From green to sustainability: Information Technology and an integrated sustainability framework

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ARTICLE INFO	ABSTRACT
	Sustainability has increasingly become important to business research and practice over the past decades as a result of rapid depletion of natural resources and concerns over wealth disparity and corporate social responsibility. Within this realm, the so-called triple bottom line seeks to evaluate business performance on its impacts on the environment and interested stakeholders besides profitability concerns. So far, Management Information Systems research on sustainability has been somewhat constrained in the realm of green IT, which focuses mostly on the reduction of energy consumption of corporate IT systems. Using the resource-based view as the theoretical foundation, the manuscript develops an integrated sustainability framework, illustrating the integration of human, supply chain, and IT resources to enable firms develop sustainability capabilities, which help firms deliver sustainable values to relevant stakeholders and gain sustained competitive advantage. Particularly, the role of automate, informate, transform, and infrastructure IT resources are examined in the development of sustainability capabilities. The work calls for a bold new role of IT in sustainability beyond energy consumption reduction. Implications for future research and management practice on IT and sustainability are also discussed.

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1. Introduction

The fast changing and dynamic global business environment requires firms to be more flexible to quickly adapt and respond to market changes. Among the forces that drive changes, requirements for corporate responsibility and sustainability are getting more urgent. During such difficult time as this economic downturn, companies are faced with hard choices to survive. Research has acknowledged that addressing sustainability issues is critical to the long-term existence and thriving of companies (Porter and Kramer, 2006).

Sustainability has increasingly become an important issue for both management scholars and practitioners. This recent push can be attributed to the facts that while the last two decades have brought much economic growth, there is much concern surrounding both wealth disparity and natural resource depletion. This concern has manifested itself in legislation expanding the responsibility of firms, increasing attention on training managers in sustainable management, and the development of theory to support sustainable managerial decision making (e.g. Mintzberg et al., 2002; Hart and Milstein, 2003). As such, more recently, a perspective has emerged that defines sustainability to include three components: The natural environment, society, and economic performance (Elkington, 1994, 2004). This perspective is generally referred to as the *triple bottom line* (TBL). TBL approach suggests that besides economic performance, organizations need to engage in activities that

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positively affect the environment and the society. In fact, it is argued that a firm's long-term profitability and existence are best served by balancing them with social and environmental goals (see e.g. Hart and Milstein, 2003; Porter and Kramer, 2006).

Recent research has shown that competition in the business market has heightened since the mid 1990s, and that one of the main reasons is the significant increase in investments and application of Information Technology (IT) (McAfee and Brynjolfsson, 2008). Various studies have acknowledged the permeation of IT in all aspects of business and the importance of IT resources in enabling business capabilities that help firms survive and thrive (e.g. Aral and Weill, 2007; Rai et al., 2006; Ray et al., 2005). However, little research has examined the role of IT resources in enabling firms develop capabilities to address TBL issues. In practice, the major contributions of IT to sustainability has been centered on reducing IT's energy consumption through green IT initiatives (Wagner et al., 2009). Meanwhile, in order to develop capabilities to address TBL issues, businesses need to engage in wide ranging activities such as changing business culture and redesigning business processes (Hart, 1995; Hart and Milstein, 2003; Porter and Kramer, 2006). Given the recognized role of IT resources in enabling business capabilities, it is arguable that IT resources should be critical in enabling firms to develop capabilities to address sustainability issues, deliver sustainability values to stakeholders and gain sustained competitive advantage. However, insight on such issues is limited (Chen et al., 2008; Melville, 2010).

This paper aims to broaden the contribution of IT to sustainability. Using the resource-based-view as the theoretical foundation, we accomplish such objectives by introducing an integrated theoretical model for sustainability that includes IT resources as a critical component in helping firms develop sustainability capabilities, defined as a firm's capacities to effectively coordinate bundles of complex human and non-human resources to achieve sustainability goals, delivering sustainable values to its stakeholders and gaining sustained competitive advantage. Taking a cross-disciplinary approach by integrating literature from Management Information System (MIS), human resource management (HRM), supply chain management (SCM), and sustainability, we develop theoretical arguments for the integration of IT, HRM, and SCM resources in helping firms develop sustainability capabilities. The paper aims at provide theoretical insights to address the research question: *What is the role of IT resources and their integration with human and supply chain resources in helping firms develop sustainability capabilities that help firms deliver sustainable values and gain sustained competitive advantage?* Our theoretical contributions thus lie in the introduction of the integrated sustainability framework by integrating complimentary frameworks, and the development of theoretical insights on the integration of different types of IT resources (automate, informate, transform, infrastructure) with human and supply chain resources to help firms develop sustainability capabilities. In doing so, our research provides a theoretical framework that helps guide future research and management practices in integrating IT resources with other firm resources to help firms build capabilities that address sustainability issues, deliver sustainability values to their stakeholders, while at the same time create values for the firms and confer them with competitive advantage.

The paper is structured as follows. Section 2 provides a brief review of sustainability definitions and the triple bottom line, and a review of the resource-based-view of the firm as a theoretical foundation for sustainability research. This section also introduces the theoretical research model and provides a review of research on sustainability in HRM, SCM, and MIS literature. Section 3 integrates complimentary sustainability value frameworks into an integrated framework, develops theoretical arguments for the importance of integrating HRM, SCM, and IT resources in helping firms develop sustainability capabilities, and introduces propositions on the role of different types of IT resources – automate, informate, transform, and infrastructure – in enabling firms develop sustainability capabilities. We finish with discussion on the paper's contributions and the implications for future sustainability research and management practices.

2. Sustainability

2.1. Sustainability and the triple bottom line

The idea that businesses and organizations in general have more than mere financial responsibilities is not a new idea. Research as early as the post World War II era focused on businesses' role within society (Marens, 2008). Carroll (1991, 1998), Matten and Crane (2005) and others have acknowledged that a socially responsible company must do more than simply make a profit. According to Carroll's (1991, 1998) model of sustainability, managers, corporations, and employers in general have four levels of responsibility: capital, legal, ethical, and philanthropic. Carroll also suggests that organizations owe these duties to a broad group of "stakeholders" that includes anyone with a "stake, claim or interest in the operations or decisions of the firm" (Carroll, 1991; 1998). Likewise, Mintzberg et al. (2002) suggest that too many corporations operate on a series of "half-truths" that result in a sole focus on profits. Over the last decades, sustainability has increasingly become mainstream within management studies and practices.

The most widely adopted definition of sustainability is that of the Brundtland commission (World Commission on Environment and Development, 1987, p. 8): "...development that meets the needs of the present without compromising the ability of future generations to meet their needs." However, this definition is rather broad and difficult for organizations to understand and apply. As a result much of the focus on sustainable development tends toward an ecological perspective without explicit incorporation of the social aspects of sustainability (Carter and Rogers, 2008).

More recently, a triple bottom line (TBL) perspective of sustainability, as illustrated in Fig. 1, has been adopted which considers organizational sustainability to include three components: The natural environment, society, and economic
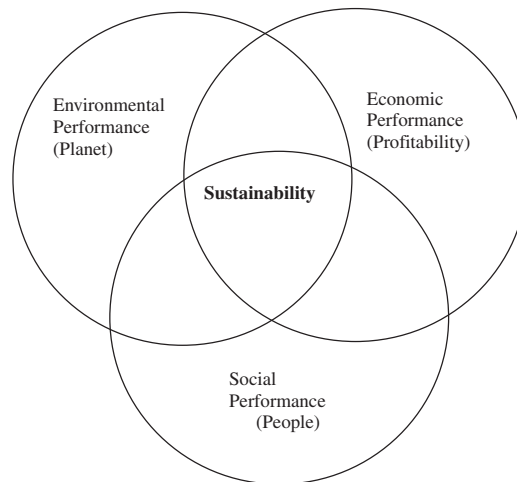
Fig. 1. The triple bottom line of sustainability.

performance (Elkington, 1994, 2004). By considering people and planet in addition to profit, effects on the environment and stakeholders will be incorporated when contemplating alternatives, leading (presumably) to a more sustainable outcome (Elkington, 1994). In fact, it is argued that long-term profitability is best served by balancing it with social and environmental goals (e.g. Aguilera et al., 2007; Hart and Milstein, 2003; Porter and Kramer, 2006).

