AN INTEGRATIVE MODEL OF GREEN SUPPLY CHAIN MANAGEMENT: THE ROLE OF INTERORGANIZATIONAL INFORMATION SYSTEM

Xiyue Deng, University of Toledo
Yuan Wang, University of Houston Victoria

Abstract

Sustainable development has attracted interest from a broad range of academic disciplines as well as the practical world since Brundtland introduced the notion. Firms have started to rely on interorganizational information systems and strategic green supply chain collaboration to incorporate sustainability considerations into the current business structure since any of the achievements in sustainability could easily be brought to naught because of any member's poor sustainable operations and management in the supply chain. This article is aiming at exploring the role of interorganizational information system among green supply chain strategy, supply chain collaboration practices, and sustainable performance. Additionally, it is vital to notice that large firms and small firms might react differently for the pressure of pursuing sustainability, the article discuss and analyze the function of firm size in the green supply chain management by identifying four types of sustainability seeker from dynamic perspective of sustainability.

Keywords: *Green Supply Chain Management Collaboration, Sustainability, Interorganizational Information System, Firm Size.*

INTRODUCTION

Since sustainable development was defined and introduced by the Brundtland Commission in 1987 (WCED, 1987), the pressure for pursuing sustainability, both internal and external, has dramatically increased. Governmental agencies, society, supply chain members, internal employees, and managerial stakeholders are all increasingly demanding sustainable products globally.

The achievement of sustainability requires not only the organization's internal collaboration and coordination but also the sustainable operation of its extended supply chain (Miemczyk & Johnsen, 2012). The focal firms enjoy increased

sustainable performance thanks to the supporting from supply chain members (Lacoste, 2015). During sustainable development, supply chain members play an important role, such as supply green resources/materials, provide information about customer needs, and share their green knowledge. These collaborative and coordinative activities between supply chain members and focal firms will help firms implement operations with an eye not only on economic performance but also on social performance and environmental performance (Mangla et al., 2013; Lacoste, 2015).

Despite the importance of green supply chain management (GSCM) strategy and supply chain collaboration, the achieved high sustainable performance by focal firms can be brought to naught because of other supply chain member's poor sustainable operations and management due to the risks and uncertainties in the global supply chain management (Faruk A. C., 2002). Environmental uncertainty, cultural complexity, and informational asymmetry might all trigger the potential deviations from the initial "global" objective, which in turn causes the diminution of value-added activities at different levels (Kumar et al., 2010). Therefore, the effect of GSCM and supply chain collaboration on sustainable development remain equivocal and underexamined.

Starting from the 1960s, the utilization of information systems has increased steadily by offering robust and comprehensive solutions (McConahy & Dutt, 2016). IT managers, supply chain managers, and C-level managers started to standardize the information sharing process and migrating a business problem into the actual implementation of a software solution. There are B2B trading systems (private or many-to-many public exchanges), B2B support systems (hubs, directories, and other services), electronic fund transfer, groupware, integrated messaging systems, shared databases, and so on (Lee, 2013).

Toyota has developed the Kanban system to sustain lean operation and JIT concepts, which improve process throughput and eliminates waste, and in turn, enrich both environmental and economic performance (Fliedner & DeHondt, 2015). Infosys and R3 Patterners bring blockchain solutions to secure information transportation to achieve a sustainable competitive advantage (Infosys, 2018). To enhance socially responsible investing, electronic financial networks frameworks, and electronic ethical problems have been implemented by companies (Chuang, 2016; Ke et al., 2016).

Recently, both practitioners and researchers have claimed the importance of information systems which can be a key enabler, supporting individuals, organizations, governments, and society to make transformation towards environmentally sustainable practice (Loeser et al., 2017). Additionally, information technology is commonly acknowledged to be an important success factor for information sharing among supply chain members (Cho et al., 2017). Current literature has focused on the role of interorganizational systems in green

supply chain management. For instance, Dedrick et al. (2008) have indicated that an interorganizational information system (IOS) can shape the strategy of the green supply chain. Additionally, the researchers have also found the influence of IOS in green supply chain management in terms of reducing transaction costs and information asymmetry (Kumar & van Dissel, 1996; Kim et al., 2011).

It is clear that interorganizational information systems can sustain sustainable performance and leverage the effect of GSCM strategy and supply chain collaboration; however, few firms have the ability to completely exploit the supply chain partners' information resources (Simatupang et al., 2004). Additionally, the researchers have indicated the great inequality between the potential and actual practice of IOS (Mentzer et al., 2000). No research has been done to examine the overall effect of IOS in the integrative green supply chain management process. Therefore, this study aims to investigate how IOS influences the relationship among GSCM strategy, supply chain collaboration, and sustainable development outcomes.

LITERATURE REVIEW

Sustainability

Sustainable development was first introduced and defined by Brundtland in the World Commission on Environment and Development, which refers to the ability of present generations to fulfill their needs without compromising the ability of future generations to meet their own needs (WCED, 1987). Driven by current legislation, social interest, and competitive capability, operations management academics and managers are challenged by the issues of integrating sustainability with their traditional areas of interest (reducing cost and gaining market performance).

