Green IT Adoption and Sustainable Value Creation

Research-in-Progress

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Abstract

The sustainable organization is one that "*contributes to sustainable development by simultaneously delivering economic, social, and environmental benefits*" p56 (Hart and Milstein 2003). This three-dimensional value is known as sustainable value. This research will examine the creation of sustainable value using green IT. We propose a model – the green IT resource based view (GIT-RBV) - that has two theoretical bases: *the resource based view (RBV) of the firm* (Wernerfelt 1984); and the *advanced model of corporate ecological responsiveness* (Bansal and Roth 2000). The GIT-RBV connects the various constructs within the green IT empirical literature, revealing three sets of antecedents – environmental, economic and legitimation factors, and two value outcomes – environmental and economic. It incorporates the constraints imposed by the natural environment in that it posits that the firm creates economic value by deliberately using its resources and capabilities to generate cost savings and revenue streams through the conservation of natural resources.

Introduction

Sustainable Organizations and Sustainable Value

The sustainable organization is defined as an organization that "*contributes to sustainable development by simultaneously delivering economic, social, and environmental benefits-the so-called triple bottom line*" p56 (Hart and Milstein 2003). Sustainable organizations deliberately create economic value (profit) as usual; however, in the process of creating profit, they also create either environmental or social value (or both). This multi-dimensional value - economic value coupled with the economic and/environmental value dimension(s) - is known as sustainable value.

When organizations create sustainable value, they achieve two goals. The first is their contribution to sustainable development. Sustainable development is defined as "*development that meets the needs of the*

present without compromising the ability of future generations to meet their own needs" (Brundtland 1987) and it essentially aims to achieve economic prosperity while ensuring social and environmental sustainability. Firms contribute by creating social and environmental value.

The second goal achieved is their contribution to their triple bottom line, which is defined as "*a method of communicating effectively with stakeholders on progress towards economic prosperity, environmental quality and social justice*" (Wheeler and Elkington 2001). The triple-bottom line essentially communicates to organization's stakeholders that the firms are on board with the need to ensure the wellbeing of people and the planet whilst ensuring their profits. Firms contribute to the creation of their triple bottom line by creating social and environmental value.

Sustainable Value, Resources and Capabilities

Firms create [traditional] value (profits) using the resources they acquire and capabilities they develop (Wernerfelt 1984, Teece 1986). Resources, defined as "*those (tangible and intangible) assets which are tied semi-permanently to the firm,*" include: "*brand names, in-house knowledge of technology, employment of skilled personnel, trade contacts, machinery, efficient procedures, capital*" (Wernerfelt 1984). Unlike traditional value, sustainable value requires the use of resources, complemented by sustainability capabilities.

Our study focuses on the creation of two value dimensions – economic value and environmental value. We use a single concept in this discussion to refer to resources, but focus on a particular set – green IT resources - IT resources that are implemented specifically to create environmental value. However, we distinguish between the capabilities used for each value dimension. For *economic capabilities*, geared toward the creation of economic value, we adopt Wade & Hulland's (2004) definition - a firm's "*abilities to use its assets properly to create, produce and offer its products to a market*". For *green capabilities*, geared toward the creation of environmental value, in the absence of such a definition in the literature, we offer the following - "*a firm's abilities to use its resources to conserve the natural environment and its resources.*"

Green IT research is generally very sparse, and those studies that have examined it have focused on un-named green IT resources and green capabilities that are not generalizeable across firms. Our research is motivated by the paucity of research as well as the need for a theoretical model that will not only

integrate the various strands of empirical green IT research, but also provide a common ground from which further work in green IT can proceed.

We use the resource-based view (RBV) of the firm (Wernerfelt 1984, Peteraf 1993, Teece 1986), the *advanced model of corporate ecological response* (Bansal and Roth 2000), and prior green IT and IT business value literature, to develop a model – the Green IT Resource-Based View (GIT-RBV). The GIT-RBV explains how a firm, based on certain motivations, identifies the capabilities and green IT resources it requires, and then uses complements of the two to create sustainable value.

