecard structure" derived from three components of Green IT's competitive advantages--that is, the Green IT infrastructure scorecard and Green IT usage scorecard functioned as the enablers of the Green IT Strategic scorecard this strategic scorecard, in turn, functions as the driver of the sustainability business scorecard.



<Figure 1> Green IT Balanced Scorecard



<Figure 2> Sustainability Scorecard Structure

IV. Theoretical Validation

As the first step of the validation procedures, the key concepts of companies' environmental reports were assessed. For the purposes of this validation, we selected four electronic companies (Nokia Corporation, Samsung Electronic Ltd., Sony, and Sony Ericsson) which had successfully embedded green technologies into their business (Greenpeace, 2009) as our case study subjects. Using a content analysis method, we reviewed the sustainability reports of these companies. Content analysis is defined as a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit coding rules (Krippendorff, 1980; Weber, 1990). This is a popular technique in diverse fields of social science research (Krippendorff, 1980) for collating publicly available information (for example, company reports), and systematically categorizing the data to highlight trends or differences within the dataset, allowing the researcher the opportunity to comment on its 'latent content' (Bryman and Bell, 2003; Fraser and Fraser, 2008). Content analysis enables researchers to sift through large volumes of data with relative ease in a systematic fashion (Krippendorff, 1980). The most common notion in qualitative research is that a content analysis simply entails conducting a word-frequency count (Weber, 1990).

According to Lijphart's study (Lijphart, 1971), content analysis plays 5 roles in theory development. First, content analysis is valuable in collecting data in cases in which no theoretical underpinnings are available. Second, this method is useful in cases in which scholars usea theoretical perspective as the basis for collecting data, without intending to make generalizations to a larger population (interpretative content analysis). Third, in cases in which researchers make inconclusive predictions regarding a phenomenon, the exploratory value of content analysis may be used to provide evidence for specific hypotheses (hypothesis-generating content analyses). Fourth, theory-confirming content analyses would examine what is being predicted by established theories, thereby confirming or invalidating the theoretical

position. Finally, deviant-results content analyses would assess those stimuli that fail to comply with the balance of the sample (Kolbe and Burnett, 1991).

According to Krippendorff (1980), six questions must be addressed in every content analysis: (1) Which data are being analyzed? (2) How are they defined? (3) From what population are they drawn? (4) What is the context relative to which the data are analyzed? (5) What are the boundaries of the analysis?; and (6) What is the target of the inferences? For the objectives of this research, however, content analysis can provide a transparent analysis of the environmental reporting content, thereby enabling the authors to observe objectively the attitudes of companies with regard to Green IT. Because this research only assessed companies' activities as described in the environmental reports, the other activities not reported on the website or sustainability reports are not reflected in the results presented herein.

A. Data Construction

A total of 4 companies were analyzed in this research, all of which were from the Telecommunications and Information Technology sector. We selected Nokia, Samsung, Sony Ericsson, and the Sony Company as our empirical subjects, since these companies have been reported as the best companies in terms of implementing green technology (Greenpeace, 2009). Another reason for our selection is that these companies are multinational companies with relatively equivalent firm size aspects. The significant information for this research was obtained from companies' sustainability reports. We utilized the CSR report for 2008 however, we utilized the 2007 CSR report for Nokia, since this is the final version provided on the website. For each company, the following information was obtained and categorizedas follows:

1. Corporate environmental concerns, including whether a company has an environmental report, which includes climate change and environmental concerns. This context is measured simply by assessing whether the company mentions

climate change or environmental issues in their reporting.

2. Whether a company mentions regulation and international policy issues, such as the Kyoto Protocol, RoHS, UNFCCC, the Bali Communique, etc.

3. Whether the company has established environmental management system procedures, such as ISO 14001 or OSHAS18001.

4. Whether the company has implemented (a) energy efficiency actions, and (b) substance materials reduction actions.

5. The key concepts of green words used by the companies in their sustainability reports--including whether they used "green" ideas in the description of their business processes.

6. Whether the company mentioned innovative solutions for dealing with energy efficiency, such as alternative energy.

7. Whether there is any external party involvement behind the companies' green activities, e.g. a supplier or business partner.

According to Fraser and Fraser (2008), using public information provided by the companies in their public media, such as a website or a sustainability report, was consistent with the content analysis methodology outlined above.

B. Analysis and Result

The HyperRESEARCH 2.7 software issued by Research Ware was used for analysis. This software offers several advantages for content analysis, such as allowing the researchers to encode the data and to test the proposed hypothesis as the basis of theory building. Via the use of automatic content analysis, it requires several procedures for handling texts. According to Neuendorf (2002), these procedures include problem identification, conceptualization decisions, operationalization, the development of coding schemes, sampling, coding, and the interpretation and reporting of results. The coding scheme is at the heart of content analysis. The first step in developing a coding scheme is to define the

content categories. The second step is to define the basic unit of text to be classified. Individual words, phrases, sentences, paragraphs, or entire texts may be established as the unit of analysis. The final step is to develop lists of words and phrases associated with each of the content analysis terms.

C. Content Analysis Results

In order to make sense of the data, the environmental reports of 4 companies were coded into 9 categories. The frequency report lists were based on the frequency with which the codes appeared in each case in the study. The standard deviations represent the distribution of the codes across cases. The larger the standard deviationwas, the more variation there was in the use of a given code. For example, the standard deviations of climate change and regulations and policy were 3.775 and 2.062, reflecting a very small variation across cases. The means represent the average number of times a given code was employed across all cases in the study. The descriptive coding results can be seen below, in Table 4.

<Table 4> Descriptive results

Code	Total	Mean	SD
Climate change	53	13.25	3.775
energy alternatives	30	7.50	8.583
energy efficiency	125	31.25	15.283
Envi. Mng. and Ass.	57	14.25	8.221
Green disposal	195	48.75	26.663
Green IT initiatives	44	11.00	10.456
Reduction	50	12.5	7.853
Regulations and policy	37	9.25	2.062
Suppliers	40	10.00	7.528

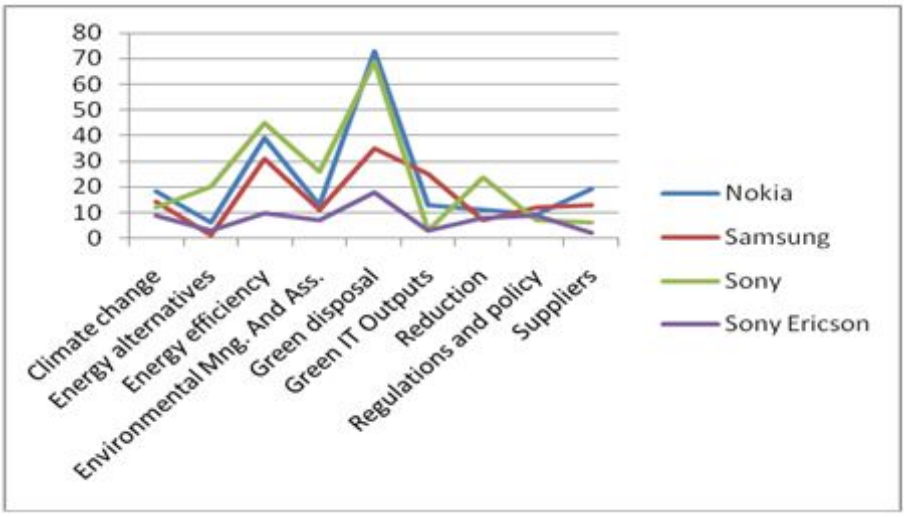
Additionally, we provided the detail scores for each company in table 5. Confirming the chi-square results, the level of reporting associated with climate change and regulation was similar, regardless of any other keywords. Interestingly,

these electronic companies appeared to place more emphasis on green disposal and energy efficiency. There also appeared to be a significantly higher level of reporting conducted on matters associated with disposal and energy efficiency. From the graphic (see Figure 3), we can observe that these four companies are responding to the same trend.

<Table 5> Detail score for each case

CaseIDs	C1	C2	C3	C4
Climate change	18	14	12	9
Energy alternatives	6	1	20	3
Energy efficiency	39	31	45	10
EMS	13	11	26	7
Reduction	11	7	24	8
Regulations and policy	9	12	7	9
Suppliers	19	13	6	2
Green disposal	73	35	69	18
Green related activities	13	25	3	3

C1: Nokia; C2: Samsung; C3: Sony; C4: Sony Ericsson



<Figure 3> Code frequency graph

Using hypotheses tools provided by HyperRESEARCH, we constructed the hypotheses to be evaluated herein. We proposed 9 propositions, and for each

proposition, we established a hypothesis.

Proposition 1: Energy efficiency initiatives are associated with international regulations and policies as a response to the climate change issue.

For instance, in Nokia's report, it was stated that "Nokia signed an international communiqué, along with over 150 other global organizations, ahead of the December 2007 United Nations Climate Change Conference". Additionally, Samsung claimed that "our climate change response strategies…improved the energy efficiency of our products". "Sony Ericsson signed up in support of The Bali Communiqué, a comprehensive United Nations framework to tackle climate change."

Proposition 2: Substances emission/reduction initiatives are associated with international regulations and policies as a response to the climate change issue.

As noted in Nokia's report, The European Union Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (known as REACH) aims to evaluate and register tens of thousands of chemicals.