The definition of sustainable development has been evolved into various dimensions from political, institutional, individual, and some other perspectives. In this paper, we investigate sustainable development in the business context by considering organization development of environmental sustainability, economic sustainability, and social sustainability with equal attention to sustain and improve business performance (Elkington, 1998). Economic sustainability performance is measured in terms of project speed, project cost, and market performance. Shrivastava (1995) claims that environmental sustainability performance is inferring the potential of reducing long-term risks associated with energy costs fluctuation, resource depletion, product pollution, and waste and recycle management (Shrivastava, 1995). And social sustainability performance refers to the relationship measurement of business among its different stakeholder groups—communities, employees, suppliers, etc. (Ranganathan, 1998). Thus, in this study, we investigate these three aspects of sustainability as the outcomes and performances of sustainable business development.

Green Supply Chain Management Strategy

The supply chain considers the product from the initial processing of raw materials to delivery to the end customer, the emphasis on the entire supply chain is a step towards the broader adoption and development of sustainability (Linton et al., 2007). One of the most challenging aspects of developing sustainability is the boundary of responsibility often beyond the corporation's ownership and direct control (Gimenez & Tachizawa, 2012). The managers should adopt proper green supply chain management (GSCM) strategies to improve sustainable performance.

GSCM, in a broader sense, has been defined as the management of minimizing life cycle impacts of products and services by integrating green design, resource usage, allocation, and dispose to decrease environmental damage, and the management process throughout the internal and external environmental perspectives that involves supplier, customer, and reverse logistics (Zhu & Sarkis, 2004). Some scholars have focused on environmental considerations in a more wholesome perspective, which involve green strategies into supply chain management to create, deliver, and capture values across the information flow, product flow, and monetary flow (Zhu & Sarkis, 2007; Sarkis et al., 2011). GSCM strategies vary in different levels of analysis, such as organizational level, supply chain level, industrial and global industrial network levels (Tachizawa & Wong, 2014, Ageron et al., 2012). Eco-Design, green sourcing, investment recovery, customer cooperation, etc. have been discussed in the previous works of literature as the specific strategies of implementing GSCM, which is extensively investigated but lack of guideline feature of generalizability.

Henriques & Sadorsky (1999), the researchers have classified the green strategy into four groups in terms of managerial perceptions of environmental commitment: reactive strategy, defensive strategy, accommodative strategy, and proactive strategy. Similarly, Murillo-Luna et al. (2008) have proposed four different types of environmental response perspectives, namely passive response, attention to legislation response, attention to stakeholder's response, and total environmental quality response. The boundary of reactive strategy and defensive strategy discussed by Henriques & Sadorsky (1999) is not clear in the context of GSCM. For example, satisfy environmental regulation as one of the defensive strategy characteristics shares features of reactive strategy because companies develop their strategies by reacting to what the relations require. Even though there have been different classification regarding the corporate's environmental/green strategy, they have been fallen into the same scheme, that there is a continuous measure from the most passive strategies to the most proactive ones (Murillo-Luna et al., 2011). Based on this scheme, this study has classified green supply chain management strategies into two groups: Reactive Strategies and Proactive Strategies.

Companies with reactive green supply chain management strategies have concerns about the cost of failure or have limited resources, so they focus on the end of pipe methods, such as acquiring, storing, or treating emissions (Dixon-Rowler, et al., 2013). Driven by the compliance, legislation, as well as other pro-environmental pressures, the companies follow incremental changes and respond to "green pressures" by adjusting current practices "as needed." Companies with proactive strategies view the aspects of GSCM as the company's competitive advantage. The GSCM strategy has been incorporating into the corporate entire business strategy beyond the requirements of government regulation. Proactive strategies focus on preventing environmental issues by solving the problems from original sources, such as material substitution, redesign of production, innovative process development, and service delivery processes development (Dixon-Rowler et al., 2013).

Supply Chain Collaboration

Supply chain collaboration (SCC) is the partnership process that involves multiple independent parties work together to mastermind and execute supply chain operations to solve shared concerns and fulfill mutual benefits (Cao & Zhang, 2011). Supply chain management (SCM) is a set of processes involved to effectively coordinate focal firm with its suppliers even second, third-tier suppliers, and customer to transform the information flow and product flow among the network of organizations (Lamber & Enz, 2017; Chopra and Meindl, 2001 & 2016; Archer et al., 2006). SCM is complex with involving different levels of stakeholders and numerous activities, which normally across multiple functions, processes, and organizations, even over long time horizons (Kanda & Deshmukh, 2008).