A growing majority of corporations (68% of the top 250 global companies on the Fortune 500) has embraced TBL public reporting, alternately termed corporate responsibility or sustainability reporting. Many of those companies vie for industry, national, and international honors, such as the Dow Jones Sustainability Index, awarded to the world's most sustainable firms by industry sector (Colbert and Kurucz, 2007).

2.2. The resource-based-view and sustainability

While there are firms that still perceive sustainability as a liability, recent studies have empirically shown that environmental performance and economic performance are positively linked (e.g. Russo and Fouts, 1997), and firms engaging in sustainability efforts have gained legitimacy and increased market value (Bansal and Clelland, 2004). A focus on sustainability has been argued to help firms improve operation, innovation, strategic growth, while gaining a sustained competitive advantage, and delivering sustainable values to the broader society (Colbert and Kurucz, 2007; Hart and Milstein, 2003; Porter and Kramer, 2006). Recent research has utilized the resource-based-view (RBV) of the firm as the theoretical foundation to argue for the benefits of adopting TBL for firms' growth.

The RBV states that a firm develops competitive advantage by not only acquiring but also developing, combining, and effectively deploying its physical, human, and organizational resources in ways that add unique value and are difficult for competitors to imitate (Barney, 1991). The resource-based-view differentiates resources and capabilities. Resources are inputs of the production process and comprise physical and financial assets, employees' skills, organizational (social) processes, and so on (Hart, 1995). Capabilities are defined as the capacities of a bundle of resources being brought together to perform particular value-added tasks or activities (Hart, 1995). RBV posits that firms' capabilities to create sustained competitive advantage are supported by resources that are not easily duplicated by competitors (Barney, 1991).

Based on the arguments of RBV, research argues that adopting sustainability strategy would result in firms being able to deliver sustainable values and gain sustained competitive advantage (e.g. Hart, 1995; Hart and Milstein, 2003; Porter and Kramer, 2006). Sustained competitive advantage comes from the fact that capabilities that help firms engage in sustainability efforts are rare, non-substitutable, and causally ambiguous (e.g. Hart, 1995; Hart and Milstein, 2003), characteristics that make them difficult to imitate (Barney, 1991). As such, in our research context, a firm's *sustainability capabilities* constitute the firm's capacities to effectively coordinate bundles of complex human and non-human resources to achieve sustainability goals, delivering sustainable values to its stakeholders and gaining sustained competitive advantage. Specifically, in this paper, we argue that bundling HRM, SCM, and IT resources enable firms develop such sustainability capabilities. Fig. 2 illustrates our theoretical research model.

While our focus is on the role of different types of IT resources (automate, informate, transform, and infrastructure) in enabling firms to develop sustainability capabilities, we examine such roles by studying the integration of IT resources with SCM and HRM resources for the following reasons which are discussed here and will be elaborated in the remaining sections of the essay.

First, sustainability could not be achieved by a single firm's action. Research has shown that for sustainability to be truly effective, entire supply chains, not just individual partners, must operate in a sustainable manner (Carter and Rogers, 2008;
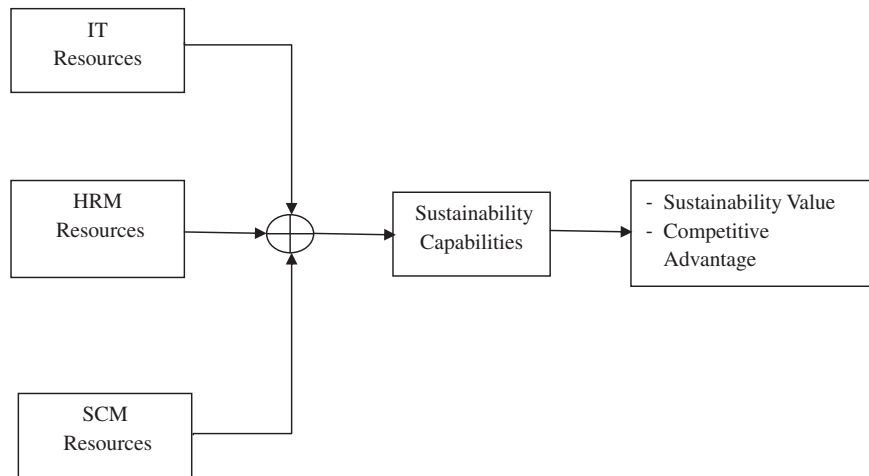
Fig. 2. Theoretical research model.

Kleindorfer et al., 2005). For example, if a manufacturer has strict environmental and labor management standards, its business is not truly sustainable if it suppliers exploit labor and have operations that have harmful impacts on the environment. IT resources have been shown to enable coordination among supply chain partners develop business capabilities across the supply chain that help them increase profit and confer them with competitive advantage (e.g. Banker et al., 2006; Bharadwaj et al., 2007). Thus, by extending such line of research, we will examine the role of IT resources, when integrated with SCM resources, in enabling firms develop sustainability capabilities across supply chain partners.

While sustainability has gained increasing attention from academics and practitioners, sustainability research and practice have been traditionally over-concerned with the environment and under-concerned with people, chief among them employee well-being. This is particularly true with the current literature on IT and sustainability, where most research has focused on the role of IT in reducing carbon footprint of firms' technical IT infrastructure (Mine, 2007; Healey, 2009). By discussing the integration of HRM, SCM, and IT resources, we will help further our insight on the impacts of IT resources on sustainability performance with regards to People factor of the TBL.

In the following sections, we provide a review of research on sustainability in human resource management (HRM), supply chain management (SCM), and Management Information Systems (MIS). We then develop theoretical arguments that sustainability capabilities can be built by bundling HR, SCM, and IT resources, and propose specific propositions on the role of different types of IT resources (automate, informate, transform, and infrastructure), when integrated with HR and SCM resources, in helping firms building sustainability capabilities.

2.3. Human resource management and sustainability

From an HRM standpoint, resources could be defined as the human capital within an organization, the social and intellectual capital of employees, and the HR processes of an organization. HRM can help organizations to reach its goals by adopting best HRM practices (Huselid, 1995), adopting HR practices that best fit these organizations (Baird and Meshoulam, 1988), aligning HR practices both internally and externally (Wright et al., 1995; Youndt et al., 1996), creating bundles of HR practices, (MacDuffie, 1995), utilizing internal resources (Barney and Wright, 1998), managing human capital (Snell et al., 1996; Wright et al., 2001) by building strong HR systems (Bowen and Ostroff, 2004), or through the complex interaction and relationships between HR practices and human capital within an organization (Colbert, 2004). As organizations move to sustainable business goals HRM practices must continue to focus on creating this strategic value, but the value focus must be on all three elements of the bottom line – people, planet and profit.

