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UNDERSTANDING THE ROLES OF IS/IT IN SUSTAINABLE SUPPLY CHAIN MANAGEMENT

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Abstract

A growing focus on sustainability issues has permeated the area of Supply Chain Management (SCM) over the past two decades. The concept of Sustainable Supply Chain Management (SSCM) has been introduced to reflect a commitment to addressing economic, environmental and social dimensions of sustainability in managing supply chain activities. The transition from traditional SCM to the new landscape of SSCM implies that the roles of IS/IT supporting SCM may need to be revisited as a result of the shift to a SSCM focus. Currently, the role of IS/IT in SSCM has only been discussed in a fragmented manner in a handful of studies. In this conceptual paper, we therefore explore current understandings of SSCM practices focusing on identifying the way IS/IT roles are played out in supporting SSCM practices. We find that SCCM presents a serious challenge to the IS/IT community for leveraging the transformation role of IS/IT that can help increase the adoption of SSCM practices.

Keywords: Sustainable Supply Chain Management, Supply Chain Management, Information Systems, Information Technology

1   INTRODUCTION

A growing media and trade focus on concepts of sustainability and sustainable development has led many organizations to consider the ways in which sustainability can be supported across their business operations. Supply chain management (SCM) is an important business function because it accounts for the majority of external spending in most organizations (Tate, Ellvam & Kirchoff 2010). Due to its importance, there is considerable potential for SCM to have an impact on sustainability. As such, organizations are becoming more aware of how greater social and environmental responsibility can lead to increased performance through revisiting their SCM operations (Zadek 2004).

The past two decades have seen a shift from traditional SCM to a growing commitment to SSCM, and this is reflected in both the SCM literature and in business practice. Traditional SCM supports business operations and economic performance, but does not consider responsibility for environmental and social concerns. The Council of Logistics Management defines supply chain management as "the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements" (Lambert & Stock 1993:4). Likewise, Simchi-Levi et al. (2011) define supply chain management as "a set of approaches to integrate supply chain participants so that products are produced and distributed at the right quantities, to the right locations and at the right time to ensure the total cost is minimized and the service level is maximized". These definitions clearly emphasize the focus on economic performance which is a characteristic of traditional SCM.

The incorporation of sustainability into SCM has resulted in a much broader scope for SCM in terms of responsibilities and practice. New conceptualizations of SSCM require organizations to recognize the interdependence of economic, environmental and social systems, and address sustainability issues across all these dimensions. While numerous definitions of SSCM can be found in the literature, for the purposes of this paper, we define SSCM as "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements" (Seuring & Muller 2008). These three dimensions are known as the triple bottom line (Elkington 1998).

Understandings and approaches to sustainability in general have been characterized by a growing sophistication and breadth of scope. While early iterations of sustainability only referred to economic issues, environmental and social sustainability perspectives have become increasingly popular. This shift reflects a growing interest in corporate social responsibility (CSR) to address triple bottom line issues. The goal of CSR is to embrace responsibility for an organization's actions and to encourage a positive impact through its activities on the environment, consumers, employees, communities and other stakeholders (Peloza & Shang 2010). CSR supports triple bottom line commitment to performance across the three 'pillars' of economic, environmental and social concerns (Elkington 1997).

We argue that the incorporation of sustainability within the SCM of an organization cannot be achieved without appropriate support and participation of IS/IT management. Given that IS/IT professionals are engaged in a variety of activities supporting traditional SCM (such as supporting information flows of products, services, financial resources and information from a source to a customer, development of tools and modules to execute supply chain transactions, manage supplier relationships and control associated business processes), the changes highlighted by a shift to a SSCM focus now implies that relevant activities in the IS/IT domain and the broader responsibility (and specific roles) of IS/IT management require further changes as a result. However, there are currently very limited studies that discuss the roles of IS/IT specifically in supporting SSCM practices and

demonstrate how these roles are played out, which are important before we understand the possible implications of SSCM to IS/IT management. Therefore, the purpose of this paper is to explore current understandings of SSCM practices with a focus on identifying the way IS/IT roles are played out in supporting SSCM practices. Based on this understanding, we then identify implications for IS/IT professionals supporting sustainable supply chain management. The research questions addressed in this study are:

a) What are the current practices that characterize the concept of SSCM?
b) How are the roles of IS/IT played out in each of the SSCM practices?

In this study, we broadly define Information Systems (IS) as a combination of software, hardware, infrastructure, data, people, processes, procedures and activities that support business operations, interaction between people, data and technology and decision making. Based on this definition, IS embraces various types of Information Technologies (IT) and the related procedures/processes to use IT to support organisations.