Successful supply chain management requires the collaboration of all value chain members to create cooperative environments to foster information exchanges, process interactions, and cash flows (Kukalis, 1989; Hong and Joeng, 2006). The scope of SCC can categorize as a collaboration with customers, cross-function within the company, suppliers, competitors, and non-competitor organizations. (Barratt 2004, Simatupang & Sridharan, 2002). The coordination and collaboration overspread the operations processes within a firm embrace the intra-organizational activities, meanwhile inter-organizational activities consist of the activities throughout the entire value chain from suppliers to customers.

Thus, we conceptualize supply chain collaboration into two dimensions, which consist of inter-organization activities and intra-organizational activities. Inter-organizational activities incorporate boundary spanning characteristics, such as product scheduling, supply planning, shared distribution, demand replenishment, etc. between suppliers and customers. Intra-organizational activities consist of internal process integration and cross-functional coordination (e.g., purchasing, manufacturing, marketing, logistics process collaboration). Furthermore,

collaboration is not merely about developing a closer relationship between value chain entities; it requires to be implemented at the tactical, strategic, and operational level of collaboration (Gimenez & Tachizawa, 2012; Gimenez & Sierra, 2013; Tachizawa & Wong, 2014; Narayanan et al., 2015).

Interorganizational Information System

Interorganizational information systems are technology-based systems that used to communicate and share the information which transcends legitimate enterprise boundaries (Kumar & van Dissel, 1996). Current literature has found equivocal results about the impact of IOS in supply chain management. On one side, researchers view IOS as the infrastructure which facilitates information sharing (Kim et al., 2011) as well as important success factors in enhancing supply chain visibility and collaboration (Grover & Saeed, 2007). However, on the other side, some researchers also found the positive effect of IOS on supply chain performance was not statistically significant or even negative.

Considering the potential opportunistic behavior by any one or more supply chain members in the collaboration, including but not limited to internal employees, suppliers, customers, and competitors, the initial supply chain collaboration can be subjected to the risk of potential conflict (Kumar & van Dissel, 1996; Webster, 1995). Besides the nature of collaboration, IOS could be the possible source of the dangers of conflict as well. Starting from 1971, Stern and Craig provided a warning that the usage of "interorganizational data systems" might lead to the shifting of power in the current industry and supply chain, which creates new winners and losers (Stern & Craig, 1971). More recently, Kumar & van Dissel (1996) summarized the danger of domination caused by the initiating member of IOS. Other than that, Kim et al. (2011) emphasized the existing of asymmetry in IOS and the imbalance of power in information sharing, as well as its influence on supply chain performance.

With the consideration of sustainable effects of all aspects of the supply chain from the extraction of raw materials to the final distribution of goods/services, green supply chain players are urging in terms of motivating focal firms and other supply chain members to go green. Customer requirements about sustainability, expectation and specification clarification, support, and guidance from both buyer and supplier all required additional information sharing. Kumar & van Dissel (1996) also provided initial insight about IOS in sustainable collaboration by identifying the risk and risk management strategy of IOS in the supply chain. Loss of resource control, data contamination, and information stealing all act as risk factors of IOS in green supply chain management. However, with the understanding of the potential risk and conflict of IOS in sustainable collaboration, we are still lacking an overall image of how IOS influences the overall green supply chain management. The following section discusses the overall integrative

green supply chain management and develops the propositions about IOS on this integrative model.

THEORETICAL DEVELOPMENT

Integrative Model of GSCM

Since Brundtland introduced the notion of sustainable development, organizations have been called to figure out ways to create a new era of economic growth that considers both environmental and social influences. Since then, the pressure for developing a sustainable product, both internal and external, has dramatically increased. In order to meet strict environmental regulations, improve organizational reputation, satisfy customer demand, and encourage cooperation along with the supply chain, an increasing number of organizations already claimed to pursue sustainability.

Based on the previous discussion, firms might pursue sustainability reactively or proactively. For reactive corporations, managers follow incremental changes and only perform "as needed" practices to "green" pressures. In this case, the middle managers will tend to averse environmental improvements and are less able to get support from the top management or may facing other internal and external obstacles (Heyes & Brust, 2016). On the other hand, corporations input a large number of resources in the development of proactive strategies, such as R&D, green product development, waste minimization, recycling/reusing, remanufacturing, energy reduction, as well as continuous improvement.

Proposition 1: Green supply chain management strategy shapes sustainable performance.

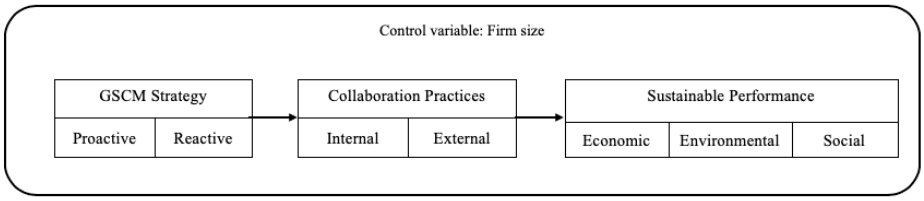
SCC has been viewing as a strategic consideration for companies that aim to achieve their economic, social, and environmental sustainability targets. The studies on SCM spotlight the importance of inter-collaboration and intra-collaboration. Soylu et al. (2006) investigate that supply chain collaboration is an effective way for companies to share information and make strategic alliances to improve performance throughout the supply chain. The integration of internal interfaces among various business functions, such as marketing, purchasing, manufacturing, logistics, is dramatically helping business to overcome functional myopia, and foster internal integration to fulfill effective performance outcomes (Barratt, 2004). Through supply chain collaboration, companies should able to explicitly identify external and internal concerns to become more environmental and socially responsible while retaining their responsibility toward economic sustainability (Chen et al., 2017).

