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SUSTAINABLE INFORMATION SYSTEMS: DOES IT MATTER?

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Abstract

Using the Natural Resource Based View (NRBV) as our theoretical lens, green IS or sustainable IS is conceptualized as comprising the different dimensions of sustainability practices that can create competitive advantage for the organization. This study examines (i) the impact of adoption of sustainable IS on organizational performance; and (ii) the impact of the extent of adoption of sustainable IS on organizational performance. Analyzing secondary data on sustainable IS and performance measures of 115 global organizations, we find that the adoption of sustainable IS is positively associated with market valuation and innovativeness but not with profitability. However, sustainable IS organizations that have greater extent of adoption realize better profitability, market valuation and innovativeness. Implications of results for research and practice are discussed.

*Keywords**:** Sustainable IS, organizational performance, adoption*

1 INTRODUCTION

Given the growing concerns over the harmful ramifications of industrial development and urbanization and the challenges posed for future generations in terms of climate change and the depletion of natural resources, there is an increasing need to focus on the utilization of resources with minimal negative impact on our environment and their conservation for future generations. Information systems (IS) can facilitate the efficient utilization of resources and reduce the adverse impact on the environment emanating from various organizational processes through energy analytics (Watson et al. 2010). However, IS is also associated with the negative impact on the environment in terms of the carbon footprint. Computing technologies such as servers and datacenters contribute to about 2% of the global carbon footprint (Computerworld 2007). This trend will grow with the proliferation of IT. This realization has led to the emergence of "green IS" which refers to the development of information systems to support practices aimed at managing environmental footprint (Boudreau et al. 2008). Such practices are also termed as "sustainable IS" (Walsh 2007). We use the term sustainable IS as it clearly reflect the objective of environmental sustainability behind adoption of such practices.

Despite the increasing interest in the field of sustainable IS, empirical research in this area is still relatively sparse. A recent survey reveals that factors such as the increasing consumer awareness of sustainability and the rapid depletion of natural resources are salient in the organization's adoption of sustainability practices (Berns et al. 2009).Such factors impact organizational performance and hence raises the question - what impact does sustainability practices, specifically; sustainable IS have on the dimensions of organizational performance? Since organizations are primarily driven by the profit motive (Williamson 1993) and hence are concerned about their return on investment (ROI), there is a need to investigate if organizations that adopt sustainable IS perform better. In addition to this distinction, there is also a need to examine if indeed organizations that have adopted sustainable IS *more comprehensively* show better performance. In other words, is the greater extent of the adoption of sustainable IS practices necessarily better?

> *RQ1: Is sustainable IS positively related to organizational performance (defined in terms of profitability, market valuation, and innovativenesss)?*
>
> *RQ2: Is the extent of the adoption of sustainable IS positively related to organizational performance (defined in terms of profitability, market valuation, and innovativeness)?*

This study makes the following contributions. First, while the business value of sustainable IS has been theoretically recognized in the literature (Watson et al. 2010), to the best of our knowledge no prior empirical studies have compared the organizational performance of sustainable IS organizations and organizations that have not adopted sustainability practices. We fill this gap by comparing the adopters of sustainable IS and non-adopters of sustainability practices (black organizations) in terms of the various dimensions of organizational performance. In doing so, we provide empirical evidence of the performance impact of sustainable IS. Second, we analyze various sustainability initiatives of organizations using archival data such as their sustainability reports, information on their websites, reports on websites dedicated to sustainability initiatives such as environmentalleader.com, csrwire.com as well as the various news reports found in the Factiva database and PRNewswire. This allows us to go beyond the case study and survey approaches adopted on sustainable IS such as Mithas et al. (2010), and Thambusamy and Salam (2010). These works are based on perceptual data (survey) or often lack generalizability (case study). In contrast, our analysis is based on the objective measures of organizational performance and the various sustainability initiatives reported by the organizations. In addition, our analysis spans a 4-year time period rather than a single point of time and thus our results indicate the impact of sustainable IS on organizational performance over a longer time period.

The rest of the paper is structured as follows. We review the literature streams that are relevant to this study. We then propose our framework and hypotheses. Next, we describe our dataset and analysis procedure. This is followed by the results, discussion, implications for research and practice, and concluding remarks.

2 BACKGROUND

This study is at the confluence of two distinct streams of research: (i) sustainability portfolio; and (ii) business value of IT specific to sustainability. In the following sections, we describe how our work relates to each of these streams.

2.1 Sustainability Portfolio

Prior research has examined the concept of sustainability (Hart 1997) as well as the role of IS in facilitating environmental sustainability (Jokinen et al. 1998, Cohen 1998, Kazlauskas & Hasan 2009). Research has also examined factors that influence the adoption of sustainable IS (Molla et al. 2009). Hart (1997) proposed various sustainability practices as a portfolio of four different dimensions, each with a different focus. The prominence of IT and related policies in sustainability initiatives across the globe (Berns et al. 2009) suggest that the general classification of sustainability practices applies equally well to sustainable IS.