For the purpose of this study, we conducted an extensive literature review on the concepts, theories and practices of SSCM, and how they relate to the role of information systems (IS) and information technology (IT) in organizations. A literature review can be regarded as a systematic and reproducible design for identifying and evaluating an existing body of scholarly work (Fink 2005). The strength of a literature review, particularly in terms of a rapidly expanding area such as SSCM, is that it can provide an in-depth view of the field and also lay the initial foundation for the process of theory development (Mentzer & Kahn 1995). The search for relevant literature was carried out using several databases including ScienceDirect, EmeraldInsight, and InterScience Wiley, EconLit with Full Text (EBSCO), Expanded Academic ASAP (Gale), SCOPUS - V.4 (Elsevier), Web of Science (ISI) and Google Scholar. Examples of keywords used in the search were *green supply chain management, sustainable supply chain management, supply chain management, green IT, green IS, sustainability, social sustainability, economic sustainability, environmental sustainability, role of IS [professionals] and role of IT [professionals]*. In addition, recent issues (2009-2011) of the leading eight journals in IS (MISQ, EJIS, JIT, I&M, JMIS, ISR, JSIS and ISM) were systematically examined for relevant articles specific to the topic of SSCM. Key practices on the three dimensions of SSCM (economic, environment and social) are identified from the literature synthesis and analysis. In analysing the implications for IS/IT professionals arising from the current literature, a content analysis was conducted. The content analysis, based on the approach of Gold et al. (2010), allows for an objective and systematic review of content found in relevant literature, resulting in the clustering of the issues or themes emerging from current literature.

Guided by the four roles of IS/IT in SSCM as proposed by Dao et al. (2011) which include Automate, Informate, Transform and Infrastructure, we show how these roles are played out in each of the SSCM practices identified from the literature. In particular, we highlight that the transformation role of IS/IT appears to be more important as we consider practices on the enviromental and social dimensions of SSCM. We argue that SCCM presents a serious challenge for both researchers and practitioners to leverage the transformation role of IS/IT that can help facilitate the adoption of SSCM practices.

2   OVERVIEW OF SSCM: CONCEPTS AND PRACTICES

The literature on sustainable approaches to supply chain management can be characterized as suffering from conceptual confusion. This is reflected in a tendency of past research in the supply chain management field to use the terms "sustainability" and "environment" interchangeably. In addition, many studies refer to sustainable supply chain management but are only referring to economic and environmental (green) approaches (Carter & Easton, 2011). More recent literature concerning sustainable approaches to supply chain management now reflects a growth in more holistic or

integrated interpretations reflecting an emphasis on CSR. SSCM has emerged as a new approach for improving business outcomes on economic, environmental and social dimensions. A number of seminal papers in the field review the trends underpinning SSCM and provide a comprehensive review of the research to date in this area. Most of these reviews articulate a conceptual model of SSCM based on economic, environmental and social dimensions (Ratan et al. 2010; Seuring & Muller 2008; Teuteberg & Wittstruck, 2010; Markley & Davis, 2007; Carter & Rogers 2008; Carter & Easton 2011). Closs et al. (2011) develop a framework based on four dimensions of economic, environmental, educational and ethical sustainability. However, in most conceptual frameworks in the literature, educational and ethical issues are subsumed under the 'social' dimension of sustainability.

SCM has traditionally been viewed as primarily operational in nature, with a major focus on cost reduction (Closs et al. 2011). In recent times, this perspective has broadened substantially as organisations strive to respond to stakeholder pressures regarding sustainability issues. The transition from SCM to SSCM has been characterised by increasing commitment to environmental and social concerns rather than being wholly driven by economic or bottom-line concerns. (Closs et al. 2011; Ratan et al. 2011; Carter & Easton, 2011). Teuteberg & Wittstruck (2011) note that economic understandings of SSCM have dominated the literature since 2002, with a shift towards legal and compliance issues becoming more apparent after 2006. In the economic dimension, there is only one question, and that concerns whether or not SSCM can be profitable. Overall, the literature on SSCM is dominated by a focus on the economic and to an increasing extent, the environmental dimension of sustainability. The social dimension of sustainability still lags behind economic and environmental dimensions in the research literature on SSCM.

A number of key practices involved in the economic, environmental and social dimensions have been identified from a comprehensive review of the SCCM literature and are briefly outlined below. The literature sources for these practices are shown in the Appendix. Holistic SSCM incorporates all three dimensions of sustainability and supports these key practices that address social and environmental issues through better management of SCM operations.