Proposition 3: Environmental management and association are associated with companies efforts to reduce energy usage

Samsung reported that "these activities (energy reduction activities) earned us several voluntary energy reduction certifications from Energy Star, Korean e-Standby Program, and Chinese Energy Conservation Program". Sony stated that "Sony has been in the Green Power Certification System since their first purchase in December 2001".

Proposition 4: Greenhouse gases/CO2 Emission activities are correlated with environmental management and association.

Sony joined the Climate Savers Programme, organized by the world-renowned environmental NGO, the World Wide Fund for Nature (WWF), and established the goal of achieving an absolute reduction in greenhouse gas emissions. In addition, Nokia stated "….work with WWF to achieve targets to reduce greenhouse gas emissions". It is clear that environmental management systems and

associationssuch as WWF, MPPI, WEEE, GeSi, etc. contribute to the emissions efforts of the companies. Moreover, Samsung stated "We assist the overseas production subsidiaries to acquireISO14001 and OHSAS18001 certifications".

Proposition 5: Companies try to find an energy alternative to tackle with energy efficiency and emission activities.

In Japan, Sony began by considering introducing wind power. Samsung also stated, "We are exploring new business opportunities in the ever-expanding market of renewable energy".

Proposition 6: Companies' energy efficiency practices and emission/reduction efforts are associated with their green disposal practices.

Nokia stated that "Our priorities in environmental management are energy efficiency, managing substances in our products and take-back of used devices for proper recycling." Samsung also reported, "we developed a slurry renewal system to recycle 99% of the used slurry". "Sony not only saves energy but also reduces the amount of new materials used at time of manufacture." Currently, the recycling issue and take-back have become the most important issues in the electronics industry.

Proposition 7: Companies' energy efficiency practices and emission/reduction efforts are associated with their green related activities (green products, green operation, green workplace, green packaging, etc.)

By 2015, the goal is to reduce total greenhouse gas emissions throughout the entire life cycle of Sony Ericsson's products. Samsung also claimed, "we will continue to develop initiatives for reducing our environmental footprint and for green workplaces". "Our strategy includes changing workplace practices to reduce travel, as well as improving the energy efficiency of our buildings", Nokia noted.

Proposition 8: Supplier involvement in energy efficiency and emission processes is associated with the companies to produce green IT innovation (e.g. Green IT

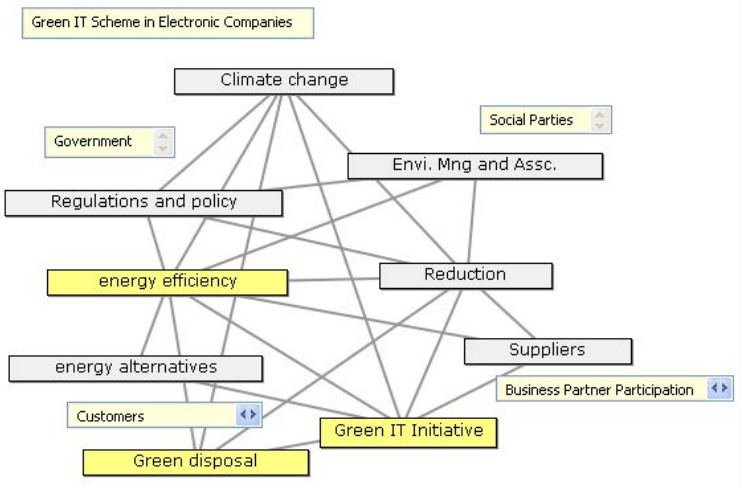
initiatives and green disposal)

Nokia stated that, "….in close cooperation with its suppliers, has full material declarations for our mobile devices. This means we can respond swiftly if new concerns arise about substances we use."Moreover, Samsung involved and encouraged its suppliers to implement environmental systems. They reported that "raw material inspection has been completed on around 800 business partners in Korea and overseas,and all parts and finished products used in the production site are subjected to hazard substance tests". Similarly, Sony noted, "Sony acts responsibly in all areas and strives to resolve environmental issues together with our peers and business partners".

Proposition 9: Companies' climate change awareness/environmental responsibility is correlated with the companies to innovate through Green IT.

Sony stated "Innovation is Key to Efforts to Reduce Global Warming". Sony Ericsson also reported that they were using "….innovation to bring you phones that offer you a greener choice".

Lastly, we create a code map of a Green IT Scheme in Electronic Companies generated from our content analysis.



<Figure 4> Green IT Scheme in Electronic Company

In relation to Green IT components, energy efficiency and greenhouse gas/carbon reduction refer essentially to green manufacturing; whereas "green initiatives" refers to green design; green disposal (and take back) refers to green disposal, and all activities during the process implementation might be argued as constituting green use. From this point, we have proof that the companies' green initiatives have been driven by the awareness of climate change, regulations and policy, and stakeholders (e.g. suppliers, environmental management systems and association, social parties, business partners, and government). Thus, we validated that the **stakeholders' perspective** should be one of the dimensions of scorecard. The results also revealed that energy efficiency during the lifecycle is one of the critical success factor of the companies' operational process (**process perspective**). The green IT innovation along with the green IT disposal efforts indicated that "**future orientation**" is addressed to achieve a sustainable development. Lastly, the business owners are likely to obtain a financial benefit from their green investments (**financial perspective**).

V. Strategic Metrics Scorecard

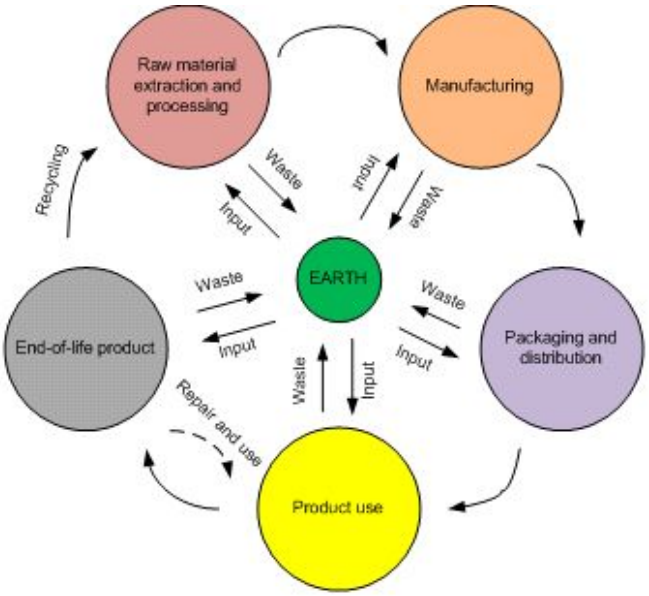
A. Process Perspective

The process perspective represents the process by which Green IT can be used to create and deliver support to applications in a sustainable fashion. An important focus of environmental technologies is to improve the ecological performance of manufacturing processes. This can be achieved via the redesign of production systems to reduce environmental impacts, the use of cleaner technologies, the use of higher-efficiency production techniques, minimizing waste at its source, and maximizing fuel and energy efficiency (Shrivastava, 1995). Hence, the process perspective focuses on the operational process of technology used to satisfy environmental expectations. We adopted the Life Cycle Approach to obtain the entire picture of Green IT from the process perspective. A life cycle approach means that we recognize how companies' choices influence what happens at each of these points so they can balance trade-offs and positively impact the economy, the environment, and society (UNEP United Nations Environmental Program , 2004). It identifies both the opportunities and risks of a product or technology, all the way from raw materials to disposal.

"Life Cycle Approaches help us to find ways to generate the energy we need without depleting the source of that energy and without releasing greenhouse gases that contribute to climate change." (UNEP 2004, p.5)

The Life Cycle Approach is a powerful tool to help companies' better understand the environmental effects of their technology usage, thus providing valuable information regarding opportunities to improve environmental performance (Hendrickson et al., 1998). LCA is also, next to other tools, critical for technology choices, setting technologies into a product-related chain perspective (UNEP, 2005). The LCA assesses the environmental impacts of a system or product from cradle to grave throughout the full life cycle, from the exploration and supply of materials

and fuels, to the production and operation of the investigated objects, to their disposal/recycling (Pehnt, 2006). This approach focuses first and foremost on (1) compiling an inventory of relevant energy and material inputs and environmental releases; (2) evaluating the potential environmental impacts associated with the identified inputs and releases, and (3) interpreting the results to assist companies in making more informed decisions (EPA, 2010). A life cycle approach is generally decomposed into several stages (see figure 3), and most commonly into six stages: (1) product design; (2) raw material extraction and processing; (3) manufacture of the product; (4) packaging and distribution to the customer; (5) product use and maintenance; (6) end-of-life management: reuse, recycling, and disposal(EPA, 2010).