The rest of the paper proceeds as follows. In the next section, we present an overview of green IT, the green IT and business value literature as well as the theoretical lenses we use. We then present the model and its propositions.

Background

Creating Sustainable Value with Green IT Resources

We identified three sets of green IT resources from the literature. The first are IT innovations that replace older generations of IT. These innovations provide the same IT services - data collection, analysis, and storage; however in doing so, they reduce the IT impact on the environment relative to those they replace. They may, for example, consume less energy in use. Examples include virtualized storage units and servers. They consume less energy for storing and processing the same amount of data relative to the storage units and servers in use before them.

A second set of green IT resources are IT innovations that are embedded in equipment that perform specific process functions. The role of the IT is to ensure that the outcomes specified for the equipment are achieved using the minimum natural resources possible. An example of an innovation is the IT controller embedded in the heating, ventilation and air conditioning (HVAC) system that capture and analyze data such as desired temperature and oxygen level, and moderate the power supply of the cooling system to ensure that the energy supplied to the cooling process is no more than is necessary for achieving the desired building environment. They reduce the environmental impact of whatever process is carried out by the equipment in which they are embedded.

The third set of green IT resources are software used to analyze historical process data in order to identify opportunities for reengineering or improvements that minimize the consumption of natural

resources and the output of waste. These IT provide firms with "*the ability to incessantly assess and reinvent themselves*" (Kohli et al. 2008) in order to become more environmentally friendly. An example is the "*telematics-based*" green IT system implemented by UPS, which allowed the company to reduce mileage, fuel consumption and vehicle replacement parts (Watson et al. 2010). They, like the second set, also reduce the environmental impact of various processes.

Prior Academic and Industry Research

Traditional IT business value research has established that IT as an organizational resource has income generating and cost reduction capabilities (Mithas et al. 2011, Amit and Zott 2001). Research based on the resource-based view (RBV) of the firm has decisively established that firm resources and capabilities create economic value. These resources and capabilities have been found to generate higher revenues and reduce production and other process costs. Greater revenues for the most part have come through innovation or renovation of products and services. Cost reductions have come through efficiencies achieved by innovating or refining process methods or practices.

Green IT research is sparse but four strands can be identified in the literature to date: one set discusses the sustainability dilemma, calls for research intersecting sustainability and IS, and recommends research agendas; a second proposes green IT models and frameworks for both research and practical evaluations; the third consists of empirical green IT adoption research; and the fourth, empirical green IT value research.

The green IT adoption literature (Molla and Abareshi 2012, Cai, Chen, and Bose 2013, Kuo and Dick 2010).has been mostly exploratory, and has provided evidence of motivations driven by three sets of factors which can be classified as economic, environmental and legitimation The green IT value creation research (Benitez-Amado and Walczuch 2012, Ryoo and Koo 2013) has been more theory-based, applying the RBV, dynamic capabilities theory, and other theories. This research has provided evidence that green IT enables the development of strategies (Benitez-Amado and Walczuch 2012, Ryoo and Koo 2013) and capabilities (Meacham et al. 2013) that together with the use of the green IT resources have resulted in the creation of both environmental and business value. However, these two strands of literature are separate: the adoption studies involve causal chains that end with *green IT adoption* as the final dependent

variable; and the value investigations start with the resources and capabilities and end with the value variable. No single study has examined the entire causal chain from adoption factors to value outcomes.

There are other shortcomings within the green IT literature. For example, whereas the adoption literature has identified the green IT resources investigated, the value literature has treated IT as a black box – failing to identify the particular IT resources that were examined. Value studies have also focused on particular capabilities such as *proactive corporate environmental strategy* [i] (Benitez-Amado 2011); and *green practices-manufacturing coordination* and *green practices–marketing coordination*[ii] (Ryoo et al. 2013). The latter two are not particularly generalizeable across different types of firms. Finally, while the adoption literature identifies the green IT resources investigated, it has tended to focus only on green IT such as data centers and virtualized servers that conserve environmental resources in IT service provision processes rather than focusing on IT that conserve resources more generally in processes across the firm.