2.1 Economic Dimension

The most traditional focus of SSCM has been on economic sustainability, which encompasses practices such as ensuring healthy cash flow, good profit margins and a proper return on investment (Ratan et al. 2010). Other practices may include business performance improvement (McCormack et al. 2008) and fine tuning of both internal and external management practices (Fabbe-Costes et al. 2011; Flint & Golicic 2009; Closs et al. 2011). Creating competitive advantage and value through cost, quality, speed and flexibility factors also add to bottom-line performance (Ketchen & Hult 2007). Attaran & Attaran (2007) discuss how collaboration, forecasting, and a focus on working smarter can contribute to economic sustainability. Others advocate the adoption of strategic SCM and quality improvements as a means to increased organisational performance (Yeung 2007). Increasing logistics performance as well as improving buyers' and suppliers' performance can also support economic sustainability (Wang & Lalwani, 2007; Paulraj, Lado & Chen, 2008; Cousins & Menguc, 2006), as can the practice of enhancing sales (Ratan et al. 2010).

2.2 Environmental Dimension

The literature on SSCM practices relating to the environmental dimension of sustainability has grown substantially over the past decade. Often termed green supply chain management (GCSM), Sarkis et al. (2010) define this environmental dimension of SSCM as integrating environmental concerns into the inter-organizational practices of SCM. Environmentally focused or GSCM can encompass supplier selection, supplier development, modal and carrier selection, vehicle routing, location decisions, or packaging choices (Carter & Easton 2011). A focus on environmental sustainability may also include inbound and outbound logistics activities such as packaging use and disposal, warehouse safety or

transportation issues such as emissions (Sarkis et al. 2011; Sarkis 2003; Closs et al. 2011; Ratan et al. 2010). Other operational issues might include energy use, the disposal of hazardous materials and after-sales service issues such as environment friendly disposal or reverse logistics (Ninlawan et al. 2010; Azevedo et al. 2011), and green purchasing or green procurement (Walker & Brammer 2009).

Recent literature on environmental aspects of SSCM can be seen to represent a fusion of economic and environmental SSCM thrusts (Rao & Holt 2005). This fusion implies an increased complexity as another layer of performance measures related to sustainability are added to supply chain and business performance issues (Sarkis et al. 2011). This increased complexity also implies the need for greater cooperation, collaboration and more of an interdisciplinary focus in SSCM (Dao et al. 2011; Tate et al. 2010). Additional complexity has also been reflected in logistics processes and managing the customer-supplier relationship (Simpson, Power and Samson, 2007).The confusion regarding terminology (SSCM versus GCSM, as well as other labels denoting 'green' activities within a supply chain) only adds to this complexity. In terms of measuring outcomes, the fusion of economic and environmental sustainability imperatives means a necessary trade-off in terms of balancing outcomes. The effects of green approaches to in SSCM on firm performance are at best ambiguous. Eltayeb et al. (2011) report that green initiatives in purchasing and reverse logistics were found to have little impact on firm performance; rather, they contributed to intangible outcomes. Testa & Iraldo (2011) advocate that a balance can be achieved between economic and environmental SSCM practices, but that cost-efficiency is a weak driver of environmental concerns, as some GCSM practices can be expensive. Despite the growth in literature relating to environmental approaches to SSCM, the area lacks rigorous research and investigation, and could also benefit from more appropriate theory development (Sarkis et al. 2011).

2.3   Social Dimension

The social dimension of SSCM includes community issues, corporate governance, diversity considerations, employee relations, human rights and safety (Sroufe & Drake 2009), as well as educational and ethical considerations (Closs et al. 2011). The social dimension of SSCM also includes supporting activities in the value chain such as technology development relevant to SSCM and procurement, such as purchasing from minority-owned suppliers or ensuring safe and humane working conditions in supplier plants (Carter & Rogers 2008; Awaysheh & Klassen 2010; Prasad & Tata 2010; Hall & Matos 2010). Ethical considerations could include the integrity of various business management practices, issues relating to employee relations and the manner in which community engagement might occur (Chabowski et al. 2011; Closs et al. 2011; Ratan et al. 2010; Sroufe and Drake 2009). Educational aspects of SSCM might address the nature of the employment relationship, as well as training and talent development issues (Closs et al. 2011). Product safety and social responsibility is a recurring theme, as are issues relating to diversity and human rights (Ratan et al. 2010; Sroufe & Drake 2009).