<Figure 5> Stages of the product life cycle - Australian Government: Department of the Environment and Heritage (Adapted from UNEP, 2005)

We developed our process perspective metric via derivation from the Life-Cycle Approach, focusing on the key issue as to "How effective and efficient isGreen IT during its life-cycle?" The process metric is illustrated in Table 6. The principal issues here are as follows: reducing the quantity of technology pollution/carbon footprint/Green house gases (GHG) emissions for conducting the operational

process, decreasing the consumption of energy and resources inherent to the operational process, minimizing environment-related risks, and adopting technologies that are easy to recycle, reuse, and decompose at the end of the technology life-cycle. The first objective can be measured by calculating the pollution control index, transportation efficiency assessment, emission ratio, and corporate report (ISO14001, GRI Global Reporting Index, or EMAS Eco-Management and Audit Schemeversion). The energy consumption and resources may be measurable via the management system project score, average consumption of water, materials, energy, and corporate report (ISO14001, GRI, or EMAS version). The third objective, minimizing the environment-associated risks, can be evaluated through hazardous waste ratings, risk technology assessments, and corporate reports. The final objective, related to end-of-life products, can be measured via life cycle assessments, material investigations, e-waste ratios, and corporate reports.

<Table 6> Metric for Process Perspective

Perspective	Process Perspective
Key Question	To optimize the utilization of Green IT during its lifecycle
Objectives	Reduce the amount of technology pollution/carbon footprint/GHG emission for conducting the operational process Measures ■ Pollution control index ■ Transportation efficiency assessment ■ Emission ratio ■ Corporate report (ISO14001, GRI,or EMAS version)
	Decrease the consumption of energy and resources for conducting the operational process Measures ■ Management system project scores

	■ Corporate report (ISO14001, GRI, or EMAS version) ■ Average consumption of water, materials, energy
	Minimize the environment-related risks Measures ■ Hazardous waste ratings ■ Risk technology assessment ■ Corporate report (ISO14001, GRI, or EMAS version) ■ Environmental impact assessment
	Easy to recycle, reuse, and decompose at the end of technology life-cycle Measures ■ Life-cycle assessment ■ Material investigation ■ e-waste ratio ■ Corporate report (ISO14001, GRI, or EMAS version)

B. Stakeholder Perspective

The stakeholder perspective represents stakeholders'evaluation of Green IT. Our Green IT balanced scorecard showed that stakeholders perform a pivotal role in the green business environment. Many surveys have indicates that stakeholders' growing interest in the natural environment, and have provided clear evidence for popular environmental demands on business firms. Funk (2003) reported that "Companies that actively manage a wide range of sustainability indicators are better able to create long-term value for all stakeholders" (Funk, 2003, p. 1). Thus, stakeholder reactions are a crucial element, as they may affectshort-term revenues and costs and long-term corporate performance on many levels (Epstein and Roy, 2001). Hendriques and Sadorsky (1999) identified four categories of stakeholders from an environmental perspective: (1) regulatory stakeholders (governments, trade associations, informal networks, and leading firms in environmental matters); (2)

organizational stakeholders (customers, suppliers, employees, and shareholders); (3) community stakeholders (community groups, environmental organizations, and other potential lobbies); (4) the media (mass media). Furthermore, Buysse and Verbeke (2003) re-conceptualized these classifications into regulatory stakeholders (national and regional governments, local public agencies); external primary stakeholders (customersand suppliers); internal primary stakeholders (employees, shareholders, and financial institutions); and secondary stakeholders (rivals, international agreements, environmental non-government organizations, and the media). In this study, to determine the state of the Green IT balanced scorecard, we adopted four major stakeholders' groups as proposed by Buysse and Verbeke (2003), and these can be seen in Figure 6.

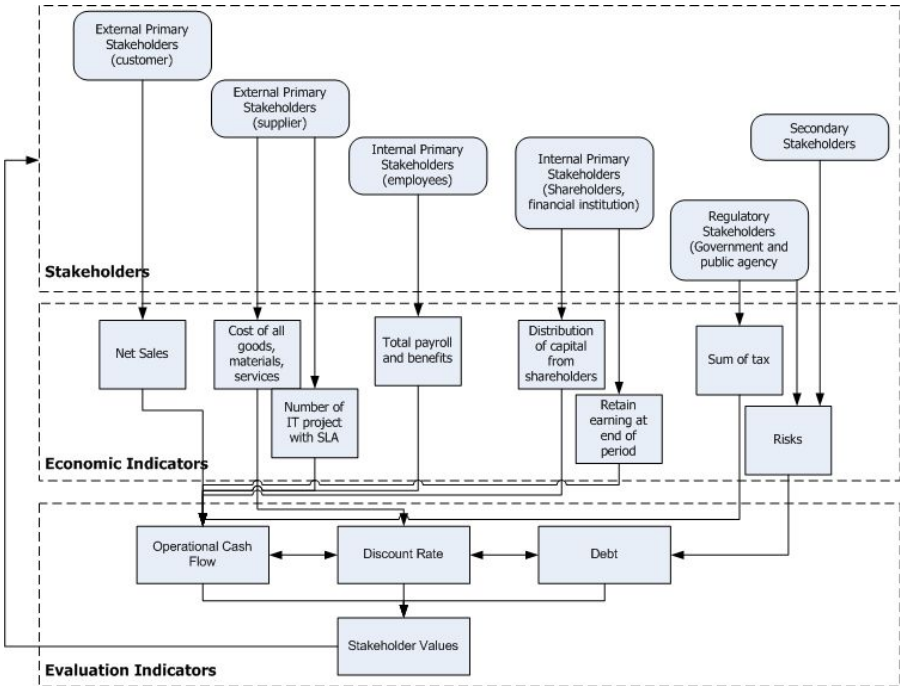
Companies may gain lasting advantage via stakeholder relationships that are uniquely structured to provide strategic advantage. For instance, customers can provide this advantage through loyalty and a long-term stream of green product/service purchases employees can do the same by committing to excellent service, innovation, and reliability shareholders provide a persistent advantage whenthey provide long-term, patient capital additionally, partnerships between business and environmental groups can constitute strategies for the integration of corporate environmental strategies with market objectives (Hartman and Stafford, 1997). As stakeholder relationships have already been established as one major driver of strategic success, companies must clearly identify key stakeholder groups (Epstein and Roy, 2001). However, it should be noted that a well-prepared organization operating within a business environment that is insensitive to environmental progress will find its financial performance lower than it would be if customers, suppliers, and regulators actively supported environmental advances (Aragon-Correa and Rubio-Lopez, 2007).

A range of key questions related to stakeholders and corporate strategies are as follows (Bremser and Chung, 2005):

1. Stakeholder satisfaction: Who are the key stakeholders and what do they need?

2. Strategies: What strategies do we need to implement to satisfy the wants and

needs of these key stakeholders?



<Figure 6> Linkage of Stakeholders into Economic Indicators

3. Processes: What critical processes are required if we are to execute these strategies?

4. Capabilities: What capabilities do we need to operate and enhance these processes?

5. Stakeholder Contribution: What contributions do we require from our stakeholders if we are to maintain and develop these capabilities?

The objectives of stakeholders' orientations are stakeholders' satisfaction, measurement of stakeholders'needs, and ethical and legacy systems (table 7). Stakeholders'satisfaction can be measured through surveys of stakeholder satisfaction and the number of stakeholder complaints, while stakeholders' needs can be evaluated in terms of numbers of meetings with stakeholders, numbers of IT projects with SLA (Service Level Agreement), level of communication between

CIO (Chief Information Officer), CEO (Chief Executive Officer), and key stakeholders, and capital accessibility. Finally, ethical and legal mitigation might be assessed in terms of the availability of formal environmental technology procedures, numbersof IT environmental awards, and sustainability performance record.

<Table 7> Metrics for Stakeholders Orientation

Perspective	Stakeholders Orientation
Key Question	To quantify the efficiency and the effectiveness of Green IT in supporting stakeholders' needs
Objectives	Stakeholders Satisfaction Measures ■Stakeholder satisfaction survey ■Number of stakeholder's complaint
	Management of stakeholders' needs Measures ■ Number of meeting with stakeholders ■ Number of IT project with SLA ■ Level of communication between CIO, CEO, and key stakeholders ■ Capital accessibility
	Ethical and legal mitigation Measures ■ The availability of formal environmental technology procedures ■ Number of IT environmental award ■ Sustainability performance record

C. Financial Perspective

Related to stakeholder perspective, Green IT implementation also contributes to

the creation of costs (tangible and intangible). The financial perspective of the Green IT balanced-scorecard indicates the contribution of the implementation of green technology from a financial perspective. It represents released business costs and values created via Green IT investment. The environmental dimension can naturally be considered in corporate sustainability development and is normally perceived as a cost for firms (Viederman, 1993). When companies decide to integrate environmental management into their business processes, certain resources and capabilities can be exploited within the organization (Claver et al., 2007). On the other hand, environmental management has also been recognized as a significant factor in determining a firm's economic performance (e.g. Crissmann, 2000). Thus, managers are faced with a number of trade-offs, and should recognize both the long-term and short-term costs and benefits of adopting alternative environmental strategies (Epstein and Roy, 1998).By doing so, the explicit costs of environmental management are minimized and can generate other management benefits, including higher morale and increased productivity, thereby resulting in revenue growth (McGuire et al. 1988).

Another argument holds that the financial performance of a firm is influenced by strong environmental performance via both market and cost pathways. From the marketing perspective, customers tend to prefer environmentally oriented companies. On the cost side, firms that invest heavily in environmental management systems and safeguards may potentially avoid environmental spills, crises, and liabilities in the future. Costs due to material waste and inefficient process are also minimized (Klassen and McLaughlin, 1996).More comprehensive approaches to environmental management that take into account the environmental impacts of firms'operations throughout the entire life-cycle of the firm's products can also contribute to these cost advantages. Moreover, such innovations (e.g. potential liability costs, legal fees, and potential product take-back costs) can also mitigate the environmental costs to some degree. Environmental management practices such as pollution prevention technologies and environmental technological innovations may reduce cycle time, and cut emissions well below the required levels, thereby resulting in compliance and liability costs (Christmann, 2000).