Industry and Anecdotal Evidence of IT Green Value

The industry literature supports the academic literature with respect to the environmental and economic value that going green brings to organizations. For example, the McKinsey Global Survey Results show that some benefits of going green include: support for corporate reputation; operational growth; reduced costs; new markets; and new products. The report also indicates that firms in energy-intensive industries are engaging in activities that will prevent the negative impacts of expected regulatory and natural-resource constraints (Bonini 2011).

The World Business Council on Sustainable Development reports on case studies of organizations that implement green IT. In one such study on data center energy efficiency, the Council reports that IBM developed a green IT, the *Mobile Monitoring Technology,* which analyzes the thermal profiles of operating data centers. The system assisted in identifying opportunities for reducing energy demand at 4 data centers resulting in energy usage reduction of 7,553 megawatt-hours (MWh) per year (11%), and economic savings of US$ 619,000 per year (WBCSD 2008).

While these reports are interesting and insightful, our knowledge needs to be more theoretically based. There is need for more generalizeable knowledge and for investigations of wider applications of IT – of IT applied in more processes in firms than just in IT service provision. Against this background we

propose this study. This study aims to first propose a resource-based model that examines the adoption, use and value creation of green IT, and then to test the model. This research-in-progress paper presents the proposed model.

Theoretical Background

The proposed model has two theoretical bases: *the resource based view (RBV) of the firm* (Wernerfelt 1984); and the *advanced model of corporate ecological responsiveness* (Bansal and Roth 2000). Relevant aspects of both theoretical bases are presented below.

The Resource Based View (RBV) of the Firm

The *resource based view (RBV) of the firm*, introduced by Wernerfelt (1984), is said to contrast two opposing views of firm profitability: the resource view which explains "*the relationship between profitability and resources*"; and the product view which explains the relationship between firm profitability and external forces. Wernerfel conceptualized that *resource position barrier*s, analogous to *first mover advantages*, may be built up in **resources** [our emphasis] based on the resources' properties and their acquisition modes. He proposed that firms holding such resources may be ahead of their competition and may also "*use these barriers to cement that lead'* making it "*more difficult for others to catch up*" (Wernerfelt 1984) p173-174.

Since Wernerfelt's original proposal, Barney has elaborated that only resources that are "*valuable, rare, imperfectly imitable, and not substitutable*" (Barney 1991) can create these sustained competitive advantages. Peteraf further proposed four resource-based "*theoretical conditions which underlie competitive advantage*": *resource heterogeneity***,** from which come Ricardian or monopoly rents; *ex post limits to competition***,** which are necessary to sustain the rents; *imperfect resource mobility,* to ensure that the rents are bound to the firm and shared by it; and *ex ante limits to competition*, to prevent costs from offsetting the rents (Peteraf 1993). Many others have made notable contributions to the RBV, including Dierickx and Cool 1989; Connor 1991; Mahoney and Pandian 1992; Montgomery and Hariharan 1991; Davis and Thomas 1993; Amit and Schoemaker 1993; Helfat 1994; and Henderson and Cockburn 1994.

The Advanced Model of Corporate Ecological Responsiveness

The *advanced model of corporate ecological responsiveness* (Bansal and Roth 2000) presents a complementary perspective to the RBV. The main thrust of the model is the set of *firm motivations* that explain the adoption by firms of "*ecologically responsive initiatives*," an example of which may be green IT adoption. However, in addition to the motivations, the model also presents examples of initiatives which, on inspection, could be classified as resources, goods, or process capabilities that may result in environmental value.

The model proposes three sets of motivations: environmental responsibility; competitiveness; and legitimation. The environmental responsibility motivation is said to stem from the "*the concern that a firm has for its social obligations and values*" (Bansal & Roth, 2000, p. 728). While this definition sounds more like social than environmental responsibility, the initiatives outlined in the study that are adopted as a result of the *environmental responsibility motivation* include: "*the redevelopment of previously used land to green areas, the provision of a less profitable green product line, donations to environmental interest groups and other local community groups, the use of recycled paper, the replacement of retail items or office products with ones more ecologically benign, and the recycling of office wastes*."