3   ROLES OF IS/IT IN SSCM PRACTICES

Upon reviewing SSCM concepts and practices, we now explain how the roles of IS/IT are played to support these practices. The importance of IS/IT in organisations and SCM is widely recognised. Without IS/IT, it is impractical to manage organisation and supply chain activities effectively and efficiently as supply chain participants are typically dispersed over a large geographical distance (Gunasekaran & Ngai 2004). IT enables supply chain members to share information to reduce uncertainty and variability, integrate various value-added business activities, and minimise non-value added activities (Simchi-Levi et al. 2011). Due to the importance of IT in supply chain management, several scholars (e.g. Dewett & Jones 2001; Browne & Zhang 1999) have discussed how IS/IT can play roles in support of SCM practices. However, it is not clear how those roles apply to the context of SSCM.

In this paper, we adopt the four roles of IT in SSCM proposed by Dao et al. (2010) which include: Automate, Informate, Transform and Infrastructure. These four roles are arguably comprehensive enough and embrace other possible roles that IT may play in organisations and supply chain management such as Communication, Coordination (Dewett & Jones 2001; Love 1996), Knowledge Codification and Management, Decision Making, Information Sharing (Dewett & Jones 2001), Transformation (Elliot 2011) and Integration (Browne & Zhang 1999). We suggest that the role of Automate is related to Integration and Operational, while the role of Informate embraces Communication, Coordination and Decision Making. Likewise the role of Infrastructure is related to Integration and Knowledge Codification and Management. These four roles of IS/IT, in turn, enable organisations to have information transparency within and across organisational boundaries, monitor and evaluate performance, be flexible and responsive, optimize resources, create added value, and achieve competitive advantage through the creative use of information and knowledge (Dewett & Jones 2001; Joshi 2010; Johnson et al. 2008; Elliot 2011).

We now synthesize and briefly discuss each SSCM practice and explain how the roles of IS/IT are played out in each practice. Table 1 shows a summary of what roles IT/IS play in each of the SSCM practice identified.

Dimension	Key Practice	IT Roles			
		Automate	Informate	Transform	Infrastructure
Economic					
	Analysing ROI and profit margin	Y	Y		Y
	Analysing cash flow	Y	Y		Y
	Achieving consumer satisfaction		Y		Y
	Creating repeat customers		Y		Y
	Enhancing sales		Y		Y
	Quality initiatives		Y		Y
	Creating competitive advantages		Y	Y	Y
Environmental					
	Eco-design of products	Y	Y	Y	Y
	Green purchasing	Y	Y	Y	Y
	Clean/Lean Production (Manufacturing)		Y	Y	Y
	Green Distribution/Logistics (Transportation)		Y	Y	
	Reverse Logistics (Waste Management)	Y	Y	Y	Y
Social					
	Community relations		Y	Y	Y
	Employee well-being		Y	Y	Y
	Human rights		Y		Y
	Work safety		Y		Y
	Ethical considerations		Y		Y
	Purchasing from minority-owned suppliers	Y	Y		Y
	Product safety		Y	Y	Y
	Education support		Y		Y

Table 1. Practices and the Roles of IS/IT

3.1   Economic Dimension

In this study, various practices on the economic dimension identified from the literature are summarised into seven main practices.

Analysing ROI and profit margin: This practice evaluates the financial consequences of business investments, decisions, or projects affecting various functional areas (including the supply chain) of organisations. ROI analysis compares the magnitude and timing of investment gains directly with the magnitude and timing of investment costs. Likewise, profit margin analysis assesses the economic performance of an organisation. It can also be used by management to benchmark itself with the performance of its competitors. To support analyses of ROI and profit margin, data is generally collected about costs, risks, and benefits from multiple sources (internal and external). IT systems are commonly used to extract relevant data from various organisational databases and external websites and databases. Once relevant information is collected, the actual tasks involved in calculating ROI and profit margins can be automated (Automate Role) using various types of ICT platforms (Infrastructure Role) and appropriate reports can be prepared for management to make timely decisions (Informate Role).

Analysing cash flow: It represents a crucial accounting activity that, when not adequately monitored, has the potential to disrupt business operations. Cash flow analysis is the study of the cycle of business' cash inflows and outflows, with the purpose of maintaining an adequate cash flow for the business, and to provide the basis for cash flow management. It involves examining the components of business that affect cash flow, such as accounts receivable, inventory, accounts payable, and credit terms. IT-based accounting systems are commonly deployed by organisations to analyse and monitor cash flow situation (Informate Role) based on various types of ICT platforms (Infrastructure Role).

Achieving customer satisfaction: For every organisation, pleasing customers has become something of a corporate obsession (Johnson et al. 2008). This is because customer satisfaction is often considered by management as a key to success. Hence, senior management is keen to regularly evaluate and monitor customer satisfaction for the products/services organisations offer. Web-based systems and CRM systems operating on a range of ICT platforms (Infrastructure Role) are generally used to contact customers, solicit their feedback, and analyse their satisfaction for management decision making (Informate Role).