Proposition 2: Collaboration practices positively influence sustainable performances .

Other than the direct relationship between GSCM strategy and sustainable performance, all of the above activities require creative problem solving, innovative technologies adoption, as well as collaborations with stakeholders. The collaborations include not only the intra-organization collaborations but also the inter-organization collaborations. With proactive strategies, the organization needs to simplify and remove the unnecessary steps in the production, utilize environmental raw materials, which need supports from the top management. Activities such as recycling, reusing, and remanufacturing, requires intra-collaboration among different department of the organization, including but not limited to marketing, operation management, R&D, and supply chain management. More importantly, the benefit of proactive strategies can be brought to naught very easily if other members in the supply chain have poor sustainable operations and management (Faruk, 2002), so inter-firm collaboration is as important as a collaboration with internal stakeholders.

Proposition 3: Collaboration practice mediate the relationship between GSCM strategy and sustainable performances.

FIGURE 1
Theoretical Model



Based on the above discussion, we have summarized an integrative model of GSCM shown in Figure 1 above.

Role of IOS

Early work by Johnston & Vitale (1988) suggests that IOS provides different information functions, and IOSs can be categorized accordingly. The simplest IOS deals only with the boundary transactions, such as order-entry systems from accepting order to confirm order. Other than executing boundary transactions, some IOSs allow members to retrieve and analyze data. For instance, the tracking system allows buyers to track their goods as well as to measure the supplier's reliability. More complicated IOSs give members the capability to enter, store, and manipulate information, which was not acceptable to some members. Adapted from Johnston & Vitale (1988), in this article, the IOS has been measured as a continuum to the extent of IOS being implemented and integrated across the operations of supply chain members.

Researchers often link IOS to supply chain management using transaction cost economics (TCE) (Williamson, 1979). Some general consensus has been developed in TCE, that opportunism is the central concept in transaction costs literature, and an efficient information process is an important and related concept. Therefore, TCE has been used as the fundamental theory in this section.

TCE states that firms face the risk of opportunism when they are in the situation of working with external organizations, especially when asset specificity is required (Williamson, 1979). It is generally expected that having internal and/or standardized transactions reduces such risk of opportunism since focal firms depend on other supply chain members less. In this situation, a more mature and integrated interorganizational information system can provide a standardized information-sharing platform. For firms pursuing sustainability proactively, the required changes are less standardized and less incremental, but more radical and more customized. In this case, an effective and integrative IOS can lower the transaction costs of pursuing a proactive green supply chain strategy. Therefore, we propose,

Proposition 4: Interorganizational Information System shapes GSCM strategy.

On the one hand, with the development and implementation of IOS, the suppliers and buyers logically develop a deep understanding of each other's business, in terms of customer expectation, government requirement, design functionality, and specification. This mutual understanding is the fundamental of supply chain collaboration.

On the other hand, it is clear that there are challenges in managing supplier collaboration, and the most serious one is behavior uncertainty and supplier opportunism, which is consistent with literature findings related to TCE (Williamson, 1985; Williamson, 1979; Huang et al., 2014; Stump & Heide, 1996). The short-term strategy and gain taking mentality might result in the opportunistic behavior of supply chain members, such as internal employees, suppliers, customers, and competitors. Therefore, the initial intentions of collaboration are subjected to the risk of potential opportunism behavior and conflict. Many times, a firm benefit from their SC members' information sharing less than expected, another reason is the information asymmetry, which refers to the situation that one party in a transaction has more or better access to the information other than the other party (Cho et al., 2017). For instance, a supplier might hold private information about the product inspection result that the buyer doesn't have access to. However, with a mature and integrated IOS using industrywide technology platforms and data standards, each member needs to access the information regarding other member's situations. Therefore, with greater information transparency along the supply chain, the IOS monitor the supply chain member's

performance and detect possible opportunism. Based on the above analysis, we propose,

Proposition 5: Interorganizational Information System support collaboration practice.

The buyer-supplier relationship moves from periphery activities to core competencies with sustainable development; the collaborative relationship becomes more significant. As stated earlier, the proactive GSCM strategies, including minimizing environmental program risks, utilizing resources effectively, reducing waste, as well as investing innovative competences (Malviya et al., 2018), all require creative problem solving, innovative technologies adoption, as well as collaborations with stakeholders.