This perspective is represented by some five objectives (see table 8): (1) increase the revenue growth via Green IT implementation (measured through actual cost versus budgeted expenses and cost recovery versus expense); (2) reduce the environmental risk cost(measured through the average of risk costs) (3) determine the business value of Green IT Project (computed through financial traditional measurement (e.g. ROI (Return on Investment), ROE (Return on Equity), ROA (Return on Assets)), (New) Information Economics, or cost/benefit analyses); (4) management of Green IT investment (measured via capital investment rate); and (5) reduce the e-waste costs (evaluated through the average of recycle and take-back costs).

<Table 8> Metrics for Financial Perspective

Perspective	Financial Perspective
Key Question	To investigate the contributions of the Green IT implementations from financial perspective
Objectives	Increase the revenue growth through Green IT implementation Measures ■ Actual cost versus budgeted expenses ■ Cost recovery versus expense
	Reduce environmental risk costs Measures ■ Average of risk costs
	Business value of Green IT Project2 Adapted from Van Grembergen (2000) Measures ■ Financial traditional measurement (e.g. ROI, ROE, ROA) ■ (New) Information Economics ■ Costs/Benefits Analysis
	Management of Green IT investment

	Measures ■ Capital investment rate
	Reduce the e-waste cost Measures ■ Average of recycle and take-back costs

D. Future Orientation

Future orientation involves the resources and capabilities required by IT to sustainably deliver its services. As we previously asserted, businesses can increase the productivity of their resources via green innovations (eco-innovations). Innovations can be viewed as repurposing, improving, or renewing existing ideas and practices that need to be understood, particularly the correspondence between new technology ideas and corresponding new practices (Hines and Marin, 2004). In accordance with this concept, eco-innovation has been broadly defined as the process of developing new ideas, behaviors, products, and processes that contribute to a reduction in environmental burdens or to ecologically specified sustainability targets (Rennings, 2000). This eco-innovation has become the first listed target of companies wishing to sustain their competitive advantage in the future, and can be implemented in terms of product, resource, production process, equipment, waste, and pollution innovations, by embedding technology into those processes (Sarmento et al., 2007). Green innovations (eco-innovations) consist of hardware or software innovations associated with green products or processes, including innovations in technologies involved in energy conservation, energy alternative research, pollution prevention, waste recycling, green product designs, or corporate environmental management (Hart, 1995). Radical innovation is necessary, which is where technological products and systems are reconstructed drastically in order to facilitate a radical upward system shift in eco-efficiency (Hellstrom, 2007).

To address the prospect of innovation, the principal objectives of this orientation are as follows: (1) research and development of Green IT (measured through number of new innovation, number of patents, and percentage ofbudget allocated to

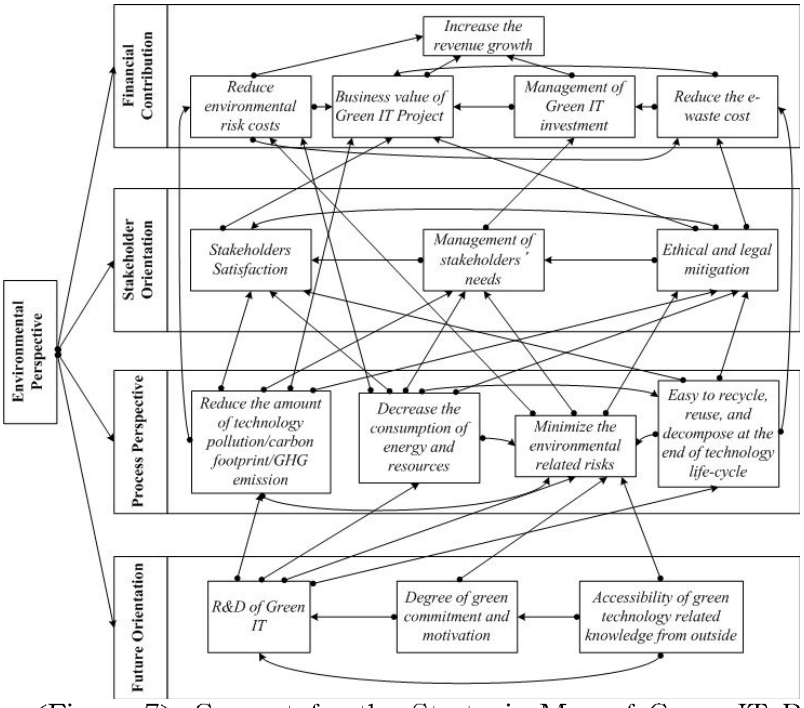
new research and development); (2) increase the degree of green commitment and motivation internal to the organization (measured through employees'green satisfaction survey, number of IT environmental certificates, and internal process improvement); (3) improve the accessibility of green technology-related knowledge from outside (measured by the number of corporations with local/international environmental associations (e.g. ISO, RoHS (Restriction of Hazardous Substance), etc.) and amount of training related to green IT usage). The metric for future orientation is illustrated in table 9.

<Table 9> Metrics for Future Orientation

Perspective	Future Orientation
Key Question	To integrate the environmental aspect of technology to achieve a sustainability development
Objectives	R&D of Green IT Measures ■ Number of new innovation ■ Number of patent ■ Percentageof budget allocated to new research and development
	Increase the degree of green commitment and motivation within the organization Measures ■ Employees' green satisfaction index ■ Number of IT environmental certificates ■ Internal process improvement
	Improve the accessibility of green technology related knowledge from outside Measures ■ Number of cooperation with local/international environmental association (e.g. ISO, RoHS, etc.) ■ Number of trainings related to green technology usage

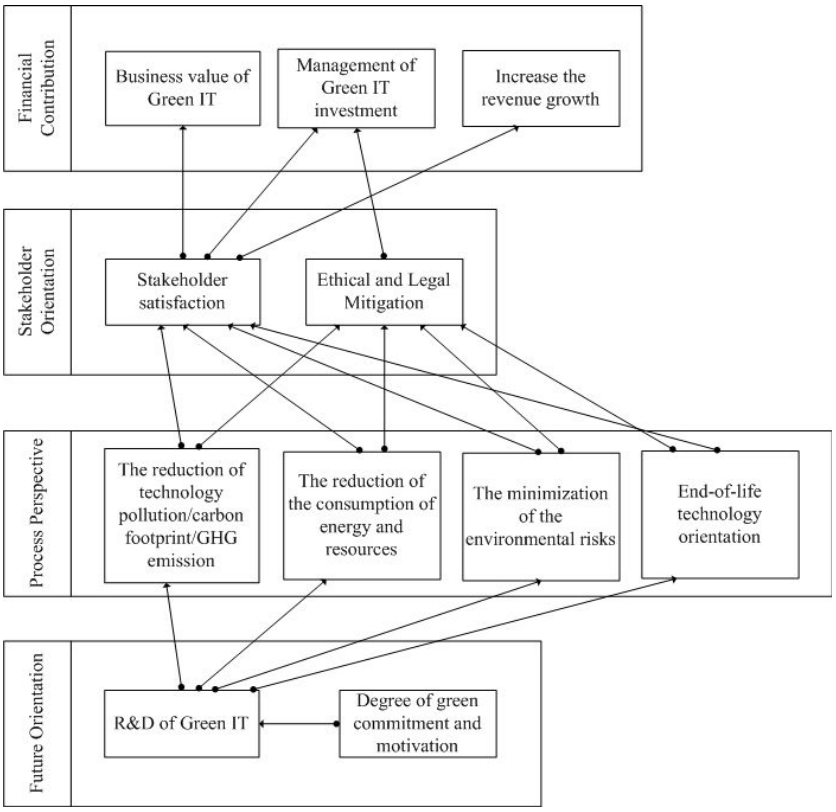
VI. Cause-and-Effect Relationships and Proposed Research Model

In the balanced scorecard model, strategy maps are utilized to communicate the hypothesized cause-effect linkages between performance measures and strategic objectives (Herath et al.,2010). In Figure 7, the concept of the strategic map of Green IT BSC (cause-and-effect relationship) is illustrated. These cause-and-effect relationships need to be defined throughout the entire scorecard (Van Grembergen, 2000). By systematically investigating the leading and lagging indicators from a top-down perspective, the interconnections of each perspective may indicate the strategic relevance of the environmental aspects of technology. For example, if Research and Development (R&D) into Green IT is increased, the amount of technology pollution/carbon footprint/GHG emissions will be reduced; this may ultimately lead to improved customer satisfaction as an enabler of business value of Green IT projects and revenue growth.



<Figure 7> Concept for the Strategic Map of Green IT BSC

As a part of the model validation, we decided to simplify the cause and effect model by testing only several objectives of each dimension. The proposed model can be seen in figure 8 below.