Creating repeat customers: Creating and maintaining a community of repeat customers is a major business objective for all organisations. This is because a pool of repeat customers represents the largest generator of revenue of an organisation (Rainer & Cegielski 2009). According to some industry sources, repeat customers spend 33% more than new customers and that referrals among repeat customers are 107% greater than non-customers (Lake 2012). Repeat customers are created when their loyalty can be attracted by satisfying their expectations with regard to the products/services organisations sell. IT systems operating on a range of ICT platforms (Infrastructure Role) have been traditionally used by organisations to design loyalty programs in support of creating and maintaining repeat customers (Informate Role).

Enhancing sales: Business organisations pay considerable attention to enhance the sales of their products/services. One way to support this is through marketing initiatives. With the emergence of the Internet, web-based systems are used to promote products online. Often organisations rely on a range of ICT platforms (Infrastructure Role) and use social media technologies and integrate them with marketing systems to help management make timely decisions about promoting sales (Informate Role). Another popular IT application to support increased sales is the automation support given to sales force (Automation Role).

Quality initiatives: As the competition gets tougher, there is more pressure on organisations to initiate a range of quality programs (e.g. ISO9000 series, Six Sigma) to improve their internal business operations and quality of their products/services. This becomes an increasingly difficult challenge when there are fewer resources available (Senge 1990). IT systems operating on a range of ICT platforms (Infrastructure Role) can help organisations to monitor the performance of various quality programs, as well as to create employee awareness about the effectiveness of quality programs via B2E portals (Informate Role).

Creating competitive advantage: Economic sustainability of organisations is directly related to the ability of organisations to create value that is unique and not easily imitated by competitors (Ketchen & Hult 2007). Organisations can create competitive advantage through collaboration iniatives with trading partners and the creative use of various business related data and information that are captured by IT/IS applications (Infrastructure role) used within the organisation and across the supply chain (Dewett & Jones 2001; Joshi 2010; Johnson et al. 2008). The availability of information and the advanced IS/IT business intelligence applications can help organisations perform more accurate demand forecasting and make timely and informed decisions (Informate role) that can lead to creating competitive advantage. In some cases, IS/IT enables organisations to re-engineer their business processes (Transform Role) within organisations and across the supply chain such as the use of the Vendor Managed Inventory initiative coupled with the Evaluated Receipt Settlement initiative that simplify business processes of organisations (Simchi-Levi et al. 2011; Love 1996).

3.2   Environmental Dimension

Based on the literature review, we synthesized various practices/initiatives on the environmental dimension into five main practices as discussed below.

Eco Design of Products: One of the key practices within the environmental dimension of SSCM is the design and development of products that minimize the harmful environmental impacts of the entire product life cycle, including conception, production, packaging, distribution, use and waste. With this practice, products are designed in such a way that during the development and use of products, the use of hazardous materials are reduced or eliminated, products and the components/materials can be reused, recycled and remanufactured and the use of materials and energy can be reduced (Eltayeb et al. 2011; Sarkis 2003). This is a complex practice that requires collaboration among parties within the supply chain that is typically dispersed over a large geographical location including the raw material supplier, manufacturer, distributor, retailer and customer to share information and knowledge about the product design and the responsibility of each party involved to achieve the goals of the eco design. IS/IT plays an important role to provide the required infrastructure platform (Infrastructure Role) based on which effective communication (Informate Role) among the supply chain partners can be greatly facilitated. In addition, IS/IT facilitates the transformation of business processes involved in the entire product life cycle that minimize the undesirable environmental impacts (Transform Role).

Green Purchasing (Material sourcing and selection): This practice refers to purchasing activity that considers environmental impacts in addition to the traditional criteria of purchasing such as cost, quality, lead time and flexibility (Eltayeb et al. 2010). It includes purchasing materials that are not harmful to the environment and purchasing from suppliers that are compliant with international standards of managing the environment (ISO 14001) or other equivalent environmental standards, monitoring and auditing supplier compliance with environmental requirements (Hu & Hsu 2006; Ninlawan et al. 2010). This practice requires organisations to widen their market reach to find suitable suppliers. IT supports green purchasing practice by providing infrastructure (e.g. e-marketplaces) to interact with potential trading partners around the globe, change current business practices in dealing with trading partners and share information about suppliers' performance (Infrastructure, Informate and Tranform Roles). IT also helps organisations to monitor the compliance of suppliers efficiently and effectively through online questionnaires or multimedia (video/audio) exchange of information

regarding the environmental management system of suppliers. Furthermore, IT can facilitate collaboration between purchasing organisation and the suppliers by establishing mentoring and educational program that can then be implemented online or offline. This in turn highlights the Transform and Infomate roles of IT in supporting green purchasing practice.