As a result, it becomes more complicated and costly to displace a partner. Information technology has been proved to be essential in terms of supporting strategic as well as operational supply chain decisions (Paulraj & Chen, 2007). And IOS provides simultaneous information sharing, which replaces the sequential and linear chain of information exchange. The effective and seamless information flow meets the requirement of supply chain collaboration under proactive green supply chain commitment. Without an effective and standardized IOS, the level of joint working required by proactive strategy could not be achieved. Therefore, we proposed,

Proposition 6: Interorganizational Information System positively leverage the positive influence of GSCM strategy on collaboration practice.

A summarized framework about the propositions has been provided in Figure 2.

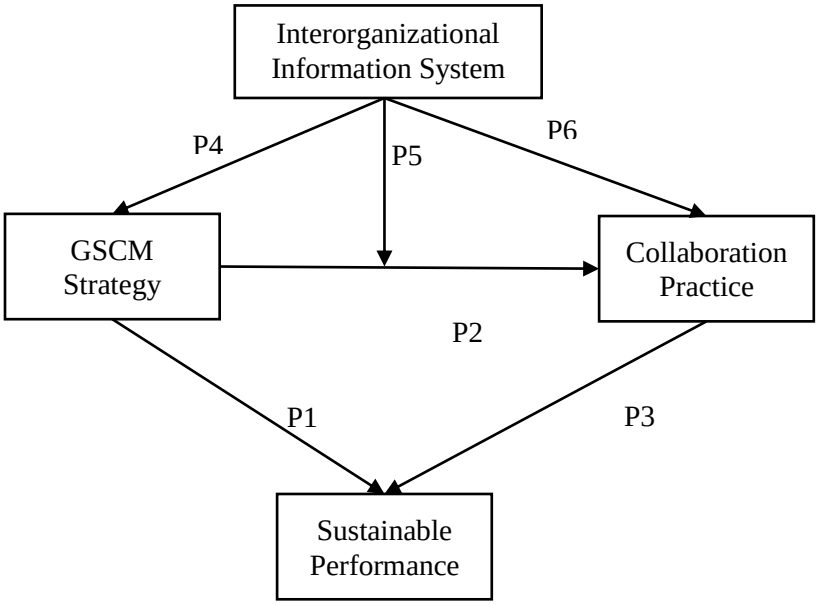
CONCLUSION AND FUTURE RESEARCH PLAN

Overall speaking, this research found the importance of GSCM strategy and supply chain collaboration in sustainability, as well as the role of interorganizational information systems in the green supply chain management process. Organizations are facing the pressure of dealing with sustainability issues more proactively. Green supply chain management in sustainable development generates competitive advantage not only in terms of sharing customer needs/environmental regulation, providing "green" knowledge and material, jointly working in order to introduce sustainable attributes into the overall business process. But also, the opportunism behavior or poor sustainable operations and management of other supply chain members can easily destroy the success of the sustainable performance of the focal firm.

In this GSCM process, IOS shapes the GSCM strategy. The standardization provided by IOS provides the infrastructure of a proactive GSCM strategy.

Additionally, IOS monitors the potential opportunism of supply chain members and provides information transparency, which lowers the transaction cost and in turn support the supply chain collaboration. Finally, IOS delivers effective and seamless information flow to meet the requirement of supply chain collaboration under proactive green supply chain commitment. The level of joint working and problem solving required by specific and customized proactive strategy would not be achieved without an effective and standardized IOS.

FIGURE 2
Conceptual Rationale



The above results and conclusion contribute in theoretical perspective in terms of theory development to related literature on sustainable development, green supply chain management, interorganizational information system, and the interface of supply chain management and information technology management. From the managerial perspective, this study shows that when pursuing sustainable development, the orientation of the GSCM strategy should "fit" the organization's entire business strategy and infrastructural information system. Additionally, the managers should build, implement, or maintain the effectiveness of IOS in trying to support supply chain collaboration and achieve a sufficient level of collaboration required by GSCM strategy.

While generating theoretical and practical contributions, this study is also subjected to some limitations, as is the case to all researches. As a conceptual paper,

no empirical data has been collected to test the propositions. Future research can collect case or survey data to test the supportiveness of the propositions.