Hart's Sustainability Portfolio comprises four dimensions: pollution prevention, product stewardship, clean technology, and sustainability vision. *Pollution prevention* refers to avoiding or controlling pollution using technology or policies. *Product stewardship* refers to the practice of enhancing the environmental friendliness of upstream and downstream supply chain management (Chen et al. 2009). It refers to practices that are aimed at reducing the overall life cycle cost of a product (Shrivastava & Hart 1995). While pollution prevention is solely focused on daily operations and its impact, product stewardship is focused on adverse environmental impact in the delivery of the product, its life cycle and its disposal. *Clean technology* refers to the development of technologies that reduces the adverse environmental impact of products or services offered by an organization (Hart & Dowell 2010). *Sustainability vision* refers to the roadmap that will guide organizations to develop products and services aimed at reducing the adverse environmental impact (Hart 1997). The sustainability portfolio provides a simple yet elegant classification of various sustainability practices.

2.2 Business Value of IS Related to Sustainability

There are two main streams of IS research that examine the business value of IS-related resources. The first stream suggests that the successful use of IS represents important outcomes in organizations (Armstrong & Sambamurthy 1999). The underlying assumption behind this stream of thought is that the successful use of IS signifies a capability that is difficult to imitate and hence creates an advantage for the organization. The second stream proposed by Zhu and Kraemer (2005) suggests that IT business value depends upon the extent of use of IS. The two streams thus differ in their approach. While the first approach emphasizes on the successful use of IS, the second approach is a step ahead and emphasizes on the extent of use of IS. The business value of IS has been examined from the theoretical lens of the resource based view (RBV). The basic tenet of RBV is that the possession and deployment of resources that are valuable, rare, inimitable and non-substitutable creates sustained performance advantage for the firm (Barney 1991). Sustained competitive advantage occurs when competitors "face significant barriers in developing and using" the resources used to create the advantage (Piccoli & Ives 2005). The engagement of organizations in different sustainability practices represents a portfolio of resources which competitors cannot easily acquire, develop and use as there are institutional barriers (Molla et al. 2009), various organizational issues such as culture, strategy imperative (Chen et al. 2009) and also technological prowess of an organization (Berns et al. 2009). Hence, the adoption of sustainable IS may help organizations to acquire a competitive advantage. However, the resource based view (RBV) precludes the constraints posed by the natural environment such as limited natural resources (Hart 1995). To address this missing link between organizations' sustained competitive advantage and natural environment constraints, an adaptation of the RBV termed as the natural-resource based view (NRBV) is proposed (Hart, 1995). The NRBV initially argued for three specific capabilities namely pollution prevention, product stewardship and sustainable development. Pollution prevention and product stewardship were conceptualized as dimensions with a distinct focus on eliminating sources of pollution and managing life-cycle of products respectively. Sustainable development is not only restricted to environmental concerns but is

also focused on economic and social concerns (Hart 1995). In recent years, sustainable development strategies have been reconceptualized as being composed of two distinct areas namely clean technology and base of the pyramid (BoP) (Hart & Dowell 2010). Clean technology emphasizes the development of technologies that meet human needs without straining the earth's natural resources. BoP is focused on the creation of market in poverty-ridden parts of the world, and eradicating poverty by serving this market. Sustainability vision, which is the fourth dimension of the sustainability portfolio, is somewhat related to BoP as BoP is restricted to creation of a market in poverty ridden part of the world, whereas sustainability vision comprises of not only vision for creation of new markets but also new products, processes, technologies and solutions to address various social, economic and environmental problems. The theoretical lens of NRBV enables us to examine the impact of sustainable IS holistically on the various dimensions of organizational performance.

3 RESEARCH MODEL AND HYPOTHESES

Our research model (Figure 1) combines the sustainability portfolio with organizational performance. There are two parts in this study. First, we compare differences in performance of organizations that have adopted sustainable IS and those that have not (Model 1). Second, we examine the relationship between the extent of sustainable IS adoption and organizational performance (Model 2).

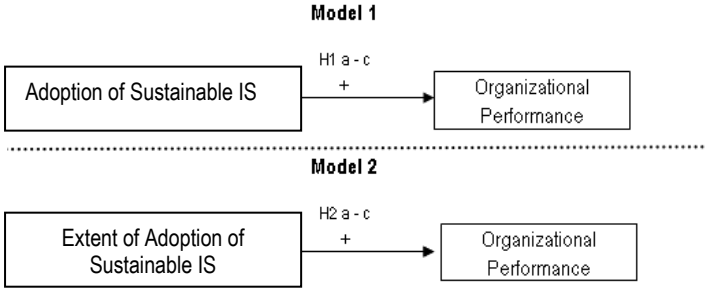

Figure 1. Research Model

3.1 Adoption/Extent of Sustainable IS and Organizational Performance

Adoption of sustainable IS also involves the successful use of IT, as organizations that are able to successfully imbibe it are able to integrate technology with people and processes (Lapointe & Rivard 2007). At the organizational level, adoption of sustainable IS can bring many advantages such as reduced energy consumption (Watson et al. 2010), overall cost reduction and revenue growth (Mithas et al. 2010). Organizations that have adopted sustainable IS can improve profitability in two ways. First, by reducing the cost of operations through reduction in energy expenditure, waste disposal costs and more efficient utilization of resources (Hedwig et al. 2009; Watson et al. 2010). Second, by increasing revenue through introducing green IT products that will allow organizations to differentiate themselves from competition and even command a premium on their products (Ambec & Lanoei 2008). The adoption of sustainable IS will also reduce organizations' compliance and liability costs (Rooney 1993). It will also facilitate cost-reduction for organizations through the reuse of their products at the end of the product life cycle. Consider the example of Apple Inc. where the adoption of sustainable IS initiatives such as improvement in control systems has reduced its per employee natural gas usage (Apple website 2011). It has launched products with energy efficient A-4 chips, power management software and claims to be the only organization, where all products adhere to ENERGY STAR Version 5.0 specification. Every Apple computer sold in the US, UK, Canada, France, and Germany has the highest Electronic Product Environmental Assessment Tool (EPEAT)