Clean/Lean Production (Manufacturing): Clean manufacturing refers to the manufacturing process that uses renewable resources and energy efficiently to minimise harmful effects on the environment and to avoid further resource depletion (Rao & Holt 2005; Ninlawan et al. 2010). Various IT-enabled initiatives have assisted manufacturers to improve operation efficiency through automation initiatives (Automation Role). IT also empowers manufacturing organisations to be well informed (Informate Role) about other alternative resources and energies that are available and appropriate for their internal operations. Thus, IS/IT also facilitates business process transformation as it empowers organisations to practice clean/lean production (Transform Role).

Green Distribution/Logistics (Transportation): This practice is concerned with the distribution of products from the point of origin to the point of consumption efficiently by optimising the use of resources (Ninlawan et al. 2010, Rao & Holt 2005; Van Hoek 1999; Pauka 2009). This includes the efficient design of product packaging, redesign of distribution centres that minimise the use of electricity, water and storage spaces and management of transportation. Some initiatives include the concept of warehouse collaboration among different manufacturers, retailers and logistics providers to eliminate the redundancy in distribution process (Ninlawan et al. 2010). IT once again plays a role in providing infrastructure, facilitating information sharing and transforming business proceses of different parties in their effort to maximise warehouse and truck utilization. Thus, the infrastructure, informate and transform roles of IT can be observed in support of green distribution practice.

Reverse Logistics (Waste Management): Reverse logistics is part of waste management practice. It refers to the practice of returning products and parts of products that have been consumed from the point of consumption to the point of origin. The purpose is to reuse, recycle or remanufacture the used products or materials into other usable products and to ensure safe disposal of products to avoid further environmental deterioration (Eltayeb et al. 2011; Srivastava 2007; Ninlawan et al. 2010). IT can support this practice by providing infrastructure to inform and communicate with customers and trading partners in managing and encouraging the return of products or part of products. This in turn highlights how IT can play the roles of infrastructure and informate in waste management as well as transform the way organisations deal with used products.

3.3   Social Dimension

Based on the literature review, we identified eight key practices of the social dimension of SSCM which are discussed below.

Community relations: Many organisations would need to broaden their reporting mechanism to reflect community relations to the external and internal stakeholders. Initiatives to improve community relations include community surveys to assess public opinion on the company's social and environmental performance and participating in community advisory panels. For example, Dow Chemical has established such panels in most of the communities in which it has facilities. These panels provide a forum for addressing issues and opportunities affecting Dow and the community. Initiatives such as these offer valuable feedback to the company as it provides a clearer view of how its actions are perceived and how it can improve its community relations and its performance in areas of community concern (Epstein & Roy 2006). Social media based IT systems and various web-based applications can be used to solicit public opinions (Informate Role) and to engage with the broader community to gather community concerns about the operations of a business. Thus, appropriate e-commerce and social media-based IT infrastructural platforms (Infrastructure Role) should be in place

to enable business to improve the way they interact with the community and enhance community relations (Transform Role).

Employee well-being: Employees are the most important asset a business can have. Thus, safeguarding and promoting their well-being has strategic significance. Improving employee satisfaction and maintaining their morale is an important commitment towards employees' well-being. Such popular practices as flexible working practices, training, health, equity, office facilities, opportunities for career advancement, and empowerment, can help drive employee satisfaction (Labuschagnea et al. 2005). Employee satisfaction in turn drives customer growth and retention; and customer growth and retention drive profitability (Epstein & Roy 2006). A wide range of web-enabled IT systems such as portals (Infrastructure Role) could be developed to offer online training and readily available information (Informate Role) to empower them make appropriate decisions at the right time. In addition, IS/IT enables employees to carry out their tasks from home or other location (teleworking) as required and appropriate. This highlights the ability of IS/IT to transform the way work can be accomplished (Transform Role).

Human rights: One important task involved in ensuring sustainability is to review how their business strategy could have impacts on human rights issue for both employees and community members. For example, disciplinary and privacy practices as well as employee contracts are to be designed in compliance with the laws of the country, international human rights declaration as well as other human rights and fair employment practice standards (Labuschagnea et al. 2005). The gender and racial equity inside the company is also addressed within the umbrella of human rights as well as the legitimacy of labor sourcing practices (e.g. child labor). However, the notion of human rights within sustainability is not limited to addressing the rights of employees. It has a broader appeal. In fact, the full exercise of human rights requires a healthy environment (Vischer 2006). Nuclear and other toxic wastes, atmospheric pollution, climate change, massive deforestation, depletion of fish stocks and other forms of assault on earth threaten the survival and well-being of individuals and societies and sacred lands. Web-enabled HR IT systems can be developed that would support implementing a HR strategy by supporting employee recruitment, development, and firing process in compliance with human rights regulations (Infrastructure Role). IT systems can also be developed to collect information about the waste disposal processes followed by businesses (Informate Role).