The literature on HRM and sustainability is emerging, yet still in its infancy. Colbert and Kurucz (2007) have stated, "HR strategy and planning processes should focus on building HR strategy to anticipate and support the sustainability-frames of business strategies." (p. 29). They go on to point to aligning human capital, talent management, staffing, and training and development as important HR functions to achieve sustainability. Jabour and Santos (2008) suggest that HRM can play a critical role in the development of sustainable organizations through HR practices that promote environmental performance, innovation and effective diversity management. Now instead of creating a strong system that is directed towards achieving profits, we are creating a system that perhaps focuses on profit, but also people and planet goals. Wirtenberg et al. (2007) "identified seven core qualities of sustainable enterprises and mapped out specific HR related action to help develop these qualities." (p. 10) Fenwick and Bierma (2008) have shown the need for greater HR engagement in achieving social responsibility and ecological balance. However, our review of the HR literature shows that it still lacks a holistic approach that would integrate HRM and other organizational resources to develop sustainable capabilities. With this in mind, we can begin to define what these HR systems would look like for firms to address sustainability issues. Once these processes are defined,

IT will play an important role to assure that these are known and practiced throughout the organization. While these various theories and studies suggest that HRM can indeed lead to firm value, the main focus of these studies has been to view firms in isolation.

2.4. Supply chain management and sustainability

Fulfilling a consumer's demand for a certain good or service almost inevitably necessitates the cooperation of several firms (Cavinato, 1992; Lee and Billington, 1993). Supply chain management as a field has evolved from the area of Operations Management (OM), which as a field seeks to fulfill demand through efficient production and logistics processes. The quintessential revelation of supply chain management is that in order to fulfill the customer's demand most efficiently (in terms of cost), the firms must work together, sharing information and cooperating more than has been traditionally the case (Chopra and Meindl, 2007; Lee et al., 1997).

Specifically, it has been demonstrably shown that a supply chain's profits can be maximized if the individual partners would act as if they were one profit maximizing firm. This is what is referred to as supply chain coordination (Li and Wang, 2007; Sarmah et al., 2006). Thus, it is arguable that in order for sustainability to be truly effective, entire supply chains, not just individual partners, must operate in a sustainable manner (Carter and Rogers, 2008; Kleindorfer et al., 2005). It makes little sense if one supply chain partner has a strict environmental policy and its supplier or distributor makes decisions without regard to environmental consequences. Analogously, beneficial effects of one firm addressing community concerns and fairly compensating and protecting workers would be arguably diminished by having a supply chain partner who ignores community concerns, refuses to adequately compensate and address worker health and safety issues. A firm which truly appreciates sustainability will seek to do business with other firms that likewise espouse this view. This will lead to a sustainable supply chain of partners incorporating the planet and people into managerial decision making.

While sustainability has attracted attention somewhat recently in Operations Management research, much of this attention is (1) centered on a single firm (neglecting the inter-organizational nature of the supply chain), and (2) concerned with environmental performance (at the expense of social "people" consequences) (e.g. Shrivastava, 1995; Angell and Klassen, 1999; Klassen and Whybark, 1999). More recent research has shifted focus to the relationships in a supply chain (see Zsidisin and Siferd, 2001; Vachon and Klassen, 2007, 2008; Zhu and Sarkis, 2004; Zhu et al., 2005; Hervani et al., 2005). Meanwhile, Castka and Balzarova (2008) consider people and profit by examining the social consequences of supply chain decisions. There are only a handful of articles which examine more than one firm using all three elements of the triple bottom line. Carter and Jennings (2004) look into the use of corporate social responsibility in purchasing decisions. Similarly, Strand (2008) examines sustainability of a firm including the firm's suppliers. Of course, even these excellent contributions do not direct attention towards the downstream members of the supply chain e.g. distributors, retailers, and the like.

Thinking about the triple bottom line, we can examine the role of HR and operations in sustainability. The HR department, through employee compensation and benefits, makes decisions which impact people (employee satisfaction) and profit (labor and benefit cost). The operations department typically makes decisions where the planet (environmental impact) and profit (through operating costs) are impacted. Imagining a supply chain comprised of a supplier, manufacturer, and distributor (without loss of generality), we can depict such a chain in Fig. 3. Information systems then could play a critical role in linking a geographically dispersed supply chain, enabling transparency and facilitating a sustainable strategy among its partners (Stonebraker et al., 2009).

Leveraging the resource-based-view in a supply chain context, Vachon and Klassen (2008) confirm that empirical evidence suggests that bundles of resources possessed by several supply chain partners are developed into capabilities which result in a competitive advantage for the supply chain. Such capabilities in a supply chain context include: (1) the ability to coordinate with other partners resulting in better productivity and performance, and (2) the ability to collaborate with other partners fostering inter-organization learning, which in turn facilitates the development of capabilities in other partners, a particularly potent effect. Therefore, it is arguable that supply chain resources and human resources must be integrated for firms to develop sustainability capabilities that enable them to deliver sustainable value to their stakeholders and gain competitive advantage for themselves.
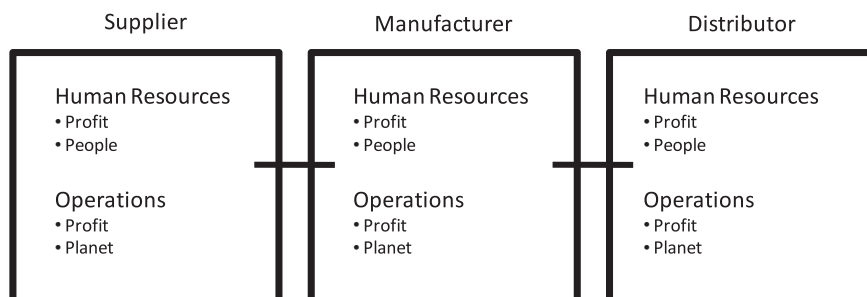

Fig. 3. A simple sustainable supply chain.

The (inarguably) essential role of IT in this realm was first alluded to by Klassen and Whybark (1999). From a sustainability perspective, information systems can enable firms to standardize, monitor, capture, and utilize data and metadata that help evaluate economic, environmental, and social impacts of business activities (Melville, 2010). Information systems could also improve information flows among supply chain partners (Banker et al., 2006) that help increase stakeholder involvement in the management of operations, increase employee training in environmental matters, develop and facilitate cross-functional coordination, and monitor internal and external performance in both financial and environmental terms.

While the role of both human resources and information systems are recognized in enabling supply chains to develop sustainability capabilities, to the best of our knowledge, little research on SCM and sustainability has examined the role that human resources management and information systems play in the development of sustainability capabilities across supply chain partners. Our research represents one of the first efforts to take an inter-disciplinary to examine the role of human resources and information systems in enabling sustainable supply chains.

2.5. IT and sustainability

As discussed, close collaborations and information exchange within and across firms enabled by information systems are critical for firms to develop sustainability capabilities. Capabilities that confer firms with competitive advantage have been shown to be supported by combining IT resources and their complementary human and management resources (e.g. Bharadwaj et al., 2007; Klein et al., 2007; Rai et al., 2006). IT resources have been defined as comprising of (1) tangible technical components, (2) human technical and managerial IT skills, and (3) intangible IT-enabled resources such as knowledge and customer orientation (Bharadwaj, 2000). Utilizing the resource-based-view of the firm, different studies have shown that the combination of IT technical resources (e.g. infrastructure, business applications) and human resources (e.g. technical and managerial skills) confers firms with unique capabilities that help them increase efficiency, profitability, innovation, and gain sustained competitive advantage (e.g. Aral and Weill, 2007; Bharadwaj, 2000; Melville et al., 2004). However, such research predominantly focuses on economic impacts of IT. Within sustainability perspective, it is arguable that the integration of IT technical and human resources with HR and SCM resources is critical in enabling firms to develop sustainability capabilities. Such arguments lead to our first proposition, which serves as the foundation for us to examine the role of different types of IT resources' contribution to firms' strategy in developing sustainability capabilities.