gold ratings[1] . Apple is on the list of global high performers prepared by Forbes (DeCarlo 2010) with five-year average sales growth of 38.6% and net income growth of 89.2%. Such figures suggest that the adoption of sustainable IS is positively associated with profitability. Organizations that have adopted sustainable IS will have better bottom-line as well as top-line compared to those that have not adopted any dimension of the sustainability portfolio. The reduction in cost and enhancement of revenue will result in better profit. It follows that:

H1a: Adoption of sustainable IS is positively associated with profitability.

While one stream of IS research based on the RBV perspective emphasizes the use of IT for sustained competitive advantage, another stream emphasizes the extent of use of IT as a source of sustained competitive advantage (Zhu & Kraemer 2005). This stream of research argues that the greater extent of adoption of IS enables organizations to develop enhanced capabilities owing to greater acquisition and assimilation of knowledge. We draw upon NRBV (an adaptation of RBV) to examine the relationship between sustainable IS and organization performance. We examine whether the extent of the adoption of sustainable IS characterized by adoption of different dimensions of sustainability (pollution prevention, product stewardship, clean technology, and sustainability vision) has a positive impact on different dimensions of organizational performance. An organization that is engaged in multiple dimensions of the sustainability portfolio has imbibed sustainable IS to a greater extent compared to those that have adopted just one dimension. An organization that has adopted sustainable IS more comprehensively will positively impact different organization's functions and different drivers of costs and revenue. Consequently, the extent of adoption of sustainable IS should have a positive relationship with profitability. It follows that:

H2a: Extent of adoption of sustainable IS is positively associated with profitability.

Adoption of sustainable IS will result in a positive impression in the minds of consumers due to the increasing awareness of global warming and climate change. This may result in enhanced revenue, as consumers may prefer products from such organizations. As discussed above, the adoption of sustainable IS is expected to reduce operational expenditures. Both reducing costs and increasing revenues will improve profitability, create positive sentiments about the organization in the minds of investors, and improve its market value. Previous research show that the adoption of sustainability initiatives is positively associated with an organization's image and reputation (Hart 1995; Russo & Fouts 1997; Mithas et al. 2010), which would help to enhance market valuation. Hence, we hypothesize that:

H1b: Adoption of sustainable IS is positively associated with market valuation.

As discussed above, organizations with more comprehensive adoption of sustainable IS are hypothesized to be more profitable. The positive impact of the extent of adoption of sustainable IS on profitability will result in better market sentiments, and the organization will be valued more favorably by investors. In addition, the greater extent of adoption of sustainable IS will demonstrate that the organization is sincerely committed towards the environment, thereby resulting in better corporate image and reputation. Consequently, the extent of adoption of sustainable IS should have a positive relationship with market value. Recent industry surveys support this perspective (Haanaes et al. 2011). The results from this survey show that over 60% of the organizations that have embraced sustainability practices believe that it has helped them to improve their reputation and corporate perception in the minds of consumers and investors. It follows that:

H2b: Extent of adoption of sustainable IS is positively associated with market valuation.

Prior research has found support for the positive impact of IT investments on an organization's innovativeness (Aral & Weill 2007). Research have conceptualized IT as an enabler of knowledge acquisitions and assimilation (Tippins & Sohi 2003; Joshi et al. 2010). IT has also been found to help

[1] The most comprehensive and widely adopted environmental standard in the world, products are assessed on criteria such as its recyclability, energy use, design and manufacturing process, products with gold ratings meet all mandatory requirements as well as 75% of the optional criteria (http://www.epeat.net/resources/criteria-discussion/)

organizations develop innovation capability (Sabherwal & Sabherwal 2005). The adoption of sustainable IS involves technical prowess of an organization (Berns et al. 2009). Its adoption implies that organizations will employ technologies superior to conventional technology in terms of characteristics such as energy efficiency. The adoption of sustainable IS may facilitate the creation of new knowledge to enhance its effective utilization (Mithas et al. 2010), and hence will improve innovativeness of organizations. The Xerox example illustrates this. Xerox launched the earth awards program in 1993 as part of its sustainability initiatives, and over the last 17 years, this program has helped Xerox to motivate its employees to develop green innovations (Xerox website 2010). It follows that:

H1c: Adoption of sustainable IS is positively associated with innovativeness.

The greater extent of adoption of sustainable IS will imply that organizations have imbibed more dimensions of the sustainability portfolio. This will result in an organization's increased effort in sustainable IS initiatives. This implies that organizations will put more efforts in acquiring new knowledge and development of technological prowess to ensure success of various initiatives. Consequently, the extent of adoption of sustainable IS should have a positive relationship with innovativeness. It follows that:

H2c: Extent of adoption of sustainable IS is positively associated with innovativeness.