The competitiveness motivation comes from the "*potential for ecological responsiveness to improve long-term profitability*." The competitiveness motive is said to result in "*greater attention paid to the cost-benefit analyses of ecological responses*" with the result that firms will choose those initiatives that are expected to bring the "*highest returns, independent of their ecological consequences*."

Finally, the legitimation motivation comes from "*the desire of a firm to improve the appropriateness of its actions within an established set of regulations, norms, values, or beliefs.*" The initiatives prompted by this motive are said to include: "*reactions to external constraints made to avoid sanctions; and environmental policies aimed at complying with environmental regulations and with norms articulated by specific stakeholders, such as the local community and customers*."

The Research Model

We propose the *Green IT Resource-Based View* (GIT-RBV). The GIT-RBV extends the *resource-based view* (RBV) *of the firm* (Wernerfelt 1984), using the *advanced model of corporate ecological responsiveness* (Bansal and Roth 2000) according to the evidence presented in prior green IT research.

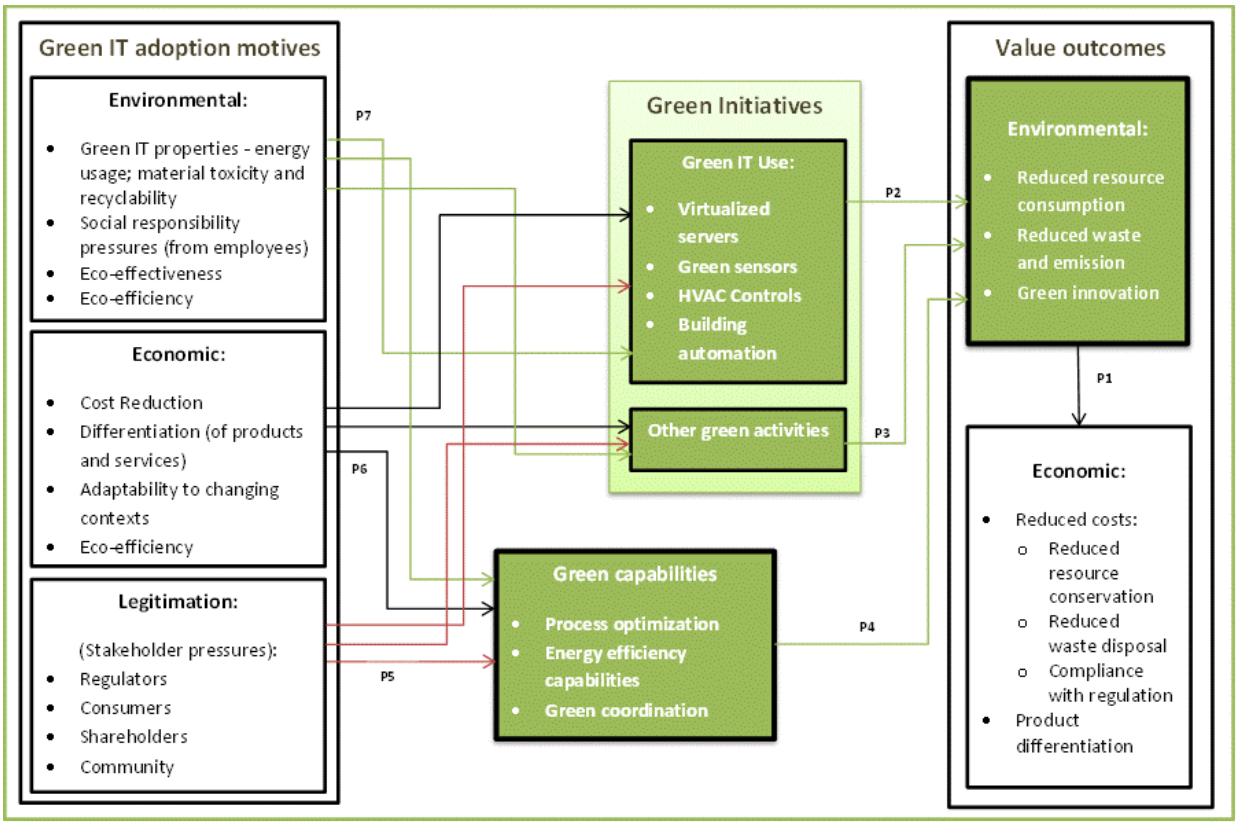

Figure 1: The Green IT Resource Based View of the Firm (GIT-RBV)

The model, captured in Figure 1, presents three sets of motivations which drive the adoption of: (1) *green IT*; (2) *green practices* which include *green IT use*, and (3) *green capabilities*. *Environmental value* results from the adoption of these three, and *economic value* from the environmental value. The model proposes that, motivated to adopt green IT through external legitimation pressures, internal concerns for the natural environment, and the traditional profit motives, firms adopt and use green IT resources, combine them with green capabilities and create not just environmental value, but also profit, thus contributing to sustainable development.

Propositions

Green Practices and Sustainable Value

Green practices are initiatives aimed at creating environmental value. While we acknowledge and discuss multiple such initiatives that firms may engage in, our focus is on the use of green IT resources. Green IT resources can enhance the environmental performance of firms at the process level in at least three major ways: (1) by conserving natural resources used as process inputs inside the firm; (2) by

conserving the natural environment and natural resources used outside the firm to process firm waste and emissions; and (3) by enabling innovation (or renovation) of products, services and practices that are (or become) more environmentally friendly in use or on disposal.