Work safety: IT focuses on the health and safety of the workforce and evaluates preventive measures as well as the occurrence and handling of health and/or safety incidents (Labuschagnea et al. 2005). As organisations recognise that people they employ are the greatest asset, they would require adoption of occupational health and safety (OHS) as an integral practice to delivering their corporate values. Businesses are to be ready to provide a safe and healthy workplace, free of occupational injury and illness, for employees and others who might be affected by their operations. Awareness about work safety can be generated using innovated IT systems (Infrastructure Role). Complaints and concerns of employees about work safety can be captured through employee portals (Informate Role).

Ethical considerations: It could include the integrity of various business management practices, issues relating to employee relations and the manner in which community engagement might occur (Chabowski et al. 2011, Closs et al. 2011, Ratan et al. 2010, Sroufe & Drake, 2009). IT systems (Infrastructure Role) can be used to generate and distribute relevant reports (Informate Role) to the key stakeholders.

Purchasing from minority group: The social dimension of SSCM also includes supporting activities in the value chain such as purchasing from minority-owned suppliers (Carter & Rogers, 2008; Awaysheh & Klassen 2010; Prasad & Tata 2010; Hall and Matos 2010). Various types of IT systems operating on a range of IT platforms (Infrastructure Role) can be used to identify the minority group for helping management to decide the types of products their organizations can procure from the minority groups (Informate Role).

Product safety: Product safety is a recurring theme within sustainability literature (Ratan et al. 2010, Sroufe & Drake, 2009). It is argued that consumers have a right to get information about products' impacts on health and environment. Sometimes, consumers are concerned about the presence of particular chemicals in products. As such, businesses are required to work in partnership with other organisations, often assisted by various types of inter-organisational systems operating on a range of IT platforms with research organisations, industry partners, NGOs and regulators to strengthen consumer confidence in their products. Thus, IS/IT enables organisations to change their way they conduct business activities and interact with other parties in order to provide the required product information. This highlight the Infrastructure, Informate and Transform roles of IS/IT.

Education support: According to Closs et al. (2011), providing educational support to employees is an important sustainability initiative. It aims at ensuring managerial talent and labour workforce is properly developed and trained. Talent development includes a breadth of firm capabilities ensuring the development of management and a workforce having the necessary skills and breadth of experiences to sustainably guide and deliver the firm's products/services over time (Colbert & Kurucz 2007). Appropriate sustainability objectives should be embedded into the human capital recruitment process to ensure that employees have the "soft skills" in addition to the technical competency to sustainably meet the firm's management and labour requirements in the global geographies that the firm chooses to operate in (Colbert & Kurucz, 2007). Beyond the necessary employee skills and capabilities, talent development includes visible diversity and inclusion practices (Smith et al. 2001). A range of online technologies (Infrastructure Role) can be used to devise training and knowledge sharing programs by organisations to help develop knowledgeable work force (Informate Role).

4   DISCUSSION AND IMPLICATIONS

Adequate and appropriate applications of IS/IT are essential to help businesses implement SSCM practices. However, as SSCM represents a major shift in the ways businesses and their supply chain partners are expected to operate by addressing economic, environmental and social concerns, a systematic re-evaluation is necessary on the traditional roles played by IS/IT. Towards this goal, drawing upon a taxonomy proposed by Dao et al. (2011), we have highlighted how IS/IT can be conceived to play various roles in support of the key practices involved in SSCM initiatives. Our conceptual analysis suggests that 'Informate' and 'Infrastructure' are the most widely used roles that IS/IT is currently called upon to play in support of key SSCM practices on the three dimensions. In some cases, IS/IT also play an 'Automate' role in SSCM practices. Our study further shows that the 'Transform' role appears to play a more important role for practices along the environmental and social dimensions of SSCM compared to the economic dimension. However, this transformation role has not yet been quite explored in the literature. We argue that the slow uptake of SSCM practices is likely to be related to the need for organisations to change various business processes in order to address the environmental and social dimensions of SSCM. Future research attention is thus needed to examine how the 'Transform' role of IS/IT affects organisations's perception towards adopting SSCM practices and how IS/IT should be redesigned to help organisations develop the required capabilities and readiness to go through various business transformation to adopt the SSCM practices effectively. We envisage that as the transformation role of IS/IT is further leveraged, coupled with the other three roles (Automate, Information and Infrastructure), IS/IT would enable organisations to develop the capabilities that can facilitate the smooth adoption of SSCM practices.