<Figure 8> Proposed Research Model

VII. Solutions and Recommendations

In this study, we recommend a relevant strategic management tool for the evaluation of Green IT investments from four perspectives (stakeholders' orientation, operational excellence, financial perspective, and future orientation) derived from an environmental standpoint. The process of formulating this Green IT BSC as described herein indicates the manner in which the environmental issue can be integrated into technology management, which can, in turn, be used to support the decision-making process. The metrics, as a component of this Green IT BSC,are essential not only for determining the status of the entity at the present time,but also for monitoring its risks associated with conducting business in a dynamic environment (Srivastava et al. 2001).

Furthermore, we have proposed a new structural model of Green IT BSC, consisting of the Green IT infrastructure BSC and the Green IT usage BSC as the enablers of the Green IT strategic BSC this Green IT strategic BSC is an enabler of sustainable business BSC. For the successful implementation of this scorecard, we have provided a range of recommendations for both practitioners and researchers, as follows.

■ Similarly to the other IT balanced scorecard, Green IT BSC is a technique that can only prove successful when the business and the IT work together and collaborate in the scorecard measurement process. The introduction of an IT balanced scorecard in an IT environment with poor management and IT practices is too large a challenge (Van Grembergen et al., 2003). In addition to this first requirement, we recommend that the stakeholders be involved in the measurement process. Thus, the existence of solid collaboration among IT, business units, and related stakeholders may enhance the accuracy and reliability of Green IT BSC.

■ In relation to the first recommendation, it is necessary to identify the key stakeholders necessary for success in sustainable environmental and business. The companies may conduct a forum dialogue with key stakeholders in order to

understand their perspectives and priorities regarding environmental sustainability, and their viewpoint on this issue is likely to affect business sustainability.

■ It is also recommended that companies incorporate this strategic tool into other environmental management systems such as ISO14000 and LCA. While currently existing environmental management systems represent only the detailed environmental factors of business, the Green IT BSC protocol has the ability to integrate both the intangible and tangible environmental aspects of business.

■ We suggest that IT management should focus on implementing Green IT BSC in every investment into environmental technology. This strategic tool should be applicable to the evaluation of various forms of technology (e.g. software, hardware, or service)that might help management to make the appropriate financial decisions.

■ A broader perception throughout the entirety of management--such as the inculcation of pro-environmental attitudes--is necessary, particularly in the process of aligning performance drivers and performance outcomes of Green IT BSC.

■ Finally, we recommend that top management become as familiar as possible with green business strategies and practices; therefore, Green IT BSC is expected to prove a useful tool for the integration of sustainable business strategies with green technology strategies.

VIII. Future Research Directions

This study has some limitations that should be overcome by adopting the appropriate research directions in the future. First, our study was designed as a conceptual study. We recommended a new model as a strategic management system for firms' IT departments. Thus, more effort will be necessary in order to validate the implementation of this Green IT Balanced Scorecard in cases of actual businesses, and to evaluate it as a component of IT governance. Second, despite the fact that we generate the structure of Green IT BSC, consisting of Green IT infrastructure BSC, Green IT Usage BSC, and Green IT Strategic BSC as the enablers of sustainability BSC, the classification metrics could likely be enhancedin the future. Thus, further research will also be necessary in order to classify our standard metrics of Green IT BSC into certain categories of the structure model. Moreover, further study including the specific measures is also necessary to adequately address this phenomenon. Third, the weights of the metrics might be affected to some degree by the companies' primary orientation and initial business type. Determining the weights on the basis of the importance and potential impact of each green technology device might result in some interesting and valuable results. Further research will be necessary to address this issue by comparing the evaluation results across different business settings. Finally, our study is only a technique by which business strategies and IT strategies are aligned. Among the currently available measurement tools, it is somewhat difficult to judge which method is superior, since each method has its own distinctive objectives and characteristics. This study can be viewed as an advanced step in the development of IT strategic management tools designed to enhance the concept of environmental sustainability.

IX. Conclusion

The objectives of the Green IT balanced scorecard are to evaluate technology performance by integrating environmental aspects effectively, to investigate both the tangible and intangible assets of Green IT investment, and to align IT performance and business performance and transform the results into competitive advantage. The transformation of existing technology by green technology is associated with high risk, and thus must be carefully considered. To address this situation, our conceptual model should be considered a systematic set of guidelines to ensure a strategic alignment of Green IT and to achieve integration between sustainable business and technology. This integration concept offers a new possibility for both practitioners and researchers to translate their sustainable business strategies into Green IT actions.

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Questionnaire of the *Green IT* Balanced Scorecard

Dear Respondent,

This survey will ask you to provide information about your *Green IT* (Green Information Technology) practices. The questionnaire is divided into five parts. The initial part asks you about your profile as well as your company's profile. Part A of the questionnaire asks a series of questions to assess your environmental aspect from process perspective. Part B asks certain criteria related to your stakeholders' roles in your decision related to environmental technologies. Part C requires you to provide your financial performance and Part D asks you to indicate your future orientation perspective. When answering each question, please tick the column of the appropriate answer, or fill in specific data. Please answer ALL questions as thoroughly and accurately as possible.

If you need help completing the survey questionnaire, please call the contact person below.

Researcher's name: Yulia Wati
Address: College of Business, Chosun University, 375 Seosukdong Donggu, Gwangju 501759
Phone number: 010-7635-7705

Confidential Business Information is protected

We assure the confidential of the business information you will provide for this survey. Your information will be disclosed by the researcher only for this research purpose.

Demographic Respondent

Gender: ___ Male ___ Female

Job type in the company:
____ IT Manager (CIO, Software Architecture, Software Developer)
____ Business Manager (Production/Operation, Marketing, Strategic, Human Resource, etc.)
____ Other _____ (Please mention)

Please indicate the type of your business sector:

	Telecommunication		Consumer goods
	Utilities		Energy
	Basic Materials		Healthcare
	Industrial		Technology

Location of your company: _____

Please indicate the total number of employees in your company:

	≤100
	101-200
	201-300
	301-400
	401-500
	>500

Please indicate the average revenue of your company for the last two years?

_____

In the last two years, to what extent this company invested resources in Green Technology program in the following areas, relative to the company's annual budget?

	Computer hardware/software		Storage virtualization
	Server consolidation and virtualization		High efficiency and stand-by power systems
	Free cooling in large scale date centers		Installation of more energy efficient lights
	DC powered IT equipment		Rightsizing IT equipment
	High voltage AC power		Desktop virtualization
	Others, _____		

How long has your company been operating? _____ year(s)

Please indicate your market position in the industry!

	Defender (your company has narrow product-market domains; top managers are highly expert in their organization's limited area of operation, but do not tend to search outside their narrow domains for new opportunities; centralized control; high degree of formalization; vertical information flows; simple and expensive coordination)

	Prospectors (your company almost continually searches for market opportunities and regularly experiment with potential responses to emerging environmental trends; control is results-oriented; low formalization; info flow to decentralized decision-makers; complex and expensive coordination)
	Analyzers(your company operates in two types of product-market domains, one relatively stable, other are changing; control difficult and must be able to trade of efficiency and effectiveness; coordination is both simple and complex)
	Reactors(your company does not have a systematic strategy, design, or structure; does not prepare for changes it facesin its business environment; top managers do not make long term plans because of the dynamic environment)

A. Process Perspective from Life-Cycle Perspective

1. Green IT Commitment

***Green IT* Commitment**	**1**	**2**	**3**	**4**	**5**
We have a committee dedicated to dealing with environmental issue					
We have formulated a plan for dealing with environmental issue					
Compensation is given to the employees with *Green IT* initiative					
Our company has a long-term *Green IT* approach					
We have a bold, innovative, environmentally friendly *Green IT* product development approach					

2. Life-Cycle Approach

An environmental **Life Cycle Assessment (LCA)**has been conducted on major products manufactured in this company.

___Yes ___ No

If you answer **YES**, please go to **the next question**. If you answer **NO**, you are not required to complete this questionnaire. Please go directly to **question number 3**!

Life-cycle approach identifies the life of product or service into five phases:

(1) Raw material extraction and processing
(2) Manufacturing
(3) Packaging and distribution
(4) Product use
(5) end-of-life product
Please answer each question below for each life phase of the technologies. To answer the question, you may tick the column of the appropriate answer below: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly Agree

Raw Material extraction and processing	**1**	**2**	**3**	**4**	**5**
We gradually substitute the polluting and hazardous materials/technology parts with the more environmental and less-polluting materials/technology part					
We prefer green materials in purchasing					
We develop a clean *Green IT* process					
We use recycled materials or material-efficient techniques					
Manufacturing	**1**	**2**	**3**	**4**	**5**
Process manufacturing focuses on reducing energy consumption and natural resources consumption by using *Green IT*					
Acquisition of clean technology/equipment					

Production planning and control focused on reducing waste and optimizing material exploitation					
We use renewable energy (e.g. solar, wind) during the manufacturing process					
Packaging and Distribution	**1**	**2**	**3**	**4**	**5**
Our designs process focuses on reducing resource consumption and waste generation during production and distribution					
Our designs process focuses on reducing resource consumption and waste generation during product usage					
Our design process is committed to disassembly, reusability, and recyclability					
We carefully select cleaner transportation methods					
Product Use	**1**	**2**	**3**	**4**	**5**
Customers are provided with the *Green IT* guidelines					
The final products/services delivered to the customers are energy-saving products/services					
We regularly educate customers about responsible *Green IT* practices					
We reduce the energy usage of data center					
The IT department of our company intensively create a virtual counterpart for either hardware or resources					
End-Of-Life Product	**1**	**2**	**3**	**4**	**5**
We commit to responsible disposal of e-waste and residues					
We collect recyclable or reusable packaging/containers					
We have recuperation and recycling systems					
We have a product take-back program					

3. Environmental technology portfolio indices

Please think about all the projects or investments over the last twoyears in your company that have benefited the natural environment in any way. A benefit is defined as reducing any negative impact of manufacturing operations on the environment or improving the quality of life. Estimate the percentage of these projects that belong to each category listed below. Allocate 100 points to the five categories, based on their use of resources. **(Total of the five categories must equal 100%).**

____ % a. **Remediation projects**, such as removing underground storage tanks or cleaning up earlier environmental damage.