Future Study: Case Study to Identify the Role of Firm Size

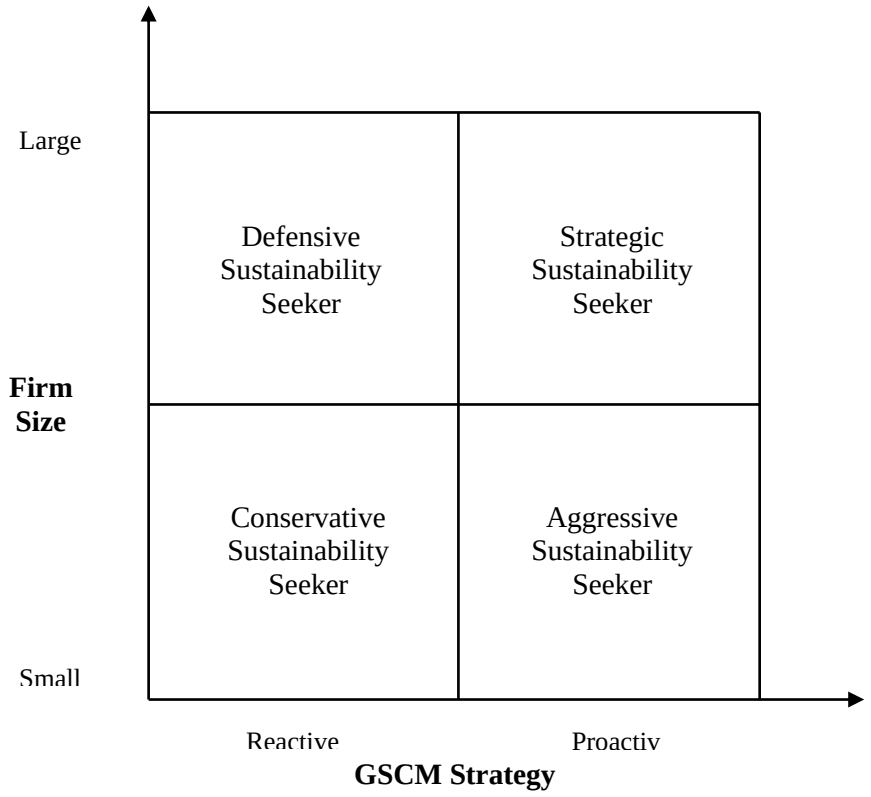
Due to resource availability and limitation, firms face a different level of sustainable pressure, have a different level of capability and resources to pursue sustainability, and develop/implement/maintain interorganizational information systems. Both sustainability development and information system development or implementation are a big investment for firms, it is important the manager understanding the position of their own company before making such investment. Multi-case studies could be conducted to identify the role of firm size in the framework of green supply chain strategy and interorganizational information system.

According to the SBA Office of Advocacy (2018), there were 30.2 million small and medium-sized businesses in the U.S., which comprise 99.9% of US business. Researchers have pointed out there are strategic differences between large enterprises and SMEs provoking the discussion of whether SEMs benefit more or less than large enterprises from the corporate reputation seeking process. Firm size can be measured by the number of employees. Firms with less than 250of employees consider as a small firm, greater than 250 are large firms.

From a resources perspective, a large firm may have more resources and capabilities than small firms allowing for advantages associated with greater scale investment in technology and brand prominence (Mahoney and Pandian, 1991), while a small firm may not have surplus resources to support extra sustainability seeking activities. On the other hand, it is possible that small firms are not burdened by public pressures of being green and seizing more flexibilities in making efforts to respond to environmental, social and economic challenges (Dixon-Fowler et al., 2013), in turn, might gain better sustainable performance by implementing the same level of GSCM strategies than the large firm.

Based on the two GSCM strategies (proactive & reaction) and firm size (large and small), we propose a typology of four sustainability seekers (Figure 3). Due to the complexity of supply chain management and sustainability, we incorporate the risk management concept of the typology building. If small firms orientated by GSCM reactive strategy, then such sustainable seekers are more conservative, may only target as being known of generalized visibility. Those firms usually start-up and low-profit margin companies aim to gradually expand their business and reputation. In this sense, we will refer to these companies as “conservative sustainability seekers”. Conservative sustainable seekers usually face less level of pressure in pursuing sustainability as well as adopting interorganizational information systems. At the same time, these companies do not have enough resources for doing so.

FIGURE 3
Sustainability Seekers



Future Study: Survey Study to Test Propositions

As future research, a large-scale quantitative survey could be employed to collect data, and the structured equation modeling (SEM) technique will be used to test the propositions empirically. An ANOVA test will be used to generate the typology of a sustainable seeker based on GSCM strategy and firm size. This study aims to seek the participation of supply chain managers, corporate sustainability managers, and information system managers from the US engineering-oriented manufacturing firms.

In future research, a total of 4 main constructs: green supply chain management strategy, supply chain collaboration practices, interorganizational information systems, as well as sustainable performance, will be measured. An initial list of measurement instruments is provided in Appendix A. To evaluate the appearance of the questionnaire in terms of clarity, layout, and style; face validation will be conducted. Feedback about instruments, length, format, and completion time will

be gained from a small sample of practitioners and/or academics. To further examine the feasibility of developed instruments and research approaches that are intended to be used in the larger scale study later, a pilot study will be conducted (Leon et al., 2011).

REFERENCES

Archer, N. P., Hong, P., & Jeong, J. (2006). Supply chain management practices of SMEs: from a business growth perspective. *Jouranl of Enterprise Information Management, 19(30*, 292-302.

Ageron, B., Gunaekaran, A., & Spalazani, A. (2012). Sustainable supply management: An empirical study. *International Journal of Production Economics, 140(1)*, 168-182.