Adopting SSCM practices is no doubt still challenging for many organisations around the globe as the adoption process is complex which involves multiple parties with diverse interests which operate within different legal frameworks. In order for IS/IT to play all four roles proposed by Dao et al. (2011) in support of key SSCM practices, there are a number of implications for senior management and IS/IT management alike that we would like to highlight. First, adopting SSCM practices by supply

chain members would require strong collaboration at both levels of management (executive and IS/IT), and a change in the collective mindset of both levels of management across supply chain members is urgently needed. Without this, organisations would be reluctant to undertake various transformations needed for SSCM practices particularly those related to environmental and social dimensions. Second, as today's supply chain members are globally dispersed across different geographical and socioeconomic boundaries, they may exhibit varying degrees of appreciation and commitment towards SSCM concerns and practices. Some members may have reluctance to participate in redesigning and aligning their IS/IT systems and capability with those of their business partners. Therefore, initiatives should be undertaken by dominant supply chain partners to encourage less willing partners to participate in redesigning their supply chain oriented systems and procedures to help the entire supply chain comply with SSCM obligations. If necessary, the dominant business partners would need to invest large sums of financial and intellectual capital through sponsoring workshops, training, seminars, etc. Third, influential businesses should join the global effort to harmonize the legal requirements across those nations in which their key supply chain members operate. This may in turn encourage successful appreciation of the relevant IT roles which are needed to better support SSCM practices by all the members of the supply chain.

5   CONCLUSION

There is a growing recognition in the business community of the significance of implementing SSCM practices. Despite this, limited understanding currently exists among senior corporate executives and IS/IT management about what SSCM really entails. In particular, scant literature is available on what roles should be played by IS/IT in supporting SSCM practices. In this paper, we have provided an outline clarifying the current understandings of SSCM practices, the roles IS/IT could possibly play to support SSCM practices and what still needs to be done by presenting several implications for both business executives and IS/IT professionals. We believe that SSCM presents a serious challenge to the IS/IT community for leveraging the transformative role of IS/IT, which is indicated in our study to be more significant as the environmental and social dimensions of SSCM are considered.

We acknowledge that our study has limitations since it is based on a literature review analysis and our understanding of how the four different roles of IS/IT are played out in various SSCM practices. Future studies that involve case studies or focus groups involving supply chain practitioners from various industry sectors to further examine how these roles are played out would be required to broaden our study findings. Nevertheless, we believe that this study still makes a basic contribution to the SSCM literature by providing some useful understanding and awareness for both academics and practitioners regarding the importance of IS/IT for the SSCM context.

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Appendix
Sustainable Supply Chain Management Practices and the Literature Sources

Domain	Key Practices	Citations
Economic	• Analysing ROI and profit margin • Analysing cash flow • Achieving consumer satisfaction • Creating repeat customers • Enhancing sales • Quality initiatives • Creating competitive advantages	Closs et al, 2011; Fabbe-Costes et al, 2011; Teuteberg and Wittstruck, 2010; Ratan et al 2010; Flint and Golicic, 2009; Carter and Rogers, 2008; Markeley and Davis, 2008; Yeung, 2008; Palraj et al, 2008; Attaran and Attaran, 2007; Wang and Lalwani, 2007; Cousins and Menguc, 2006; Amato-McCoy, 2006; Chan et al, 2006; Ketchen and Hult , 2006
Environmental	• Eco-design of products • Green purchasing • Clean/Lean Production (Manufacturing) • Green Distribution/Logistics (Transportation) • Reverse Logistics (Waste Management)	Eltayab et al, 2011; Azevedo et al, 2011; Kuik et al, 2011; Dey et al, 2011; Mollenkopf et al, 2010; Nunes and Bennett, 2010; Sarkis et al, 2011; Testa and Iraldo, 2010; Wooi and Zailani, 2010; Ninlawan et al, 2010; Zhu et al, 2007, 2008 McCormack et al, 2008; Simpson, Power and Samson, 2007; Walker et al, 2008; Srivastava, 2007; Simpson et al, 2007; Orsato, 2006; Zhu and Sarkis,2006; Rao and Holt, 2005; Sarkis, 2003;
Social	• Community relations • Employee well-being • Human rights • Work safety • Ethical considerations • Purchasing from minority-owned suppliers • Product safety • Education support	Awaysheh and Klassen, 2011; Chabowski et al, 2011; Closs et al, 2011; Ratan et al 2010; Prasad and Tata, 2010; Hall and Matos, 2010; Robert et al, 2009