IT Resources and Conservation of Natural Resource Process Inputs

Within the firm, green IT resources have the potential to enable natural resources conservation by increasing process efficiency. Green IT such as Nokia's *computer managed maintenance system* (CMMS) and mobile technology help conserve natural resources – energy and water - used as production inputs (Nokia 2011). Green IT resources also conserve natural resource inputs used in supporting firm processes. Examples include the use of IT-controlled HVAC systems in facilities management (Simmonds and Bhattacherjee 2013, Scheuer, Keoleian, and Reppe 2003). Environmental value is created when natural resource process inputs are conserved. Economic value is also created because of economic cost savings associated with purchasing fewer resources.

IT Resources and Conservation of Natural Resources in the Natural Environment

Outside the firm, by using fewer natural resources to absorb waste and emissions, resource conservation is enabled. When IT-controllers are used in HVAC systems (Simmonds and Bhattacherjee 2013, Scheuer, Keoleian, and Reppe 2003), they reduce the emissions generated by the heating and cooling processes and thus decrease deleterious effects such as global warming, ozone depletion and nitrification that occur when the capacity of natural environmental resources for absorbing emissions is exceeded (Scheuer, Keoleian, and Reppe 2003). Therefore, by reducing emissions, green IT resources conserve the natural environment and the natural resources, and create environmental value.

Furthermore, the use of IT controllers reduces the use of HVAC equipment actuators, and thus the maintenance costs and disposal costs associated with parts replacements. Therefore, economic value is also created through the reduction of maintenance and disposal costs.

IT Resources and Environmentally-Friendly Products

Green IT resources can conserve natural resources outside the firm by enabling the innovation of green products (or renovation of existing products to become greener). Teece (1986) defines innovation as implementation of "*certain technical knowledge about how to* ***do things better*** [our emphasis] *than the existing state of the art*" . (p288). Green IT use enables innovations to "*do things better*" vis-a-vis the

natural environment, both during use and on disposal. When these 'environmentally differentiated" innovations have greater appeal to consumers they may be adopted and create environmental value.