Barratt, M. (2004). Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: An International Journal, 9(1)*, 30-42.

Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management, 29(3)*, 163-180.

Chen, L., Xiande, Z., Tang, O., Price, L., Zhang, S., & Zhu, W. (2017). Supply chain collaboration for sustainability: A literature review and future research agenda. *International Journal of Production Economics, 194*, 73-87.

Cho, B., Ryoo, S. Y., & Kim, K. K. (2017). Interorganizational dependence, inforamtion transparency in interorganizational information system, and supply chain performance. *European Journal of Information Systems (26)*, 185-205.

Chopra, P., & Meindl, S. (2016). Supply Chain Management: Strategy, Planning and Operation. *Tsinghua University Press*.

Chopra, S., & Meindl, P. (2001). *Supply chain management: Strategy, planning, and operation, 2nd ed.* Englewood Cliffs. NJ: Pretice-Hall.

Chuang, M. Y. (2016). Electronic ethical leadership: A preliminary research framework. *American Journal of Information Technology, 6 (1)*, 17-34.

Das, D. (2017). Development and validation of a scale for measuring sustainable supply chain management practices and performance. *Journal of Clearner Production, 164*, 1344-1362.

Dedrick, J., Xu, S. X., & Zhu, K. X. (2008). How does information technology shape supply chain structure? Evidence on the number of suppliers. *Journal of Management Information Systems, 25 (2)*, 41-72.

Dixon-Fowler, H. R., Slater, D. J., Johnson, J. L., Ellstrand, A. E., & Romi, A. M. (2013). Beyond " Does it pay to be green?" A meta-analysis of moderators of the CEP-CFP relationship. *Journal of Business Ethics, 112*, 353-366.

Elkington, J. (1998). *Cannibals with Forks: The Triple Bottom Line of 21 st Century Business.* Gabriola Island BC, Canada and Stony Creek, CT: New Society Publishers.

Faruk, A. C. (2002). Analyzing, mapping, and managing environmental impacts along supply chains. *Journal of Industrial Ecology, 5(2)*, 13-36.

Fliedner, G., & DeHondt, G. (2015). Lean pproductivity enhancements and waste elimination through emerging technology. *American Journal of Information Technology, 5 (1 & 2)*, 24-38.

Gimenez, C., & Sierra, V. (2013). Sustainable supply chains: Governance mechanisms to green suppliers. *Journal of Business Ethics, 116 (1)*, 189-203.

Gimenez, C., & Tachizawa, E. M. (2012). Extending sustainability to suppliers: A systematic literature review. *Supply Chain Management: An International Journal, 17(5)*, 531-543. doi: 10.1108/13598541211258591.

Grover, V., & Saeed, K. A. (2007). The impact of product, market, and relationship characteristics on interorganizational system integration in manufacturer-supplier dyads. *Journal of Management Information Systems, 23 (4)*, 185-216.

Henriques, I., & Sadorsky, P. (1999). The relationship between environmental commitment and managerial perceptions of stakeholder importance. *Academy of Management Journal, 42 (1)*, 87-99.

Heyes, C. L., & Brust, D. A. (2016). Environmental protection in environmentally reactive firms: Lessons from corporate argentina. *Journal of Business Ethics, 135*, 361-379.

Hong, P., & Jeong, J. (2006). Supply chain management practices of SMEs: from a business growth perspective. *Journal of Enterprise Information Management, 19 (3)*, 292-302.

Huang, M.-C., Cheng, H.-L., & Tseng, C.-Y. (2014). Reexamining the direct and interactive effects of governance mechanisms upon buyer-supplier cooperative performance. *Industrial Marketing Management, 43*, 704-716. doi:10.1016/j.indmarman.2014.02.001.

Infosys. (2018, October 24). *Infosys Finacle and R3 Partner to bring blockchain solutions on Corda for banks*. Retrieved from Cision PR Newswire: https://www.prnewswire.com/news-releases/infosys-finacle-and-r3-partner-to-bring-blockchain-solutions-on-corda-for-banks-800718955.html

Johnston, H. R., & Vitale, M. R. (1988). Creating competitive advantage with interorganizational information system. *MIS Quarterly, June*, 153-165.

Kanda, A., & Deshmukh, S. (2008). Supply chain coordination: Perspectives, empirical studies and research directions. *International Journal of Production Economics, 115 (2)*, 316-335.

Kanzancoglu, Y., Kazancoglu, I., & Sagnak, M. (2018). A new holistic conceptual framework for green supply chain management performance assessment based on circular economy. *Journal of Cleaner Production*, 1282-1299.

Ke, K., Liao, K., & Qiang, Q. (2016). Electronic financial networks with social responsible investing. *American Journal of Information Technology, 6 (1)*, 35-58.

Kim, K. K., Lee, H., & Park, Y. J. (2011). Interorganizational Information Systems Asymmetry and Supply Chain Performance. *The 5th International Conference on New Trends in Information Science and Service Science* (pp. 388-393). IEEE.