4 METHOD

4.1 Sample Selection

We compiled a list of organizations from four sources: Newsweek Green Ranking in 2009 and 2010, Dow Jones Sustainability Index (DJSI), GRI report and Corporate Responsibility Magazine. *The Corporate Responsibility's black list provides the names of 30 organizations that are the least transparent about their sustainability initiatives (www.thecro.com 2010). These organizations failed to report any data concerning their greenhouse emissions and climate change strategies to the Carbon Disclosure Project (CDP).* Note that CDP is a non-profit organization maintaining a repository of corporate climate change information (www.cdproject.net 2010). We use this list as representative of organizations that are the laggards in the adoption of *sustainable IS or any sustainability practices*. We call them "black" organizations. The Newsweek Top 500 Green Rankings (2009, 2010), GRI report index and the DJSI index provided the list of organizations that had adopted sustainability practices. From these lists, we extracted 106 organizations that had adopted sustainability practices for past few years. We further classified 85 organizations as sustainable IS organizations and 21 organizations as green but non-sustainable IS organizations.

4.2 Coding Process

We developed two types of coding protocol; first for classifying the sustainability practices into sustainable IS and non-sustainable IS, and second for classifying the various sustainability practices into the four dimensions of Hart's (1997) sustainability portfolio. To identify whether the sustainability practices fall under the category of sustainable IS or not, we identified the presence of IT artifacts such as IT infrastructure and IT policies as the criteria for distinguishing between sustainable IS organizations and non- sustainable IS organizations. We developed a list of IT artifacts based on a literature review of research focused on sustainable IS. The list includes IT technical infrastructure (hardware and software) (Molla et al. 2009), IT policy (e.g., procedures regarding deployment and utilization of IT infrastructure) (Goasduff & Forsling 2007), deployment of IT in the environment management (Watson et al. 2010), IT to provide information to support decision making, IT tools for collaboration and IT for delivery of sustainable products and services (Corbett 2010). Of the 106 organizations identified to be engaged in sustainability practices, we randomly selected 25 organizations and they were classified into sustainable IS and non-sustainable IS by one of the authors and a practitioner working with an IT organization. The reliability was tested using Perrault and Leigh's (1989) reliability index. The test yielded a reliability value of 0.90, thus providing credence to

our coding scheme. In order to achieve third-party validation of our class, we examined websites specializing in tracking environmental practices to check if initiatives of such organizations had been categorized into the sustainable practices. The classification in publicly available information supported our classification.

We categorized 85 organizations as sustainable IS firms, which is over three-quarters of the organizations that have adopted green practices, thus underlining the importance of IS in sustainability initiatives. Organizations that were not categorized as sustainable IS organizations engaged in practices such as purchasing renewable energy, recycling paper and sourcing from well-managed forests and *were lacking in the presence or application of any IT artifacts* in their sustainability practices. We also did not include organizations that are in green energy sectors such as solar energy or wind energy as part of our sample, as they are green solely due to their industry characteristics. We then coded various sustainability practices for sustainable IS organizations. We examined the sustainability reports of various organizations to categorize their sustainability practices. The sustainability reports of various organizations are publicly available. In some cases, we also referred to the organizations' websites as such organizations do not publish their sustainability reports but they discuss their various initiatives on their websites that are dedicated to sustainability practices. We also referred to third-party websites such as www.environmentalleader.com, FACTIVA database, and various news archives. We examined their sustainability initiatives from 2004 – 2007 (four years), hence in total we examined 340 sustainability reports, organizations' websites and third-party websites reports. Seventy-five sustainability reports (over 20%) were randomly selected and were coded in terms of Hart's sustainability portfolio (1997) by one of the authors and a practitioner. The inter-coder reliability test yielded index values ranging from 0.77 to 0.89 for different dimensions, which is above the acceptable limit of 0.70 (Ryan & Bernard, 2000). Coding disagreements were discussed and resolved after deliberation. The remaining sustainability reports were coded by one of the authors. In order to further ensure the reliability of coding, we referred to third-party websites such as www.climatecounts.org, which rates various organizations, based on their sustainability practices. We checked whether the organizations that were rated high on overall basis were also rated high by analyzing information on the organization's sustainability practices posted on the website. We found that organizations who have been rated high on sustainability practices at overall level have been also rated high on third-party websites, thus yielding credence to our coding procedure.

5 CONSTRUCTS AND THEIR MEASUREMENTS

5.1 Organizational Performance

A summary of the constructs and their measures are shown in Table 1. The measures of organizational performance include profitability, market valuation, and innovativeness. Profitability is measured by net margin and return on assets (ROA) (Bharadwaj 2000) while market valuation is measured by Tobin's Q, which is considered to be a more robust measure of market valuation compared to measures such as price-to-earnings (P/E) ratios (Hitt & Brynjolfsson 1996; Bharadwaj et al. 1999). Innovativeness is measured by the patents applied for by the organization in a year. Prior studies have found patent count to be a robust indicator of innovativeness, e.g., Joshi et al. (2010) conceptualized the number of patents applied for by the organization in a year as "ideated innovation" and argue for it as a measure that reflects the acquisition and assimilation of new knowledge by organizations. Sustainability practices results in development of new ideas or new products (Seebode 2009), thereby enhancing the number of patents applied. The number of patents applied for in a year is a better measure than the number of patents granted as patents are not granted in a sequential order; the patent applied for in year 2005 may be granted sometime in the future (2006 onwards). Hence, the number of patents applied annually is used as an indicator of the firm's annual innovativeness.