Proposition 1. *The integration of HRM, SCM, and IT resources enables firms develop sustainability capabilities to deliver sustainability value and gain sustained competitive advantage.*

While sustainability has gained increasing attention in management and supply chain management research, our literature review finds limited research in MIS examining the contribution of IT resources in helping firms develop sustainability capabilities (also see Melville, 2010; Watson et al., 2010). While limited academic research has examined IT and sustainability, practitioners' literature has been increasingly paying more attention to the role of IT in sustainability. However, the role of IT in sustainability is not clearly defined. Recent conceptualization of "green IT" has primarily aimed at reducing carbon footprints via reductions in energy consumption of companies' technical IT infrastructure (Mine, 2007; Healey, 2009). Other research has started to argue for the contribution of IT towards sustainability beyond energy consumption reduction. For example, recent research has started to recognize the potential of IT in improving firms' business processes towards more sustainable objectives (Chen et al., 2008; Melville, 2010; Shaft et al., 2002). In this essay, we specifically propose a theoretical framework that examines the role of IT resources in enabling firms to develop sustainability capabilities via its integration with HR and SCM resources.

While IT resources have been found to have significant impacts on organizational changes, it has become well understood that such resources are not interchangeable. Different types of IT investments induce distinctive performance effects through their differential impacts on organizational capabilities, structures, processes and product-markets (Aral and Weill, 2007; Barua et al., 1995; Dehning et al., 2003; Pavlou and El Sawy, 2006; Rai et al., 2006; Weill, 1992). Thus, we specifically examine the role of different types of IT resources in enabling certain strategic business objectives that help firms develop sustainability capabilities. While different categorization frameworks of IT resources exist, we adopt a framework that was developed by Zuboff (1988), Schein (1992) and has been widely applied by recent research to examine topics such as IT signaling (Zmud et al., 2010) and the impacts of IT different types of IT assets and resources on both business performance (e.g. Aral and Weill, 2007; Dehning et al., 2003; Weill, 1992) and ecological sustainability (Chen et al., 2008), we examine IT resources (both technical and human) as categorized into:

- *Automate*: Resources that help firms automate business processes, reducing or eliminating the hands-on role served by human assets in order to carry out work processes and work tasks faster, more efficiently and/or more accurately.
- *Informate*: Resources that help firms make available timely and relevant data to managers, employees and external entities (e.g., customers and suppliers) such that these individuals better understand the work situations being faced in order to carry out work processes and work tasks more effectively and/or more efficiently.
- *Transform*: Resources that help firms restructure or reconstitute business/industry assets, capabilities, practices, processes and/or relationships in order to help firms develop new products, services, or business processes, reposition in the market place, or break into new market.

- *Infrastructure*: Resources that comprise of standardized IT services deployments (both technical and human, such as servers, networks, and help desk) that provide platforms through which standardized technical services are provisioned and from which automate, informate, and transform IT resources are utilized to deliver their intended business objectives (Aral and Weill, 2007; Weill and Broadbent, 1998).

In order to examine the distinct nature of contribution of these distinct types of IT resources to sustainability when they are integrated with HR and SCM resources, we integrate complimentary perspectives on sustainability to introduce the integrated sustainability framework and theoretically examine the role of distinct types of IT resources to sustainability within this framework. The complimentary perspectives on sustainability which are synthesized into our integrated framework come from literature in strategic sustainability management, HRM, and SCM. This study is the first study that takes an inter-disciplinary approach in examining the integration of IT resources with other resources in enabling firms develop sustainability capabilities.

3. The integrated sustainability framework

Utilizing the resource-based-view as the theoretical foundation, Hart (1995), Hart and Milstein (2003) developed a sustainable-value framework that links the challenges of global sustainability to the creation of shareholder value by the firm. The framework includes four quadrants – internal today, external today, internal tomorrow and external tomorrow. While attending to the People factor, the framework leans more towards balancing the planet and profit factors. This framework is complimented by sustainability frameworks that put more focus on balancing the people and profit factors. Colbert (2004) and Colbert and Kurucz (2007) argue that by linking HR principles to companies' triple bottom line sustainability objectives, firms can create lasting industry advantage and build capabilities for positive change. Firms could broaden strategic reference frame and enroll all stakeholders in new directions to sense out critical global issues and help solve them (Colbert and Kurucz, 2007). Likewise, Porter and Kramer (2006) propose a corporate social responsibility (CSR) framework that links firms' CSR strategy to competitive advantage, suggesting that firms move beyond best practices to identify social issues that intersect with their specific business. Addressing such social issues creates opportunities for firms to create shared values that benefit society and prove valuable to the firms. We integrate these complimentary frameworks to extend the four quadrants developed by Hart and Milstein. Fig. 4 describes the four quadrants of the integrated sustainability value framework. By developing sustainability capabilities to pursue the sustainability objectives and practices within these four quadrants, firms will be able to achieve triple bottom line results, create sustainable value for both themselves and their stakeholders, and gain sustained competitive advantage.

	Internal	**External**

Today	- *Strategy:*
	  o Prevent pollution via optimizing operation to reduce cost and impacts on the environment.
	
	  o Create organizational culture aimed towards sustainability, improve employee management practices within firms.
	
	- *Payoff:* Reduced costs, increased profitability, reduced risk.
		- *Strategy:*
		  o Improve extended supply chain to reduce pollution through material and processes choices and closed-loop supply chain,
		
		  o Extend organizational culture aimed towards addressing sustainability issues affecting both internal and external stakeholders.
		
		- *Payoff*: Reputation and legitimacy, reduced environmental impacts, increased competitive advantage

Tomorrow	- *Strategy*:
	  o Develop capabilities that enable radical clean technologies and processes that help solve social and environmental issues.
	
	- *Payoff*: Innovation, strategic positioning.
		- *Strategy:*
		  o Include core sustainability capabilities in all products, processes, and supply chains.
		  o Sustainability vision: Open new, previously ignored dialogues with stakeholders to solve social issues and locate growth opportunities.
		
		- *Payoff:* Growth trajectory.

Fig. 4. Integrated sustainability framework.

In the following sections, we define the four quadrants of the integrated sustainability framework. After that, we provide insights on the contributions of HRM, SCM, and IT resources in helping firms develop sustainability capabilities that enable them deliver sustainable values and gain sustained competitive advantage within each quadrant.

3.1. Quadrant I, internal-today

In this quadrant, firms focus on developing capabilities that enable them to optimize their internal operation in delivering sustainability value. Firms will look at current operations and determine how they will lead to improved people, planet and profit outcomes. In doing so, firms would prevent pollution by minimizing waste and emissions from their operations (Hart and Milstein, 2003). Additionally, firms focusing on this quadrant can also pay attention to social issues that are win–win conditions for them and their internal stakeholders (i.e. employees) (Kleindorfer et al., 2005). Such targets are achieved by engaging in continuous process improvements of internal operations related to sustainability such as employee involvement, employee safety and health, waste reduction, energy conservation, and emission control (Kleindorfer et al., 2005). While increasing employee involvement and improving employee management practices that help increase employee morale could lead to improved internal operations that reduce environmental impacts, empirical studies found that firms pursuing such strategies and practices end up reducing liabilities, cutting cost and increasing profits, thus increasing sustainable shareholder value (Hart and Milstein, 2003). Capabilities that enable firms to implement such strategies and practices will help improve performance in all three aspects of the TBL and could be considered rent-earning capabilities that confer competitive advantage (Bansal and Roth, 2000; Vachon and Klassen, 2007). In this quadrant, we propose that firms will look to align operational resources, human resources and IT resources in such a way as to create firm level sustainability capabilities today.