One example of an innovation is UPS' "*no left turn*" program developed through the use of green IT to capture and analyze historical logistics data. The program created phenomenal environmental value at UPS (Watson et al. 2010, Rubin and Carmichael 2008). The program was further shared with, and adopted, outside the firm within the logistics industry, thereby increasing its environmental impact. Another is Toyota's Prius, which is fitted with IT controlled hybrid engines and "*features to support eco-friendly driving such as Eco Judge, which monitors the level of eco-driving in different driving situations and Eco Wallet, which displays the cost-saving achieved through greater fuel efficiency*" (Toyota Motor Corporation 2012).

An example of a renovation is Nokia's mobile phone which, deployed "*with a solar panel integrated in the back cover, succeeded in harvesting enough energy to keep the phone on standby mode and even provide some talk time, when carefully positioned to capture the available sunlight*" (Nokia 2011).

Green IT-enabled *"environmentally differentiated*" products and practices conserve natural environmental resources outside the firm and help the firm to indirectly create environmental value and contribute to sustainable development. Economic benefits also results from these "environmentally friendly-differentiated" products, practices and services. However, while the economic impact of these products and practices is limited by the extent to which they are adopted, the environmental is limited by the extent to which they are adopted relative to less environmentally friendly offers.

Non-Green IT Activities and Environmental Value

Apart from the use of green IT resources, other practices be carried out by sustainable firms may create environmental value. These activities may be both non-IT- and IT-related activities. Examples of IT-related green activities include powering down computers, measuring IT energy use and rightsizing IT equipment to ensure that no more natural resources - energy and water, than necessary, are used to power and cool the equipment. Non-IT-related activities include Toyota's "*battery-to-battery*" recycling program that "*recovers nickel from the nickel-hydrogen batteries used in hybrid vehicles and reuses it in new batteries*" (Toyota Motor Corporation 2012). Both these create environmental value, and result in cost savings.

Based on the above, the following propositions are presented:

P1: Environmental value is positively associated with economic value.
P2: The use of green IT resources is positively associated with environmental value.
P3: The implementation of non-green IT activities is positively associated with environmental value.

Green Capabilities

Green capabilities include skills, knowledge and expertise that enable a firm to conserve the natural environment and its resources. By definition therefore, the development of capabilities imply the creation of environmental value. Therefore we propose the following:

P4: The development of green capabilities is positively associated with environmental value.

Adoption Motivations

Legitimation Motivations

Within the green IT literatures, Kuo et al. (2010) found that organizations adopted green IT resources to acquire the capability to adapt to changing environmental requirements and to avoid pressures from government, local community and external stakeholders; and Molla et al. (2012) found green IT adoption was motivated by the need avoid regulatory and social pressures that threaten the firms' legitimacy.

In addition to the above, in the management sustainability literatures, Riviera-Camino (2007) found that the perceived influence of firm stakeholders motivated the development of green marketing capabilities, and Christmann (2004) found that industry pressures led to the implementation of non-green IT practices such as minimum environmental performance standards, customers' concerns for the environment led to the implementation of environmental-related public relations campaigns, and inter-governmental regulations to the implementation of standardized operational policies within multinational corporations.

These adoption factors may all be categorized as legitimation motivations as defined by Bansal and Roth (2000). Based on these arguments, the following propositions are made:

P5a: The legitimation motivation is positively associated with green IT use.
P5b: The legitimation motivation is positively associated with non-green IT practices.
P5c: The legitimation motivation is positively associated with the development of green capabilities.

Competitiveness Motivations

Within the green IT literature, Cai et al. (2013) found that cost reductions and product differentiation influenced the adoption of green IT; Kuo et al. (2010) found that the need to comply with norms and regulations in order avoid penalties and lessen risks influenced the adoption of green IT; and Molla et al. (2012) found that eco-efficiency influenced the adoption of green IT.

In addition to the above, Høgevold (2010) found that the desire to save transportation costs motivated development of the capability to transport goods and raw materials so that, for example, "*fully loaded trucks arriving at the plant with raw materials and parts are returned with products to the customers*", and Kowoforola and Gheewala (2009) found that the desire to save energy costs led to the implementation of non-green IT practices such as periodic load-shedding and glazing windows with low solar heat gain coefficient.