____% b. **Pollution control technologies**, such as new water or waste treatment equipment or air pollutant collection

____ % c. **Management systems**, such as new environmental training for employees to minimize spills or new environmental audit programs

____ % d. **Product adaptation**, such as raising the use of recycled materials or using less hazardous materials in the product

____ % e. **Process adaptation**, such as covering open tanks or redesigning manufacturing equipment to reduce waste

_____

100%

B. Stakeholders' Perspective

To answer the question below, you may tick the column of the appropriate answer below: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly Agree

1. Stakeholder Orientation

Customer Orientation	**1**	**2**	**3**	**4**	**5**
Our IT resources assist in putting our customers' interests first					
We involve the customers to participate in our environmental program such as take-back program or reused program					
Supplier Orientation	**1**	**2**	**3**	**4**	**5**
Key suppliers are involved in design process to integrate environmental issue					
Joint R&D projects with key suppliers are undertaken for measuring environmental impact of product					
Environmental information is shared and exchanged with key component suppliers					
Employees Orientation	**1**	**2**	**3**	**4**	**5**
The employees are aware and capable of their environmental responsibility					
The employees have strong technical *Green IT* related skills					
Employees' suggestion have proven to be an excellent source of idea to improve *Green IT* in this company					
We have a regular training of *Green IT* for managers and employees					
Shareholders or financial institutions	**1**	**2**	**3**	**4**	**5**
The *Green IT* supports the achievement of business objectives					
The expenditure on *Green IT* delivers such values to sustainability business					

The cost related to *Green IT* can be managed effectively					
With the integration of *Green IT*, the targeted inter-company IT synergies can be achieved					
Government and public agency	**1**	**2**	**3**	**4**	**5**
Environmental compliance is a critical part of the employee's performance measurement					
A great deal of this Green technology performance information is voluntarily disclosed to the public					
Our formal position on environmental issues was developed after extensive consultation with the public					
Secondary stakeholders	**1**	**2**	**3**	**4**	**5**
We allow the media to expose our environmental performance to the public					
Community-based service has been conducted routinely in our company					

2. Number of stakeholders' complaints

How many environmental-related complaints that you have received from your stakeholders related to your current technologies? (Within the last 2 years)

Key stakeholders	**Number of Complaints**				
	≤20	**21-40**	**41-60**	**61-80**	**>80**
From Customers					
From Suppliers					
From Employees					
From shareholders					
From Government/public agency					
From Secondary stakeholders					

3. Meeting with the stakeholders

Indicate the total number of meetings with the key stakeholders in the last two years

____ (≤10) ____ (11-20) ____ (21-30) ___ (31-40) ___ (>40)

To answer the question below, you may tick the column of the appropriate answer below: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly Agree

Details	**1**	**2**	**3**	**4**	**5**
Meeting are held routinely by this company with local environmental groups and plant neighbors					
External meetings with the public have provided valuable input from your company's perspective					

4. Number of IT projects with Service Level Agreement (SLA)

How many environmental technology projects have you signed under SLA? (within the last two years)

____ (≤5) ____ (6-10) ____ (11-15) ___ (16-20) ___ (>20)

5. The availability of formal environmental technology procedures

To answer the question below, you may tick the column of the appropriate answer below: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly Agree

Procedures	**1**	**2**	**3**	**4**	**5**
Written *Green IT* policy exists in the company					
Technological practices are formally reviewed at least annually for their impact on the environment					
An audit of e-waste reduction programs and their results is performed annually for all production areas					
An audit of environmental technology risks for the existing production equipment is performed annually for all production areas					

C. Financial Perspective

To answer the question below, you may tick the column of the appropriate answer below: (1) Strongly disagree; (2) Disagree; (3) Neutral; (4) Agree; (5) Strongly Agree

Financial Performance	**1**	**2**	**3**	**4**	**5**
Since the implementation of the *Green IT* practices, our financial performance has been outstanding					
Since the implementation of the *Green IT* practices, our financial performance has exceeded our competitors					
Since the implementation of the *Green IT* practices, our sales growth has been outstanding					
Since the implementation of the *Green IT* practices, we have been more profitable than our competitors					
Since the implementation of the *Green IT* practices, our sales growth has exceeded our competitors					

D. Future Orientation

Future Orientation	**1**	**2**	**3**	**4**	**5**
We commit to capital investment in new *Green IT* equipment and machinery					
Our company has been a leader in introduction of *Green IT* innovation and will continue be a leader in the future					
Our company has adopted Environmental Management Systems (e.g. ISO 14001, GRI) and will continue to do so					
We actively cooperate with local communities and or local environmental association					
We actively cooperate with international environmental institution to promote the *Green IT*					

Detail information

1. Please indicate the number of patents that your company received in the last two years!

____ (≤5) ____ (6-10) ____ (11-15) ___ (16-20) ___ (>20)

2. Please indicate the percentage of budget allocated to new research and development of green technologies within the last two years! _____ %

Operational Benefit	**1**	**2**	**3**	**4**	**5**
Overall, by adopting *Green IT* in our operational process, we can gain a greater productivity					
More efficient use of materials and energy has resultedin higher yields or reduced use of purchased inputs					
Green IT practices have improved purity and quality of final products					
Green IT practices have helped us to eliminate the unnecessary production steps and simplification of designs					
More careful monitoring and maintenance of *Green IT* has resulted in less downtime and less reject					
Market Benefit	**1**	**2**	**3**	**4**	**5**
We have a strong competitive positioning for lower costs because of *Green IT* practices					
Green IT practices have helped us to improve firm image					
Green IT practices have contributed to attract customers in environmentally conscious market segments					
Green IT practices enable us to enter the growing market for environmental goods and services					
Green IT practices enable us to build an inimitable strategy as an environmental leader					

Regulatory Benefit	**1**	**2**	**3**	**4**	**5**
Green IT practices have reduced our environmental taxes and charges					
Green IT practices have reduced our liability costs					
Green IT practices enable us to sell and not buy pollution rights in emission trading markets					

녹색정보기술(*Green IT*) 균형성과표(Balanced Scorecard) 관련 설문

본 설문은 녹색정보기술(Green IT) 실행에 대한 정보를 얻고자 하는 것이 목적입니다.

- 제품 생산과정에 유해물질 사용 금지
- 유해 폐기물 처리에 대한 생산자의 책임 (자원의 재활용)
- 소비전력, 발열 및 소음을 줄인 제품 개발
- 에너지 효율의 향상과 장비 규모의 축소
- 데이터센터 가동에 필요한 전력 에너지를 친환경 대체 에너지로 변환
- 데이터센터에서 소비되는 전력 에너지의 효율을 극대화하도록 설계하고 지속적으로 개선

설문의 질문들은 5개 영역으로 구분되어 있고, 설문참여자의 조직과 개인정보를 먼저 질문하고 있습니다. Part A는 프로세스 관점에서 귀사의 환경적 측면을 평가하고자 하는 것이고, Part B는 환경 관련 기술에 관한 의사결정 시 이해관계자들의 역할과 관련된 요인들이 무엇인지 묻고자 하는 것이며, Part C는 재무적 성과, Part D는 미래 방향에 대한 질문입니다.

각 질문에 적합한 답변 칸에 "O" 표로 표시해주십시오.

질문에 답변 중 문의사항이 있으신 경우, 아래 연락처로 연락해주십시오.

연구자: 조선대 경영학부 와티 율리아
휴대전화: 010-7635-7705
주소: 광주광역시 동구 서석동 375 조선대학교 (501-759)

** 기업의 정보는 반드시 보안을 보장합니다.*

본 설문은 학술적인 목적 이외에는 절대 사용하지 않을 것이고, 반드시 보안을 보장합니다. 이에 다소 번거로우시더라도 성의 있고 솔직한 답변을 부탁 드립니다.

응답자 기본 정보

1) 성별: ___ 남자 ___ 여자

2) 직무

____ IT 관리자 (CIO, 소프트웨어 설계/분석가, 소프트웨어 개발자)
____ 비즈니스 관리자(생산/영업, 마케팅, 전략, 인사 등)
____ 기타 _____ (직접 작성해주시기 바랍니다.)

3) 귀사의 비즈니스 유형에 표시해주시기 바랍니다.

	통신 기술		소비재 관련(유통, 물류)
	유틸리티		에너지 관련 사업
	자원관련 산업		병원/헬스 케어
	제조 산업(전기,전자,기타)		정보 기술

4) 귀사의 위치는? _____

5) 귀사의 종업원 수는 얼마입니까?