5.2 Sustainability Practices

Pollution Prevention (PP) is measured by two categories as proposed by Hart (1997): (i) organizations do not engage in pollution prevention. The focus is to *control* pollution by reducing its adverse impact

through pollution treatment; and (ii) organizations engage in pollution prevention. The focus is to *avoid* pollution by reducing its generation using *technology*. The classification is done by examining descriptions of their practices. *Product Stewardship* (PS) is measured by two categories: (1) where there is absence of product stewardship as organizations are focusing on environmental friendliness of only one direction in supply chain (either upstream or downstream) or not at all focusing on the environmental friendliness of the supply chain; and (2) presence of product stewardship as organizations are engaged in initiatives aimed at enhancing the environmental friendliness of both upstream and downstream supply chain management. The distinction between product stewardship and pollution prevention is with respect to the domain. Pollution prevention is focused on organization's daily operations such as manufacturing facility, whereas product stewardship is focused on product delivery and product disposal. *Clean Technology* (CT) is measured by two categories: (1) organizations that do not develop and introduce clean technologies; and (2) organizations that develop and introduce clean technologies. *Sustainability Vision* (SV) is measured based on Hart's (1997) framework that encompasses six areas: vision toward the solution of social problem, vision toward the solution of environmental problem, vision toward the development of new technologies, vision toward the development of new market, vision toward the development of new processes and vision toward the development of new products. An organization can have vision towards one or more areas. We classify organization's sustainability vision into two categories: (1) Absence of comprehensive sustainability vision" where the organization is lacking in two or more vision areas; and (2) Presence of comprehensive sustainability vision where the organization has a comprehensive sustainability vision in five or six vision areas. Such visions are stated in organization's sustainability or corporate responsibility reports or may be stated on organization's sustainability micro-sites. The vision statement may be present as a single statement or may be composed of series of futuristic statements present in different sections of sustainability reports as such reports often discuss future vision with regards to different areas in different sections of the sustainability reports. We provide illustrative sample of classification into various sustainability dimensions in Table 2. Please note that the emphasis is on ***information technology component***.

Construct	Data Type	Measure	Data Source
Profitability	Continuous	ROA	COMPUSTAT
Profitability	Continuous	Net margin (NM)	COMPUSTAT
Market valuation	Continuous	Tobin's Q	COMPUSTAT
Innovativeness	Count	Patents applied for	USPTO (Primary source), Google Patents Search, Intellectual property office database http://www.epo.org/patents/patent-information/free.html
Adoption of sustainable IS	Categorical	1. Organizations have not adopted sustainability. 2. Organizations have adopted sustainable IS.	List of organizations that have not adopted sustainability practices is available on Corporate Register magazine black list 2010. List of organizations that have adopted sustainable IS is based on GRI reports, Newsweek Green Rankings , DJSI US Index
Extent of sustainable IS	Continuous	Number of practices adopted by sustainable IS organizations	Sustainability Reports, organization's websites, websites dedicated to sustainability, FACTIVA, news archive.
Size	Continuous	Logarithm of employee's count	COMPUSTAT
Industry	Categorical	2 Digit SIC code	COMPUSTAT

Table 1. Constructs and their measures

Sustainability Dimensions
Pollution Prevention (PP): Practices such as "One way to prevent pollution is to reduce the generation of hazardous waste at its source. ... Where possible, IBM redesigns processes to eliminate or reduce chemical use and substitutes more environmentally preferable chemicals" (IBM 2006) are classified as pollution prevention. On the other hand, mere mention of employing pollution treatment is classified as lack of pollution prevention.
Product Stewardship (PS): Practices such as "IBM began offering product take-back programs in Europe in 1989 and has extended and enhanced them over the years" (IBM 2007), where organizations are focusing on reverse logistics in addition to the environmental friendly practices for upstream supply chain are classified as presence of product stewardship.
Clean Technology (CT): Practices such as "Energy efficiency is a fundamental design criterion for all PowerEdge servers. The introduction of Energy Smart servers reduces server power draw and the resulting system heat. Dell PowerEdge Energy Smart servers use energy-efficient hard drives, advanced fan technology, high-efficiency power supplies and low-voltage processors. .. reduce power requirements by up to 25 percent" (Dell 2007) are classified as Clean Technology.
Sustainability Vision (SV): Vision such as "With the expansion of our enterprise services capabilities, HP can do more than ever to help our customers build sustainable businesses…, using IT to change the equation and help create a more efficient, environmentally responsible and equitable world. And in HP Labs, we're working on the future. Innovations like nano-scale sensors, breakthrough software for analytics and knowledge discovery, and data centers with net-zero environmental impact will be the building blocks of tomorrow's sustainable society." stated in HP's 2009 global citizenship report are classified as comprehensive vision as it encompasses vision toward solution of social problem ("working in areas such as education, healthcare and energy to harness the power of information"), vision toward the solution of environmental problem ("we will reduce the energy consumption and associated greenhouse gas emissions"), vision toward the development of new technologies, products and processes and new markets. ("…the future ... Innovations likes nano-scale sensors, breakthrough software for analytics and knowledge discovery and data centers with net-zero environmental impact").