These adoption factors may all be categorized as competitiveness motivations as defined by Bansal and Roth (2000). Based on these arguments, the following propositions are made:

P6a: The competitiveness motivation is positively associated with green IT use.
P6b: The competitiveness motivation is positively associated with non-green IT practices.
P6c: The competitiveness motivation is positively associated with the development of green capabilities.

Environmental Responsibility Motivation

Within the green IT literature, Molla et al. (2012) found that eco-efficiency (partly competitive) and eco-effectiveness influenced the adoption of green IT innovations. Kuo et al. (2010) found that firms were motivated to adopt green IT by the "*concern for doing good*"; and Alena et al. (2012) found that that green ICT properties motivated the acquisition of IT resources.

In addition to the above, Høgevold (2010) found that company-wide concern and top management support for the environment influenced the development of green capabilities such as logistics optimization, the use of software to aid the effort, and the implementation of non-green IT practices such as favoring suppliers with environmental certifications such as ISO 14025 in the purchasing process.

These adoption factors may all be categorized as competitiveness motivations as defined by Bansal and Roth (2000). Based on the preceding arguments, the following propositions are made:

P7a: The environmental responsibility motivation is positively associated with green IT use.
P7b: The environmental responsibility motivation is positively associated with non-green IT practices.

P7c: The environmental responsibility motivation is positively associated with the development of green capabilities.

Importance of Motivations

Furthermore, the expectation is that initiatives aimed at addressing environmental and legitimation issues will be exploited for profit (Hart and Milstein 2003, Lubin and Esty 2010). The literature provides evidence that only economically feasible environmental initiatives have been undertaken by firms, and among the options that are reviewed, it is the initiatives with superior economic benefits that are most likely to be adopted (Bansal and Roth 2000, Williamson, Lynch-Wood, and Ramsay 2006). While no such evidence exists with respect to legitimation issues, similar expectations are held. Hence:

P8: The competitiveness motive has a greater influence on the adoption of green IT resources than do the environmental or legitimation motivations.

P9: The competitiveness motive has a greater influence on the adoption of green capabilities than do the environmental or legitimation motivations.

Conclusion

We presented a research model - the GIT-RBV. The model integrates the empirical adoption and value green IT literature. The GIT-RBV has two major differences from the RBV. The first concerns the antecedents of resource use - whereas the RBV has a single, implicit adoption motivation - competitiveness, the GIT-RBV has three explicitly stated motivations – environmental, competitiveness and legitimation. These are evidenced in the green IT and management sustainability literature and classified according to the *advanced model of corporate ecological responsiveness*.

The second difference is in regard to value outcome - whereas the RBV focuses specifically on economic value, the GIT-RBV incorporates environmental value in addition to economic value. The GIT-RBV thus extends the RBV with respect to these two differences.

Like the natural resource based view (NRBV) of the firm (Hart 1995), the GIT-RBV incorporates the constraints imposed by the natural environment. However, whereas the NRBV focuses on ***very specific*** sustainability strategies, and their short- and long-term environmental outcomes, The GIT-RBV focuses on the motivations for adoption of environmental sustainability initiatives and the outcomes of these initiatives. And, where the final dependent variable of the NRBV is environmental value, the final dependent variable of the GIT-RBV, like that of the RBV, is economic performance.

The GIT-RBV offers the firm's responses to constraints within the natural environment as sources of environmental value creation which are enabled by the adoption and use of green IT. Economic value –

profit and competitive advantage – are created through cost savings and revenue streams that result from the conservation of the natural environment and its resources.

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[i] *proactive corporate environmental strategy* is defined as the firm's ability to implement environmental management practices voluntarily in advance of future environmental regulations and social trends, designing or altering the behavior of all functional departments, business processes and products to prevent negative environmental impacts of business activities on the natural environment

[ii] *green practices-manufacturing coordination* and *green practices–marketing coordination* is defined as the extent to which the manufacturing/marketing and green practices functions mutually understand each other's capabilities and align their respective goals and activities based on such understanding