	100명 이하
	101명 이상 200명 이하
	201명 이상 300명 이하
	301명 이상400명 이하
	401명 이상 500명 이하
	500명 이상

6) 귀사의 2년간 평균 수익은 얼마입니까?

7) 지난 2년 동안 귀사의 년간 예산을 기준으로 다음과 같은 녹색기술 프로그램(Green Technology program)에 투자한 정도(%)는 얼마입니까?

	컴퓨터 하드웨어/소프트웨어		스토리지 가상화
	서버통합 및 가상화		고효율과 대기(Stand-by)전력 시스템
	대규모 데이터센터의 자연냉각(Free cooling)		에너지 효율을 향상시키는 조명 설치
	저전력 IT 장비		IT장비를 최적화
	고압 AC 전원		데스크탑 가상화
	기타, _____		

8) 귀사는 얼마나 오랫동안 운영되어 왔습니까? _____

9) 귀사는 산업계에서 어느 정도의 시장위치를 가지고 있는가?

	수비자(Defender) 좁은 제품 영역_ 최고관리자는 조직의 제한된 영역에서 최고의 전문가이지만 새로운 기회를 찾기 위해 좁은 제품 영역에 대해 외부에서 검색하려는 경향이 없음; 중앙집중식 통제; 형식화의 높은 수준; 수직적 정보흐름; 간단하고 비싼 조정(coordination)이 특징임
	탐색자(Prospector) 거의 지속적으로 시장에서의 기회를 탐색하고 있고, 정기적으로 최근 생겨난 환경적 동향에 대한 잠재적 반응과 함께 실험을 수행함. 관리는 결과 지향적이고, 형식화 수준이 낮음; 분산된 의사결정권자에게로의 정보흐름; 복잡하고 비싼 조정(coordination)이 특징임
	분석자(Analyzer) 두 가지 유형의 제품 시장 영역에서 운영되고 있음. 하나는 상대적으로 안정적이고, 다른 하나는 변화화는 영역임; 관리는 어렵고 효율성과 효과성의 교환이 가능함; 조정(coordination)은 간단하고 복잡함이 특징임
	반응자(Reactor) 체계적인 전략, 디자인, 구조를 가지지 않고 비즈니스 환경에 직면한 변화를 준비하고 있지 않음; 최고관리자는 역동적인 환경으로 인해 장기계획을 수립하지 않고 있음이 특징임

A. 라이프사이클 관점에서 프로세스 측면

1. 녹색정보기술(Green IT)에 대한 권한 위임

Green IT에 대한 권한 위임	**매우 그렇지 않다**	**그렇지 않다**	**중립**	**그렇다**	**매우 그렇다**
우리는 환경적 이슈를 처리할 수 있는 권한을 가지고 있다.					
우리는 환경적 이슈를 처리할 수 있는 방안을 세우고 있다.					
우리는 Green IT에 대한 독려 차원의 보상을 종업원들에게 주고 있다.					
우리 회사는 Green IT를 위한 장기적인 접근방법론을 가지고 있다.					
우리는 분명하고, 혁신적이며, 환경친화적인 Green IT 제품 개발 방법론을 가지고 있다.					

2. 라이플 사이클적 접근 방법

환경 측면의 라이프사이클 평가방법(Life Cycle Assessment)은 귀사에서 제조되는 주요 제품들에 적용된다.

___예 ___아니오

'예'라고 답변한 경우, 다음 질문에 답변해주시고, '아니오'라고 답변한 경우 3번 문제로 이동하여 답변해주십시오.

라이프사이클 접근방법은 제품과 서비스의 생명을 5개의 단계로 나눈다.

(1) 원재료추출 및 처리(Raw material extraction and processing)
(2) 제조(Manufacturing)
(3) 포장과 유통(Packaging and distribution)
(4) 제품 사용(Product use)
(5) 제품 수명 완료(end-of-life product)

기술 생명주기의 각 단계에 해당하는 아래 질문에 답변하십시오.
각 질문에 적합한 답변 칸에 'O'표 해주십시오: (1) 강력하게 동의하지 않음; (2) 동의하지 않음;(3) 중립; (4) 동의함; (5) 강력하게 동의함

원재료 추출 및 처리(Raw Material extraction and processing)	**1**	**2**	**3**	**4**	**5**
우리는 환경에 더 친화적이고, 환경을 덜 오염시킬 수 있는 재료/기술로 점차적으로 대체하고 있다.					
우리는 구매에 있어 Green 재료(환경 친화적 재료)를 더 선호한다.					
우리는 분명한 Green IT 프로세스를 가지고 있다.					
우리는 재료를 재활용하거나 혹은 재료를 효율적으로 사용할 수 있는 기술을 가지고 있다.					
제조(Manufacturing)	**1**	**2**	**3**	**4**	**5**
우리는 재료의 가공과정에 있어 Green IT을 활용하여 에너지와 천연자원의 소비를 감소시키는데 중점을 두고 있다.					
우리는 환경 친화적인 기술/장비의 구입한다.					
우리의 생산계획 및 관리는 원재료 개발의 최적화와 낭비를 줄이는데 주력하고 있다.					
우리는 재료를 가공하는 동안 재생 가능한 에너지(태양, 바람 등)를 사용하고 있다.					
포장과 유통(Packaging and Distribution)	**1**	**2**	**3**	**4**	**5**
우리는 디자인 처리과정에서 제조와 유통 기간 동안 발생하는 자원 소비와 낭비를 감소시키는데 주력한다.					
우리는 디자인 처리과정에서 제품 사용 기간 동안 발생하는 자원소비와 낭비를 감소시키는데 주력한다.					
우리는 디자인 처리과정에서 분해하고, 재사용하고, 재활용하기 위해 노력한다.					
우리는 환경 친화적인 운송방법을 선택하기 위해 신중을 기한다.					

제품 사용(Product Use)	**1**	**2**	**3**	**4**	**5**
우리는 고객에게 Green IT에 대한 안내문서를 함께 제공한다.					
고객에게 제공하는 최종 제품/서비스는 에너지 절약형 제품/서비스이다.					
우리는 Green IT 실행 책임에 대해 정기적으로 고객에게 교육한다.					
우리는 데이터센터의 에너지 사용을 감소하려는 노력을 한다.					
우리 회사의 IT부서는 하드웨어와 자원을 위한 가상의 카운터 파트를 집중적으로 만들어가고 있다					
제품 완료(End-Of-Life Product)	**1**	**2**	**3**	**4**	**5**
우리는 전자폐기물(e-waste)과 잔여물 처리에 책임을 약속하고 있다.					
우리는 재활용하고 재사용할 수 있는 포장재/용기들을 수집하는데 노력하고 있다.					
우리는 제품을 회복시키거나 재활용 할 수 있는 시스템을 구축하고 있다.					
우리는 제품에 대한 회수 프로그램을 보유하고 있다.					

3. 환경적 기술 포트폴리오 인덱스(Environmental technology portfolio indices)

지난 2년 동안의 어떤 식으로든 자연 환경에 혜택을 주었던 귀사의 모든 프로젝트와 투자에 대해 고려해주십시오. 혜택이란, 생산작업의 부정적 영향을 최소화하고 삶의 질을 향상시킬 수 있는 것으로 정의됩니다. 아래에 나열된 각 범주에 속한 이 프로젝트들의 비율을 측정해보십시오.

(자원 사용을 기준으로 5가지 범주에 100점을 기준으로 할당합니다.)

____ % a. **치료 프로젝트 (Remediation projects)**, 지하 저장 탱크를 제거하나 이전 환경적 피해를 청소

____ % b. **오염 관리 기술 (Pollution control technologies)**, 새로운 물 또는 폐기물 처리

장비 혹은 공기 오염방지

____ % c. **관리시스템 (Management systems)**, 유출을 최소화 하거나 새로운 환경적 감사 프로그램에 대해 직원을 대상으로 한 새로운 환경에 대한 훈련

____ % d. **제품 적응 (Product adaptation)**, 재활용 자재의 사용을 높이거나 제품 자체에 유해한 물질 사용을 최소화

____ % e. **프로세스 적응 (Process adaptation)**, 개방형 탱크를 덮거나 낭비를 줄이기 위한 제조장비의 디자인 변경

____

100%

B. 이해관계자 관점 (Stakeholders' Perspective)

각 질문에 적합한 답변 칸에 'O'표 해주십시오: (1) 강력하게 동의하지 않음; (2) 동의하지 않음;(3) 중립; (4) 동의함; (5) 강력하게 동의함

1. 이해관계자 성향 (Stakeholder Orientation)

고객 성향 (Customer Orientation)	**1**	**2**	**3**	**4**	**5**
우리의 IT자원은 고객의 이익을 우선적으로 고려할 수 있도록 지원한다.					
우리는 take-back program 혹은 재사용 프로그램과 같은 우리의 환경적 프로그램에 참여하는 고객을 참여시킨다.					
공급자 성향 (Supplier Orientation)	**1**	**2**	**3**	**4**	**5**
우리는 환경적 이슈를 통합하기 위해 디자인 과정에 주요 공급업체를 관여시킨다.					
우리는 주요 공급업체와 함께 R&D프로젝트를 추진하여 제품의 환경적 영향을 측정한다.					
우리의 환경적 정보는 주요 부품 공급업체와 함께 공유되고 교환된다.					
직원 성향 (Employees Orientation)	**1**	**2**	**3**	**4**	**5**