Table 2. Illustration of Classification of Various Sustainability Dimensions

Control Variables – In this study, we use organization size and industry as control variables. We measure size as the log of number of employees and industry type is captured using 2 digit standard industry classification (SIC) code. The inclusion of 2-digit SIC code as control variable has been found to improve explanatory power of the model by accounting for variance unexplained by other variables (Lenox et al. 2010). By controlling for industry, we also control for industry specific characteristics such as industry concentrations, and regulations and industry specific variations in organizational performance. In order to control for the effects of time on various organizational performance measures, prior research has often included time as a control variable. In this study, we follow a similar approach as other time-related factors such as impact of macro-economic variables on measures of organizational performance are also controlled when we control for temporal effects. To control for endogeneity due to reverse causality, we use lagged measures of organizational performance. We use two year lagged measure of organizational performance as our dependent variables as prior studies (e.g., Brynjolfsson 1993) have found that IT has the strongest organizational impact two to three year after adoption.

6 EMPIRICAL MODELS

We have two different models to investigate different research questions. Model 1 examines if the adoption of sustainable IS is associated with various dimensions of organizational performance. We have three dependent variables, namely, profitability, market valuation and innovativeness. The independent variable for adoption of sustainable IS is measured as a binary construct: adopt (sustainable IS organizations) versus non-adopt (black organizations). In Model 2, the independent variable is the number of dimensions of sustainability portfolio adopted by sustainable IS organizations and the dependent variables are the various dimensions of organizational performance. Hence, our empirical specifications are as follows:

Model 1

$$\text{Profitability}_{i,t+2} = \alpha_1 + \beta_1 (\text{Adoption of sustainable IS})_{i,t} + \chi_1 (\text{Size})_{i,t} + \delta_1(\text{Industry Classification})_{i,t} + (\text{year}) + \varepsilon_{i,t}$$

$$\text{Market Valuation}_{i,t+2} = \alpha_2 + \beta_2 (\text{Adoption of sustainable IS})_{i,t} + \chi_2 (\text{Size})_{i,t} + \delta_2 (\text{Industry Classification})_{i,t} + (\text{year}) + \omega_{i,t}$$

$$\text{Innovativeness}_{i,t+2} = \alpha_3 + \beta_3 (\text{Adoption of sustainable IS})_{i,t} + \chi_3(\text{Size})_{i,t} + \delta_3 (\text{Industry Classification})_{i,t} + (\text{year}) + \xi_{i,t}$$

Model 2

$$\text{Profitability}_{i,t+2} = \alpha_4 + \beta_4 (\text{Extent of sustainable IS})_{i,t} + \chi_4 (\text{Size})_{i,t} + \delta_4(\text{Industry Classification})_{i,t} + (\text{year}) + \psi_{i,t}$$

$$\text{Market Valuation}_{i,t+2} = \alpha_5 + \beta_5 (\text{Extent of sustainable IS})_{i,t} + \chi_5 (\text{Size})_{i,t} + \delta_5 (\text{Industry Classification})_{i,t} + (\text{year}) + €_{i,t}$$

$$\text{Innovativeness}_{i,t+2} = \alpha_6 + \beta_6 (\text{Extent of sustainable IS})_{i,t} + \chi_6 (\text{Size})_{i,t} + \delta_6 (\text{Industry Classification})_{i,t} + (\text{year}) + £_{i,t}$$

We use pooled analysis by having repeated observations (yearly organizational performance and sustainability portfolio) on fixed units (organizations). This approach helps us to capture higher variation compared to simple time series or cross-section design approach (Hicks 1994). One of the econometric models, which are used in the pooled data set, is seemingly unrelated regressions (SUR), which treats each cross-sections and time series within that specific cross-section as unrelated to other cross-sections and time-series within the cross-section (Zellner 1962; Hicks 1994). SUR also overcomes the issue that the error terms in ordinary regression analysis may be correlated with each other due to the omitted factors, which might influence various dimensions of organization performance. Further, SUR has been successfully used in IS research related to business value of IT such as Dewan and Ren (2011). OLS estimates are not considered appropriate for count dependent variables due to its non-normal distribution function (Cameron & Trivedi 2008). Hence, we follow a two-pronged approach to analyze our model. We use SUR to examine the dimensions such as profitability and market valuation and Poisson regression to examine innovativeness. Poisson regression is the widely used technique to estimate parameter coefficients for model with count dependent variable (Cameron & Trivedi 2008). We use Poisson regression with clustered robust standard errors to address the issue of autocorrelation and heteroscedasticity.

7 ANALYSIS AND RESULTS

Table 3 presents the descriptive statistics for various variables. The statistics are for the complete dataset composed of sustainable IS and black organizations. We discard those organizations where we do not have data for any dependent variables for any of the years in the sampling phase. Our total sample comprises four-year observations for 115 organizations (85 sustainable IS and 30 black organizations).