First, in order to achieve sustainable competency, firms must assure that their human resources in terms of human capital and HR processes are deployed in such a way as to assure their sustainable operations today. Employers must train and develop their employees to build the level of intellectual capital geared towards sustainability (Chen, 2008; Youndt and Snell, 2004). Firms also need to manage the social capital in their organization to assure information and process improvements are shared by employees that possess the intellectual capital necessary to make the improvements (Youndt and Snell, 2004). This intellectual capital will need to be directed through the HRM performance management systems towards achieving the above mentioned goals of product and process improvements.

This quadrant would also include adequate concern and recognition of employee well-being as part of the people component of the triple bottom line. Organizations must not only look at their employees as a means to achieving profit ends, but must also focus on their moral responsibilities to employees (Paauwe, 2004). "The well-being and fulfillment of persons is never legitimately sacrificed as a means to achieving ends" (Naughton, 2006, p. 8). Employers will take measures to assure that employee needs including their lower level needs such as safety, security, and physiological are met through adequate safety, retention and compensation systems. Safe products and working conditions not only attract customers but also lower the internal costs of accidents. Employees will also be allowed to meet higher level needs of growth, esteem and belongingness through their work. HR systems will allow employees to expand their social capital, to develop their skills through training and development and to utilize their knowledge and skills on the job to further the organizational goals of sustainable operations.

In an operations context, internal today would focus on cost minimization and risk management techniques. For example, firms would focus to decrease environmental burden and associated costs of raw materials or disposal (e.g. product stewardship and product recovery management), and incorporate their internal stakeholders' (employees) concerns in decisions and ensure proper worker safety and health standards. Efficient utilization of land, water, energy, and other natural resources makes business more productive.

Through the product design decision, much of the product's environmental impact itself is determined through the sourcing of materials. Avoiding hazardous materials will result in decrease in both disposal costs of the product and risk of legislation and lawsuits. Additionally, improving business processes to reduce waste, energy consumption, could also help firms reduce their environmental impacts. For example, when a distributor deliberates developing network alternatives (where to open distribution centers) to service, trade-offs must be considered between the two criteria of profit and planet. Namely, the more distribution centers are opened, the higher the cost (since distribution centers have a considerable fixed cost) but the lower the energy required to deliver the product (since more distribution centers mean that they will be closer to consumers). Improving such business decision making and processes will require having personnel skilled in life cycle analysis and design for environment, such skills are resources difficult to obtain elsewhere but have to develop within the firms (Angell and Klassen, 1999). Therefore, it is critical that maximizing operation resources for sustainability objectives could not be enabled without appropriate integration with human resources.

While combining appropriate HRM and SCM resources is required for successful delivery of sustainable values in the internal-today quadrant, this would not be nearly as effective without the inclusion of appropriate IT resources. IT could contribute to firms' internal-today sustainability strategy in several ways. Firstly, on its own, IT could help firms reduce pollution by decreasing energy consumption of the corporate IT systems. In fact, this is where most efforts on developing IT for sustainability are focused on (Healey, 2009). Secondly, IT resources could be combined with HR and SCM resources to develop sustainability capabilities aimed at quadrant I's objectives.

First, within *IT infrastructure*, technical platform, which includes standardized technical IT services deployments through which standardized technical services are provisioned (e.g. hardware, software, networks, and data processing architecture), plays a significant role within firms' IT resources (Weill and Broadbent, 1998; Aral and Weill, 2007). Research by the Federal Environmental Protection Agency (2007) has shown that data centers consume 1.5% of the US's electrical power, costing 4.5 billion dollars. However, a large percentage of such power usage is wasted and can be saved by optimizing energy consumption of these data centers such as using virtualization and blade servers. Additionally, by optimizing technology usage behaviors such as shutting down personal computers at the end of working day, enabling power saving features of servers and personal computers, firms can cut energy usage of computers by as much as 40%, saving firms money and reducing IT infrastructure's environmental impacts (Curtis, 2009).

Additionally, viewed from the RBV perspective, firms can integrate specialized capabilities across business functions such as management, manufacturing, and IT to form cross-functional capabilities that help firms deliver sustainability values and gain competitive advantage (Hart, 1995). Here, contribution of IT resources towards sustainability capabilities moves beyond optimizing energy consumption. Appropriate combination of IT resources and HR and SCM resources could help firms develop sustainability capabilities in quadrant I.

The application of *automate* IT resources would help firms reduce costs and environmental impacts. For example, using digitized documents and e-filing systems, firms could automate different business activities, reducing costs of energy and paperwork processing. Additionally, automating business activities can free employees of mundane tasks and allows them time to focus on process improvements for sustainability objectives. However, it is the firms that decide if such automate applications of IT allow firms to cut their payrolls or enable current employees to focus on more knowledge intensive process improvement tasks. Therefore, HR activities such as hiring, training, rewarding must be aligned with the application of automate IT resources to help firms develop sustainability capabilities in this quadrant.

Additionally, in order to achieve sustainable goals with employee management practices and operation management, companies must be able to measure their use of hazardous substances, emission of pollutants, employee health and safety, and integrate such metrics within key business processes (Kleindorfer et al., 2005). Technologies, such as sensors, and RFID, that *automate* the collection and processing of such information could help firms improve operational efficiency through automating organizational information processing ability (Chen et al., 2008; Dewett and Jones, 2001). The availability of such information would also help HR managers with regards to employee management practices (rewards, engagement, etc.) to improve firms' pollution prevention record.

One can readily recognize that the combination of human, operation, and IT resources fulfill the classic requirements in the RBV of being valuable and difficult to substitute or imitate. Employees skilled in triple bottom line decision making will possess firm-specific knowledge difficult to replace or poach. For example, experienced cross-functional team whose experience is crucial in deliberating different design alternatives could not be easily imitated by competitors. The above discussion leads to:

Proposition 2a. *The integration of HRM, SCM, and IT resources enables firms develop sustainability capabilities in quadrant I of the integrated sustainability framework.*

Proposition 2b. *As focus on quadrant I increases, focus on IT infrastructure's technical platform optimization increases.*

Proposition 2c. *As focus on quadrant I increases, focus on automate IT resources increases.*

3.2. Quadrant II: External-today

While many sustainability targets could be met by improving internal operations, meeting many sustainability targets do not end at a firm's borders. Many of such practices do require cooperation from a firm's supply chain partners (Kleindorfer et al., 2005). Therefore as firms move into quadrant II they must consider not only their own internal operations but also those of their business partners both up and down the supply chain. Additionally, firms could actively integrate stakeholders' views into business processes through extensive interaction with external parties such as suppliers, customers, regulators, shareholders, Non-Governmental Organizations (NGO), and the media. All of these practices, usually referred to as product stewardship, create a web of interactions that enable a network of information and knowledge exchange between firms and their supply chain partners and stakeholders. The closed collaborations between firms and their supply chain partners and stakeholders enabled by such network create capabilities that are difficult to be imitated (Hart, 1995; Vachon and Klassen, 2007). Eventually, these capabilities could enable firms deliver sustainability values to both their stakeholders and themselves. Such values can be gained from capabilities to lower environmental impacts, address social issues related to their internal and external stakeholders, reduce costs, increase profitability, and enhance legitimacy and reputation (Hart and Milstein, 2003). Such reputation has been observed to not only in no way jeopardize a firm's competitive advantage but also reinforces and differentiates the firm's position through the positive effects of a good reputation, giving them sustained competitive advantage (Colbert and Kurucz, 2007; Lado and Wilson, 1994).