우리 회사의 직원들은 그들의 환경적 책임을 인지하고, 책임 질 능력을 가지고 있다.					
우리 회사의 직원들은 강력한 Green IT 기술을 가지고 있다.					
회사의 Green IT을 향상시키기 위해 좋은 아이디어의 원천으로 직원들의 제안을 사용한다.					
우리는 정기적으로 관리자와 직원들을 위한 Green IT 훈련을 수행한다.					
주주 또는 금융기관 (Shareholders or financial institutions)	**1**	**2**	**3**	**4**	**5**
Green IT는 비즈니스 목표 달성을 지원한다.					
Green IT에 대한 지출은 비즈니스의 지속성에 가치를 제공한다.					
Green IT에 관련된 비용은 효과적으로 관리될 수 있다.					
Green IT의 통합으로, 대상 회사 간의 IT시너지 효과가 달성될 수 있다.					
정부 및 공공기관 (Government and public agency)	**1**	**2**	**3**	**4**	**5**
환경에 관한 규정 준수는 직원의 성과를 측정할 수 있는 핵심적인 부분이다.					
Green 기술의 성과정보와 관련한 큰 거래는 일반인에게 자발적으로 공개되고 있다.					
환경 문제에 대한 회사의 공식적 입장이 일반 대중과 함께 광범위하게 협의되고 개발되고 있다.					
2차 이해관계자 (Secondary stakeholders)	**1**	**2**	**3**	**4**	**5**
우리는 환경적 성과를 일반대중에게 노출할 수 있도록 미디어에 허용한다.					
우리는 정기적으로 커뮤니티 기반의 서비스를 수행한다.					

2. 이해관계자의 불만사항 수

귀사의 현재 기술과 관련하여 이해관계자들로부터 얼마나 많은 환경과 관련한 불만사항을 접수 받았는가? (2년 이내)

주요 이해관계자들	**불만사항 수**				
	<20	**21-40**	**41-60**	**61-80**	**>80**
고객(From Customers)					
공급자(From Suppliers)					
직원(From Employees)					
주주(From shareholders)					
정부/공공기관 (From Government/public agency)					
2차 이해관계자 (From Secondary stakeholders)					

3. 이해관계자와의 회의

지난 2년간 주요 이해관계자와의 면담 횟수를 표시하시오.

___ (<10) ___ (11-20) ___ (21-30) ___ (31-40) ___ (>40)

질문에 적합한 답변 칸에 'O'표 해주십시오: (1) 강력하게 동의하지 않음; (2) 동의하지 않음;(3) 중립; (4) 동의함; (5) 강력하게 동의함

상세사항	**1**	**2**	**3**	**4**	**5**
회의는 지역 환경 단체와 이웃 공장들과 함께 정기적으로 수행된다.					
일반 대중과 함께하는 외부 회의는 회사 관점에서 가치 있는 의견을 제공 받는다.					

4. 서비스수준협약서(Service Level Agreement) 기반의 IT 프로젝트 수

얼마나 많은 환경 관련 기술 프로젝트가 서비스수준협약서(SLA)를 기반으로 계약되었는가? (지난 2년 안에)

___ (<5) ___ (6-10) ___ (11-15) ___ (16-20) ___ (>20)

***5.* 공식적인 환경 기술 절차의 가용성**

각 질문에 적합한 답변 칸에 'O'표 해주십시오: (1) 강력하게 동의하지 않음; (2) 동의하지 않음;(3) 중립; (4) 동의함; (5) 강력하게 동의함

절차 (Procedures)	**1**	**2**	**3**	**4**	**5**
우리는 문서로 작성된 Green IT 정책이 있다.					
기술 관련 Practices는 환경의 영향에 대해 최소 년 1회 공식적으로 검토된다.					
전자폐기물(e-waste) 감소 프로그램과 그 결과에 대한 감사는 매년 모든 생산분야를 대상으로 수행한다.					
기존 생산 설비에 대한 환경 기술 위험에 대한 감사는 모든 생산분야를 대상으로 수행한다.					

C. 재무적 측면

각 질문에 적합한 답변 칸에 'O'표 해주십시오: (1) 강력하게 동의하지 않음; (2) 동의하지 않음;(3) 중립; (4) 동의함; (5) 강력하게 동의함

재무적 성과 (Financial Performance)	**1**	**2**	**3**	**4**	**5**
Green IT practices 실시 후 재무적 성과가 두드러진다.					
Green IT practices 실시 후, 우리의 경쟁기업 보다 높은 재무적 성과를 나타낸다.					
Green IT practices 실시 후, 매출성장이 두드러진다.					
Green IT practices 실시 후, 경쟁사보다 우수한 수익성을 보인다.					
Green IT practices 실시 후, 매출성장은 경쟁사보다 우수하다.					

D. 미래 방향

미래 방향 (Future Orientation)	**1**	**2**	**3**	**4**	**5**
우리는 새로운 Green IT장비와 기계에 대한 자본투자를 수행한다.					
우리 회사는 Green IT 혁신 도입에 선두가 되어왔고, 향후에도 지속적으로 선두가 될 것이다.					
우리 회사는 환경 관리 시스템(ISO14001, GRI)을 도입하였고, 지속적으로 적용할 것이다.					
우리는 적극적으로 지역 커뮤니티 및 지역 환경 협회와 협력한다.					
우리가 Green IT을 촉진하기 위해 국제환경기관과 적극적으로 협력한다.					

상세정보

1. 귀사에서 2년 동안 받은 특허의 개수를 표시하시기 바랍니다.

___ (<5) ___ (6-10) ___ (11-15) ___ (16-20) ___ (>20)

2. 지난 2년 동안 새로운 연구와 Green 기술 개발에 할당된 예산의 비율을 표시하시기 바랍니다. ____ %

운영적 혜택 (Operational Benefit)	**1**	**2**	**3**	**4**	**5**
전반적으로, Green IT을 적용한 업무 프로세스는 더 큰 생산성을 가지고 올 수 있다.					
재료와 에너지의 효율적 사용은 더 높은 전력을 생산하거나 구입한 inputs의 사용을 감소시키는 결과를 가지고 온다.					
Green IT Practice는 최종제품의 품질과 순도를 향상시킨다.					
Green IT Practices는 불필요한 생산절차를 제거하고 설계 단계를 단순화 하는데 도움을 준다.					
더 신중한 모니터링과 Green IT의 유지보수는 더 낮은 다운타임과 거부 결과를 가져온다.					

시장 관점의 혜택 (Market Benefit)	**1**	**2**	**3**	**4**	**5**
우리는 Green IT 실행으로 인해 더 낮은 비용으로 강력한 경쟁적 위치를 확보하게 된다.					
Green IT Practices는 기업 이미지 향상에 도움을 준다.					
Green IT Practices는 환경에 대한 의식을 가진 시장 세그먼트에서 고객을 유치하는데 에 기여한다.					
Green IT practices는 환경 상품 및 서비스를 성장하는 시장에 진입할 수 있도록 해준다.					
Green IT practices는 환경 지도자로써 독창적인 전략을 만들 수 있도록 한다.					
규제적 혜택 (Regulatory Benefit)	**1**	**2**	**3**	**4**	**5**
Green IT 실행은 환경 세금 및 비용을 감소시킨다.					
Green IT 실행은 우리에게 책임이 있는 비용을 절감시킨다.					
Green IT 실행은 배출가스 거래시장에서 오염 권리를 사지 않고 팔 수 있도록 해준다.					

저작물 이용 허락서

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논문제목	(한글) 그린 IT 밸런스 스코어카드의 이론적 연구 모델 제시				
	(영문) An Introduction to the Green IT Balanced Scorecard as a Strategic IT Management System and its Theoretical View				

본인이 저작한 위의 저작물에 대하여 다음과 같은 조건 아래 조선대학교가 저작물을 이용할 수 있도록 허락하고 동의합니다.

- 다 음 -

1. 저작물의 DB구축 및 인터넷을 포함한 정보통신망에의 공개를 위한 저작물의 복제, 기억장치에의 저장, 전송 등을 허락함
2. 위의 목적을 위하여 필요한 범위 내에서의 편집과 형식상의 변경을 허락함(다만, 저작물의 내용변경은 금지함)
3. 배포・전송된 저작물의 영리적 목적을 위한 복제, 저장, 전송 등은 금지함
4. 저작물에 대한 이용기간은 5년으로 하고, 기간종료 3개월 이내에 별도의 의사 표시가 없을 경우에는 저작물의 이용기간을 계속 연장함
5. 해당 저작물의 저작권을 타인에게 양도하거나 출판을 허락을 하였을 경우에는 1개월 이내에 대학에 이를 통보함
6. 조선대학교는 저작물 이용의 허락 이후 해당 저작물로 인하여 발생하는 타인에 의한 권리 침해에 대하여 일체의 법적 책임을 지지 않음
7. 소속 대학의 협정기관에 저작물의 제공 및 인터넷 등 정보통신망을 이용한 저작물의 전송・출력을 허락함

동의여부 : 동의(●) 반대( )

2011년 02월

저작자 : 와티 율리아 (인)

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