Variable	Mean	Std Dev.	1	2	3	4
1. ROA (%)	6.25	9.08				
2. Net margin (%)	8.50	14.97	0.75**			
3.Tobin's Q	2.06	1.17	0.57**	0.29**		
4.#Patents applied	129.12	476.07	0.17*	0.12*	0.13*	
5.Size (log of employee strength)	4.42	0.81	0.12*	-0.10	0.05	0.13*

**p < .05, ** p < .01*

Table 3. Descriptive Statistics

We present our (SUR) regression results in Table 4 and Poisson regression results in Table 5. Starting with estimates for Model 1, the results show that coefficient for adoption of sustainable IS for both return on assets (β=.12, p>.1) and net margin (β=.08, p>.1) is positive but not significant. Hence, H1a is not supported. The coefficient for adoption of sustainable IS for market valuation (β=.41, p<.01) is positive and significant. Therefore, H1b is supported. The coefficient for adoption of sustainable IS for innovativeness (β= 2.49, p<.01) is positive and significant. Therefore, H1c is supported indicating that adoption of sustainable IS is positively associated with innovativeness.

In Model 2, the results show that among sustainable IS organizations, the extent of sustainable IS, which is reflected in the number of sustainability dimensions adopted, has positive relationship with all dimensions of organizational performance, namely, profitability [return on assets (β=.36, p<.01), net margin (β=.33, p<.01)], market valuation (β=.22, p<.05) and innovativeness (β=.82, p<.01). Hence, H2a, H2b and H2c are supported. A summary of the results of hypotheses testing is shown in Table 6.

Hypothesized Relationship	Dependent Variables	Coefficients	R^2
Model 1			
Adoption of sustainable IS ---> Profitability (H1a)	ROA	0.12{0.18}	0.27
	Net margin	0.08 { 0.19}	0.17
Adoption of sustainable IS ---> Market valuation (H1b)	Tobin's Q	0.41* { 0.18}	0.33
Model 2			
Extent of sustainable IS ---> profitability (H2a)	ROA	0.36**{0.05}	0.36
	Net margin	0.33**{0.05}	0.29
Extent of sustainable IS---> Market valuation (H2b)	Tobin's Q	0.22**{0.05}	0.34

Table 4. SUR Regression Results

Model	Variable	Coefficient	Log likelihood	Pseudo-R^2
1	Adoption of sustainable IS (H1c)	2.49**{0.99}	-49939.41	0.58
2	Extent of sustainable IS (H2c)	0.82**{0.12}	-29885.71	0.71

*Notes. All regressions in Table 4 are estimated using standardized seemingly unrelated regression. **, * denote significance at 1%, and 5% respectively. Standard errors are in parentheses. Year dummies, size and industry control were included in the regressions, but their estimates are not shown for the sake of brevity.*

Table 5. Poisson Regression Results for Innovativeness as DV

Hypothesis	Proposed relationship	Hypothesized effect	Supported	Significance
H1a	Adoption of sustainable IS---> Profitability	+	No	-
H1b	Adoption of sustainable IS---> Market valuation	+	Yes	$p < 0.05$
H1c	Adoption of sustainable IS---> Innovativeness	+	Yes	$p < 0.01$
H2a	Extent of sustainable IS---> Profitability	+	Yes	$p < 0.01$
H2b	Extent of sustainable IS---> Market valuation	+	Yes	$p < 0.01$
H2c	Extent of sustainable IS---> Innovativeness	+	Yes	$p < 0.01$

Table 6. Summary of Results

8 DISCUSSION

In Model 1, the results show that organizations who have adopted sustainable IS do not perform better on profitability compared to black organizations. One plausible explanation is that consumers do not want to pay a premium for green products, and the formation of sustainability-sensitive consumer segment may be still in the nascent phase. Another plausible explanation is that the impact of

sustainability in general and sustainable IS in particular on profitability may be possible only in few sectors *where such initiatives might impact the cost and revenue structure significantly*. Another plausible reason is that benefits from sustainable IS may *take some time* to be realized. This reason has been discussed in prior literature in the context of IT productivity paradox, where a lag period of 2-5 years between IT investment and payoff in terms of profitability is expected (Brynjolfsson 1993). Market valuation is dependent upon corporate image and reputation (Luo & Bhattacharya 2006). Although green organizations are not significantly different from black organizations in terms of profitability, their focus on environmental impact of their operations tends to result in better reputation and corporate image. By engaging in sustainable IS initiatives, organizations may be able to signal to the market that they are taking serious steps to be better equipped to cater to the new market segments, develop new products and technologies, thus contributing to enhanced market valuation. The results show support for our hypothesis that green organizations are more innovative compared to black organizations. This suggests that emphasis on sustainable IS facilitates knowledge acquisition and assimilation. As discussed in prior research, assimilation of new knowledge results in better organizational performance in the long term (Joshi et al. 2010). Hence, the increase in innovativeness due to adoption of sustainable IS is expected to contribute to better organizational performance in terms of high profitability in the long run. Model 2 shows that among sustainable IS organizations, the extent of sustainable IS, which is reflected in the number of sustainability dimensions adopted, is positively associated with various dimensions of organizational performance such as profitability, market valuation and innovativeness. This suggests that different practices may reinforce each other and hence together, they are positively associated with performance dimensions. This is consistent with the conceptualization by Chen et al. (2009), where three sustainability dimensions are conceptualized as inter-linked dimensions with different orientations. The support for the positive association between the extent of adoption of sustainable IS with profitability suggests that the comprehensive adoption of sustainable IS portfolio has stronger positive influence on organization's utilization of assets and net margin. This indicates that among sustainable IS organizations, those who adopt sustainable IS portfolio comprehensively are utilizing assets more efficiently to generate earnings and the proportion of profit in total revenue is higher. The support for the positive association between the extent of adoption of sustainable IS with market valuation is expected due to its positive association with profitability. The support for the positive association between the extent of adoption of sustainable IS and innovativeness can be explained by the argument that the comprehensive adoption of sustainable IS portfolio will result in enhanced focus on acquisition and assimilation of new knowledge in order to address environmental concerns and hence will translate into development of new processes and products. Organizations will apply for patents for such products and processes to protect their intellectual property rights and gain competitive edge over other organizations. Our results are generally consistent with prior research that found support for the positive relationship between sustainable IS spending and high profit impact of sustainable IS (Mithas et al. 2010). Preliminary qualitative studies such as Thambusamy and Salam (2010) also provide support for our results. Initial results from such studies shows that sustainable IS is expected to have positive impact on shareholder value.