From an HR standpoint, the same practices that are utilized within the firm to create sustainable practices should be present in the firm's partners. While a partner's reputation with clients may help a firm find new customers, a partnership with a

client with a poor reputation may lead to the loss of customers (Hitt et al., 2001). This may particularly be the case with human resources practices. As an example, according to the United Students Against Sweatshops, 25 campuses cut ties with Russell Athletic wear due to the sweat shop practices at their suppliers in Honduras. In today's global manufacturing environment, if organizations want to avoid losing customers due to a suppliers' poor employment practices, they will have to actively encourage their suppliers to operate in a more sustainable manner. For example, if a buyer is only trained and rewarded based upon his/her ability to buy products at the lowest cost possible, then of course he/she will not worry about how a supplier is providing the low cost products or the bad reputation of abusing labors. Therefore, the HR practices must be aligned with these firms' commitment to sustainability. These practices must support employees being open and receptive to outside stakeholders including not only suppliers, but also consumers, affected community members, NGOs, etc. In sustainability terms, Chen (2008) has defined these external relationships as green relational capital and found a definite correlation between this and the creation of competitive advantage.

More than the optimal control of a single firm in Operations Management, a supply chain setting demands that the decisions of one firm are coordinated with those of their partners, both up and downstream. Therefore, triple bottom line metrics must be examined across supply chain partners, upstream and downstream. A firm would select suppliers based on not only price but also various triple bottom line metrics (Angell and Klassen, 1999).

With regards to downstream partners, while a firm could not control which retailers buy its products, it can limit its access to retailers failing to meet triple bottom line measures. Retailers who can meet these goals can be further enticed to improve via triple bottom line bonuses. This will not only ensure a good surplus for the members, but that the entire chain is working towards a goal of becoming together more sustainable. By collaborating and utilizing up-to-date information and standards, firms can improve sustainability, while also increasing operational efficiency and performance. This is what Vachon and Klassen (2008) refer to as "environmental collaboration".

As discussed earlier, information exchange is key to collaboration among partners in developing a sustainable supply chain, different IT resources can help firms collaborate and develop sustainability capabilities in this quadrant in different ways. Particularly, *informate* and *infrastructure* IT resources enable fast communication between firms and their interested external stakeholders and supply chain partners that, when appropriately combined with complimentary resources, enable firms develop sustainability capabilities within quadrant II.

Firstly, demands for information about a firm's social and environmental impacts from external stakeholders – e.g. consumers, regulators, NGOs or conscientious investors – have risen dramatically (Porter and Kramer, 2006). While it is critical that sustainability HR practices must support employees being open and receptive to outside stakeholders, *informate* IT resources that enable such openness could help firms gain more legitimacy with regards to sustainability (Chen et al., 2008). For example, web portals could enable firms to provide transparent information about the social and environmental impacts of a firm's products or enable collaboration with outside stakeholders such as potential employees and local communities.

As discussed, enabling information exchange and collaboration capabilities up and down the supply chain is critical for firms to develop a sustainable supply chain. Such capabilities are enabled by fast flow of information that allows the chain to react to supply and demand changes and to facilitate coordinated decision making (Rai et al., 2006; Jain et al., 2009). Implementing sustainability strategies requires firms to have a sound understanding of social and environmental impacts of the production as well as consumption of their products or services. These factors must be evaluated for their impact across the full supply chain. For example, determining where a tree is cut down or whether employees' labor rights in a factory are practiced is critical to a firm in choosing sustainable supply chain partners. Additionally, firms need to develop metrics of sustainability that could be used across the supply chain to measure the social and environmental impacts of business activities at different stages of the chain. An example of it is Wal-Mart Stores Inc.'s establishment of Packaging Sustainable Value Network, a group of 200 leaders in the packaging industry. The network created a packaging scorecard with nine specific metrics that enabled suppliers to compare their packaging materials, energy efficiencies, and environmental standards against their competitors'. Such metrics help suppliers focus on specific improvements towards sustainability. Such integration of information across a supply chain requires partners to develop capabilities to (1) share information (Ho et al., 2002; Simchi-Levi et al., 2000), (2) optimize the staging and flow of materials by leveraging the visibility of resources (Lee, 2000), and (3) streamline financial operations such as billing and payments that are interdependent (Rai et al., 2006).

These capabilities could be enabled by appropriate *informate IT* resources developed across the supply chain (Banker et al., 2006a; Rai et al., 2006). For example, investments in inter-firm applications such as Electronic Data Interchange have been found to have significant impacts on customer and supplier participation (Banker et al., 2006). IT resources, such as an enterprise resource planning system or a sustainability performance database, can help firms collect and share sustainability performance data (Chen et al., 2008). These resources also provide a common benchmark and knowledge base for supply chain partners to assess their sustainability performance. The capabilities to collaborate and share information, which are enabled by informate IT resources, could enable firms improve sustainability performance, and are difficult to be imitated by competitors (Klein et al., 2007).

However, supply chain integration can be hampered by fragmented IT *infrastructure* that constrains information flows and activity coordination (Barua et al., 2004; Sambamurthy et al., 2003). A well-integrated IT infrastructure among supply chain partners requires standards for the integration of data, applications, and processes to be negotiated and implemented in order for real-time connectivity between distributed applications to be achieved (Ross, 2003; Weill and Broadbent, 1998). Integrated IT infrastructures enable firms to develop capabilities to unbundle information flows from physical flows, and to share

information with their supply chain partners, such capabilities have been found to result in sustained operational excellence and competitive advantage (Rai et al., 2006). Therefore, it is critical that besides developing informate IT resources, supply chain partners need to take appropriate steps to integrate their IT infrastructure, enabling informate IT resources to coordinate across inter-firm platforms. Such IT-enabled collaborations that deeply embed capabilities of IT platforms into organizational processes (Bharadwaj, 2000) could facilitate firms in the coordination with suppliers and partners along the supply chain in the development and evaluation of clean technologies and processes. They are firm-specific capabilities and difficult to be imitated, thus are able to confer firms with sustained competitive advantage (Banker et al., 2006; Rai et al., 2006). The above discussion leads to:

Proposition 3a. *The integration of HRM, SCM, and IT resources enables firms develop sustainability capabilities in quadrant II of the integrated sustainability framework.*

Proposition 3b. *As focus on quadrant II increases, focus on IT infrastructure integration increases.*

Proposition 3c. *As focus on quadrant II increases, focus on informate IT resources increases.*

3.3. Quadrant III: Internal-tomorrow

While firms can create sustainability capabilities today, even greater capabilities can be created in the long-term. Firms focusing on this quadrant can focus on choosing unique positions to better serve a particular set of customer needs (Porter and Kramer, 2006). Such objectives could be achieved by developing capabilities that enable firms develop radical clean technologies and processes that leapfrog and disrupt industry standard practices, reposition the innovating firms and reorient business growth (Hart and Milstein, 2003; Kleindorfer et al., 2005; Porter and Kramer, 2006). Such capabilities include those that enable firms to recover pollution-causing chemicals during manufacturing, develop substitutes for nonrenewable inputs, develop new products to reduce material contents and energy consumption during production and use (Kleindorfer et al., 2005). The groundbreaking, radically innovative products and processes created by firms following strategy within quadrant III not only do not harm people and planet factors, but also solve current and future social and environmental concerns. The sustainability capabilities that emerge from the search for clean technologies and processes will be critical in helping firms to not only solve environmental and social concerns but also achieve sustained competitive advantage by enabling them to reposition theirs internal skill sets for the development and exploitation of future markets (Hart and Milstein, 2003). An example is Toyota's success with the Prius hybrid car, which emits as little as 10% of the harmful pollutants conventional vehicles produce while consuming only half as much gas. Assuming a leading position in hybrid technology provides Toyota with unique strategic position that will enable Toyota to establish its technology as a world standard (Porter and Kramer, 2006). As such, capabilities developed in this quadrant would have impacts on all three factors of the TBL.

In order to develop the described capabilities for radical innovations, HRM must be poised to acquire and develop the talent in an organization that will develop the technologies and ideas of tomorrow. Therefore, the talent management systems must be aligned to reward the risk taking that achieves these types of radical innovations. Not every innovation will be successful and perhaps most importantly HR practices will need to reward the efforts made to achieve these innovations and to avoid creating an environment of fear of risk taking. Further, employers must also assure that employees' long-term needs are met through employment practices that assure long-term employment.

An example of radical improvements of operation and product design processes would be product recovery management. In order to efficiently gain access to the returns, a reverse distribution network must be typically set up. This reverse logistics network is more complicated than one might imagine, and may require radical improvements of operations and supply chain activities. Reverse distribution centers deal with a broader spectrum of products than traditional forward logistics distributors. They must also grade the returns, judging quality in order to make decisions where errors can be costly. The resources needed here can start with physical facilities used in production resource management, but also the personnel tasked with operations. Machinery set up to test returns and personnel experience are both valuable and mostly firm-specific.

As firms need to develop capabilities to develop radical sustainability products or processes to reposition themselves, such capabilities could be enabled by IT resources that could help *transform* prevalent business practices and processes. Such transform IT resources have been shown to have significant impacts on firms' innovation capabilities (Aral and Weill, 2007; Sambamurthy et al., 2003). For example, by utilizing IT, Netflix created a radically new business model, renting DVDs online. As a result, the company positions itself distinctly from dominant market player Blockbuster, gaining new market share, competitive advantage, and at the same time reducing environmental impacts by not having to operate regular stores, and not having customers driving back and forth to rent and return DVDs. Such innovation capabilities are not readily available off the shelf, but require significant time and efforts of developing and implementing appropriate strategies that integrate and bundle IT assets and capabilities with HR and SCM resources to encourage employees to innovate and develop clean technologies and supply chain processes (Bharadwaj, 2000; Powell and Dent-Micallef, 1997; etc.). Therefore, for firms that want to deliver sustainable value and gain sustained competitive advantage via the development of radical clean tech-

nologies and processes, it is critical that HR, SCM, and transform IT resources are integrated in the development of such sustainability capabilities, and such capabilities can confer firms with sustained competitive advantage.

While transform IT resources enable firms innovate to develop radical product and process changes, such resources need to be supported by appropriate IT *infrastructure* that are prepared for future anticipated needs (Aral and Weill, 2007). IT infrastructure provides the resources that make feasible innovation and improvement of products (Duncan, 1995). As IT infrastructure is seen as the foundation of computing, network, shared data platform on which specific IT applications are built (Broadbent and Weill, 1997), many infrastructure investments are typically made to provide a flexible base for future business initiatives in anticipation of future business needs. However, as it is difficult to predict the future technology needs of different innovation processes, IT infrastructure needs to be flexible in meeting such varied future demands. The flexibility of an IT infrastructure is reflected in the extent to which a firm's IT infrastructure components, including hardware, operating systems, communications network, data, and applications, are designed to evolve with emerging technologies and support continuous redesign of business and related IT processes (Broadbent and Weill, 1997; Duncan, 1995; Ray et al., 2005). As such, a flexible IT infrastructure could facilitate rapid deployments of IT applications required for innovation activities. For example, United Parcel Service's flexible IT architectures enable data integrity and connectivity with customers' applications, providing real-time inventory information that can be leveraged by customers to improve inventory management, asset efficiencies, and market responsiveness (Rai et al., 2006).

Viewed from the RBV perspective, a flexible IT infrastructure needs to be carefully planned for and developed over time. This path dependent process creates differences across firms that are difficult to be imitated (Ray et al., 2005). As such, a flexible IT infrastructure could enable firms develop sustainability capabilities and confer competitive advantage. The above discussion leads to:

Proposition 4a. *The integration of HRM, SCM, and IT resources enables firms develop capabilities in quadrant III of the integrated sustainability framework.*

Proposition 4b. *As focus on quadrant III increases, focus on IT infrastructure flexibility increases.*

Proposition 4c. *As focus on quadrant III increases, focus on transform IT resources increases.*

3.4. Quadrant IV: External-tomorrow

While it is critical for firms to look to the future of their own operations to create sustainability capabilities, firms must also think beyond their own boundaries to create true sustainable business practices. Firms in addressing this quadrant will pursue strategies that utilize such capabilities in exploring unmet markets to produce new products (Hart and Milstein, 2003; Kleindorfer et al., 2005). Such sustainability strategy focuses on helping firms sense out critical global issues that intersect with firms' business and help solve them. By doing so, firms would create value broadly for the society and at the same time creating value and sustained competitive advantage for themselves, an approach consistent with base of the pyramid business development (Colbert and Kurucz, 2007; Hart, 1995; Prahalad and Hart, 2002; Porter and Kramer, 2006). Firms could enable such strategies by developing a sustainability vision about the shared roadmap of growth between the firms and their social context, which makes it easier for firms to communicate and enroll relevant internal and external stakeholders in addressing sustainability issues and sensing out the growth opportunities (Hart and Milstein, 2003).

Just as HRM practices should be developed to lead to innovative practices in both operational excellence and innovation, a firm should strive to assure the HR practices are in place throughout their supply chain. Firms need to have an external focus even beyond their own supply chains if they want to be truly and remarkably innovative. For instance, according to 3 M's web-site, customers are an important part of the innovation process and the company, or more specifically the people of the company, spend a great deal of time listening to the customers. In order to accomplish this, organizations will have to manage their human capital in such a way that employees are able, willing and enabled to engage in listening to the customers and turning this information into innovative products. Employers must focus on the supply of human capital not only within their firms but also outside of their firms. Employers should look to develop talent in their communities and society at large.

Additionally, sustainable supply chain management within this quadrant would entail relationship building where upstream and downstream members are embedded in a strategy to ensure that the entire chain becomes more sustainable over time. This would entail investment in inter-firm systems (of which IT would certainly be a part) to facilitate cooperation of different partners. Gathering of triple bottom line metrics, training and development, and continuous improvement would ensure strategic alignment of partners.

For example, through communicating sustainability vision across the supply chain, a firm can help develop its suppliers to be more sustainable. As mentioned earlier, suppliers would be selected based on their triple bottom line performance. Supplier development refers to encouraging suppliers to improve performance over time, through encouragement as well as training. Another example could be investing in communities where the firm operates in order to have access to better employees tomorrow. This might be achieved by, for example, investing in schools directly to raise the general education level in the areas where the firms operate. Less direct community investment which positively affects neighbors could also

lead to more productive (and happier) employees tomorrow. This long-term thinking will require firms possessing what Bansal (2005) referred to as "organizational slack", the ability to tolerate decisions sacrificing some gains today for larger gains tomorrow.

As such, in order to open up new pathways for growth in previously unserved markets, firms need to open dialog with new, previously ignored stakeholders to coordinate with them to understand and explore their unserved needs (Hart and Milstein, 2003). Additionally, meeting unserved needs through a shared roadmap could not be met by a single company, but requires close collaboration with supply chain partners. While developing a rigid sustainability vision is critical in a firm's success in exploring and serving unmet needs, this sustainability vision must also be developed and shared among firms' employees and related business partners.

Such coordination, in turns, could be served by investments in developing complimentary IT resources. Insightful IT leaders recognize that the greatest impediments to success are often related to people rather than to information, technology, and systems (Roepke et al., 2000). Therefore, there must be an alignment between IT and HRM resources to foster innovation and exploration of new markets to deliver sustainable value. Appropriate *informate* IT resources need to be developed to communicate the sustainability vision to all stakeholders and measure sustainability performance according to such sustainability vision.