9 LIMITATIONS

There are three key limitations in this study. First, we have a limited set of organizations. Future research could attempt at examining the various relationships discussed in this study using a larger sample. Second, we examined our research questions using pooled analysis. As new data becomes available, future research can examine the sustainable IS phenomena using *granular measures* and panel data approaches. Third, in this study we have compared the organizational performance of the black (worst) and top ranked green (best) organizations. Future studies need to consider organizations that are primarily average performers to test the generalizability of findings.

10 IMPLICATIONS FOR RESEARCH AND PRACTICE

There are two key implications for research emerging out of this study. First, this study builds on NRBV and Hart's (1997) sustainability portfolio to examine the business value of sustainable IS. It empirically examines the relationship between the adoption and extent of adoption of sustainable IS and organizational performance. Organizational performance is measured through both market-based and accounting-based measures. This study highlights *an interesting dichotomy* in the performance impact of adoption and extent of adoption of sustainable IS. While the adoption of sustainable IS has no significant relationship with profitability, the extent of adoption has a positive relationship with profitability. In other words, organizations that have not adopted sustainability are doing as well as sustainable IS organizations, but among the adopters, those who have adopted sustainable IS are doing better. This dichotomy requires further exploration. Future research is needed to examine whether the insignificant relationship between the adoption of sustainable IS and profitability is similar to the time lag observed in productivity paradox or whether there are other underlying reasons. The other possibility is that the impact of sustainable IS on profitability is mediated by other performance measures such as innovativeness and reputation. Future research can examine such mediation models. Second, among sustainable IS organizations, the extent of adoption was found to be positively associated with all the dimensions of organizational performance. This finding provides empirical evidence that greater extent of adoption of sustainable IS is better. This result implies that comprehensive adoption of sustainability portfolio has a positive effect on corporate payoffs. However, whether the quantum of impact is similar or varies from sector to sector requires further research. Our results are similar to recent findings on the performance impact of sustainability. Recent research such as Barnett and Solomon (2012) suggests that organizations realize maximum benefits from improving their social performance when they show highest commitment to it. The research suggests that in order to derive financial benefits, organizations should either adopt sustainability completely or ignore it completely. Our findings also suggest that adopters of sustainable IS do not differ from non-adopters in terms of profitability, but among adopters, profitability increases with the extent of adoption. However, prior research suggests u-shaped relationship between social performance and financial performance. Whether similar relationship would be demonstrated in the context of sustainable IS requires further exploration. This study has two key implications for practice. First, this study provides empirical evidence to the business community that sustainability has its business benefits and organizations need to adopt it to improve their organizational performance rather than being motivated by institutional factors such as regulatory norms and policies (Chen et al. 2009). Second, the study also provides some empirical evidence to support the notion that there is increased value associated with the adoption of more sustainability dimensions. Organizations may consider green practices to be an additional expense and hence, rather than comprehensively adopting green practices, may just engage in one practice and promote marketing campaigns or public relation campaigns to create perceptions among public that organization is committed toward sustainability (also known as Greenwashing). Our study suggests that it may be more beneficial for organizations to engage in more than one dimension of sustainability portfolio.

11 CONCLUDING REMARKS

From a theoretical standpoint, this *study* contributes to the broad sustainability literature by empirically establishing the link between adoption of the dimensions of sustainability portfolio (pollution prevention, product stewardship, clean technology, and sustainability vision) and dimensions of organizational performance (namely profitability, market valuation and innovativeness). Our work suggest that the extent of adoption of sustainable IS is positively related to profitability, market valuation and innovativeness. Although this study provides an *initial step*, the notion of sustainability portfolio and NRBV offers a rich theoretical framework with considerable potential for further enhancing our understanding of the performance impact of sustainable IS in organizations. Future research can provide a deeper view of how organizations can successfully adopt sustainable IS in their endeavor to improve organizational performance.

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