Additionally, sustainability has also been argued as a path dependence process (Hart, 1995). Once companies have acquired capabilities to develop clean technologies and processes, such capabilities could be developed into core capabilities that are included in products, processes, and supply chains for long-term sustainability (Hart, 1995). Such capabilities are enabled by integrating IT platforms across the supply chain and the development of organizational culture that encourages the use of technology in collaboration for innovation, both within firms and among firms' employees with relevant outside stakeholders.

Therefore, the development and diffusion of a sustainability vision within and across firms to enable the integration of sustainability capabilities into firms' products and processes and the exploration of unserved markets requires an integration of HR, SCM, and IT resources.

Proposition 5a. *The integration of HRM, SCM, and IT resources enables firms develop capabilities in quadrant IV of the integrated sustainability framework.*

Proposition 5b. *As focus on quadrant IV increases, focus on informate IT resources increases.*

4. Discussion and conclusion

Sustainability has recently gained increasing widespread attention among business practitioners and scholars. Besides focusing on economic profits of business activities, firms also need to take into account the social and environmental impacts of their business activities (Elkington, 1994, 2004). Doing so could actually help firms reduce cost, increase profitability, sustain their business market, gain competitive advantage, and become viable contributors to the society and business market in the long-term (Hart, 1995; Hart and Milstein, 2003; Porter and Kramer, 2006).

Using the resource-based-view of the firm as the theoretical foundation, and literature in HRM, SCM, MIS, and sustainability, we synthesize an integrated sustainability framework and introduce a research model which suggests that the integration of HR, SCM, and IT resources are critical for firms to develop sustainability capabilities that enable firms deliver sustainability value to stakeholders and concurrently create value and gain sustained competitive advantage for themselves. More specifically, our propositions argue for the distinct contributions of different types of IT resources – automate, informate, transform, infrastructure – in helping firms develop sustainability capabilities for different sustainability objectives across the four quadrants of the integrated sustainability framework. Our research makes several contributions to our collective knowledge about sustainability.

4.1. Theoretical contributions

First, integrating different management perspectives on sustainability, the integrated sustainability framework shows that focusing on developing sustainability capabilities will not only serve the environment and people, but also help firms generate value that could enhance profitability and gain sustained competitive advantage for themselves. Additionally, the framework stresses the importance that sustainability research and practice consider all three factors of the TBL – profit, people, planet – concurrently, and improvement in performance on each factor has positive impacts on performance on the remaining factors.

Secondly, our research shows that the development of sustainability capabilities requires a holistic approach by integrating different firm resources. Particularly, in our study, HR, SCM, and IT resources need to be integrated for the effective development of sustainability capabilities. While sustainability research has recently gained greater attention within different business disciplines, our literature review finds little research that takes an inter-disciplinary approach to study sustainability. Our research represents an early effort in approaching sustainability research from an inter-disciplinary approach.

Additionally, limited IS research has focused on sustainability. The IS research community has started to call for more attention to this important issue, as reflected in the calls for special issue on sustainability at JSIS as well as some other journals such as MIS Quarterly. Our study presents an early effort to enhance our collective knowledge on the relationship between IT resources and firms' sustainability performance, a critical research question that requires further attention from IS researchers (Melville, 2010). Our research has shed some lights on how different types of IT resources – automate, informate, transform, infrastructure – are integrated with HR and SCM resources in enabling firms develop sustainability capabilities across the four quadrant of the integrated sustainability framework. Our research shows that distinct types of IT resources contribute differently to firms' sustainability strategy.

While recent research on IT and sustainability has focused more on environmental sustainability (e.g. Chen et al., 2008; Melville, 2010; Shaft et al., 2002; Watson et al., 2010), our research shows that it is critical that all three factors of the TBL be considered in sustainability, and IT resources can enable the development of sustainability capabilities that address all three factors of the TBL.

Besides its theoretical contributions, our research also has implications for both future sustainability research and management practice.

4.2. Implications for future research

First, limited inter-disciplinary research has examined the integration of resources across functional areas within and across firms to address the TBL. More particularly, limited research has examined the contribution of IT resources to sustainability beyond reducing energy consumption of corporate IT infrastructure. Meanwhile, research has acknowledged significant broad impacts of IT resources on different aspects of organizational performance and competitiveness (Aral and Weill, 2007; McAfee and Brynjolfsson, 2008; Melville et al., 2004). Our research shows that such broad impacts potentials could be transferred to the deployment of IT resources to enable firms develop sustainability capabilities via combining IT resources with firms' HRM and SCM resources. Therefore, it is critical that research on sustainability takes an inter-disciplinary approach in examining firms' development of sustainability capabilities.

Additionally, our research lays theoretical foundation for future research on the sustainability value of IT in several ways. First, our research has shown that the contributions of IT to the sustainability go beyond reducing IT's energy consumption through green IT initiatives. Therefore, research on the sustainability value of IT needs to beyond "green" IT initiatives aimed at reducing IT's energy consumption to the contribution of IT in a broader sustainability framework. Furthermore, investments in IT resources for sustainability must be aligned with other complimentary business resources – here, HRM and SCM resources - to enable firms achieve sustainability targets. As IT is arguably an integral part of firms' sustainability strategy, future research on IT and sustainability needs to take a more integrated approach, examining IT resources and strategies that are integrated with complimentary business resources and strategies, and aligned with the situational context to enable firms develop sustainability capabilities for specific sustainability objectives.

While our research examines the integration of IT resources with HRM and SCM resources, future research can examine how other resources – such as accounting, finance, and marketing – can be integrated with IT resources to enable firms improve their sustainability performance. For example, cross-disciplinary research with Finance and Accounting could suggest performance measurement and quantifications of sustainability impacts. Research with marketing could aim at transparency and "educating the consumer" on what various metrics mean.

Our research has also developed testable propositions with regards to the potential contributions of different types of IT resources to sustainability capabilities development. Future research would expand such insights by examining how the bundling of different types of IT resources with specific complimentary resources would differ in enabling firms address specific issues of the sustainability framework.

4.3. Implications for management practice

Our research also has implications for sustainability management practice. First, by synthesizing different perspectives on sustainability using a single theoretical lens of resource-based-view, our research represents another effort that demonstrates to managers that firms operate within the larger social and environmental context, and adopting the TBL in developing their business strategy will benefit the firms themselves and their stakeholders as well as shareholders.

Secondly, practitioners should also recognize the holistic nature of sustainability strategy and need to engage all relevant stakeholders both within and outside firms' in developing and implementing sustainability strategy. The integrated sustainability framework provides a conceptual reference framework for practitioners to examine and discuss specific objectives of firms' sustainability strategy to address the TBL issues. More particularly, we have placed IT within the broader context and shown the importance of IT resources as an integral part of the sustainability solution. Therefore, using our integrated sustainability framework, business managers, and more particularly IT managers, could take a bolder approach in proposing sustainability initiatives within which IT plays a bold and integral role. Furthermore, IT practitioners need to understand how different types of IT resources, when integrated with complimentary business resources, contribute differently to firms' overall sustainability strategy to achieve different objectives across the four quadrants of the integrated sustainability framework.

It is hoped that this research will prove useful to both scholars developing comprehensive models and empirical research on the sustainability value of IT and practitioners developing business cases that support IT-enabled sustainability business initiatives being undertaken within their firms. Through this study, we hope to call for the attention of both management and IS researchers and practitioners to make IT an integral piece of the sustainability solution.

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