Kukalis, S. (1989). The relationship among firm characteristics and design of strategic planning systems in large organizations. *Journal of Management, 15 (4)*, 565-579.

Kumar, K., & van Dissel, H. G. (1996). Sustainable collaboration: Managing conflict and cooperation in interorganizational systems. *MIS Quarterly, September*, 279-300.

Kumar, S. K., Tiwari, M. K., & Babiceanu, R. F. (2010). Minimisation of supply cost with embedded risk using computational intelligence approaches. *International Journal of Production Research, 48 (13)*, 3717-3739.

Lacoste, S. (2015). Sustainable value co-creation in business networks. *Industrial Marketing Management, 52*, 151-162. doi:10.1016/j/indmarman.2015.05.018.

Lamber, D. M., & Enz, M. G. (2017). Issues in supply chain management: Progress and potential. *Industrial Marketing Management, 62*, 1-16.

Lee, S. S. (2013). *CoInterorganizational and global information systems.* Retrieved from Contents Kocw: http://contents.kocw.or.kr/document/ch8_18.pdf

Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of Psychiatric Research, 45(5)*, 626-629. doi: 10.1016/j.jpsychires.2010.10.008.

Linton, J. D., Klassen, R., & Jayaraman, V. (2007). Sustainable supply chains: An introduction. *Journal of Operations Management, 25*, 1075-1082. doi: 10.1016/j.jom.2007.01.012.

Loeser, F., Recker, J., Vom Brocke, J., Molla, A., & Zarnekow, R. (2017). How IT executives create organizational benefits by translating environmental strategies into green IS initiatives. *Information System Journal, 27 (4)*, 503-553.

Mahoney, J. T., & Pandian, R. (1992). The resource based view within the conversation of strategic management. *Strategic Management Journal, 13*, 363-380.

Malviya, R. K., Kant, R., & Gupta, A. D. (2018). Evaluation and selection of sustainable strategy for green supply chain management implementation. *Business Strategy and the Environment, 27*, 475-502.

Mangla, S., Madaan, J., & Chan, F. T. (2013). Analysis of flexible decision strategies for sustainability-focused green product recovery system. *International Journal of Production Research, 51(11)*, 3428-3442. doi: 10.1080/00207543.2013.774493.

McConahy, A. L., & Dutt, A. (2016). Towards agile system analysis & design: Improving knowledge transfer across domains using layered framework. *American Journal of Information Technology, 6 (1)*, 1-15.

Mentzer, J. T., Foggin, J. H., & Golicic, S. L. (2000). Collaboration: The enablers, impediments, and benefits. *Supply Chain Management Review, 4 (4)*, 52-58.

Miemczyk, J., & Johnsen, T. E. (2012). Sustainable purchasing and supply management: A structured literature review of definitions and measures at the dyad, chain and network levels. *Supply Chain Management: An International Journal, 17(5)*, 478-496. doi: 10.1108/13598541211258564.

Murillo-Luna, J., Garces-Ayebe, C., & Rivera-Torres, P. (2011). Barriers to the adoption of proactive environmental strategies. *Journal of Cleaner Production, 19*, 1417-1425.

Narayanan, S., Narasimhan, R., & Schoenherr, T. (2015). Assessing the contingent effects of collaboration on agility performance in buyer-supplier relationships. *Journal of Operations Management, 33-34*, 140-154.

Paulraj, A., & Chen, I. J. (2007). Strategic buyer-supplier relationships, information technology and external logistics integration. *The Journal of Supply Chain Management, 43 (2)*, 2-12.

Ranganathan, J. (1998). Sustainability rulers: Measuring corporate environmental & social performance. *World Resources Institute- Sustainable Enterprise Initiative*, 1-12.

Sarkis, J., Zhu, Q., & Lai, K. H. (2011). An organizational theiretic review of green supply chain management literature. *International Journal of Production Economics, 130 (1)*, 1-15.

Shrivastava, P. (1995). The role of corporation in achieving ecological sustainability. *Academy of Management Review, 20(4)*, 936-960.

Simatupang, T. M., & Sridharan, R. (2002). The collabrative supply chain. *The International Journal of Logistics Management, 13 (1)*, 15-30.

Simatupang, T. M., Wright, A. C., & Sridharan, R. (2004). Applying the theory of constraints to supply chain management. *Supply Chain Management, 9 (1)*, 57-70.

Soylu, A., Qruc, C., Turkay, M., Fujita, K., & Asakura, T. (2006). Synergy analysis of collaborative supply chain management in energy systems using multi-period MILP. *European Journal of Operational Research, 174 (1)*, 387-403.

Stern, L. W., & Craig, C. S. (1971). Interorganizational data systems: The computer and distribution. *Journal of Retailing, 47 (2)*, 73-91.

Stump, R. L., & Heide, J. B. (1996). Controlling supplier opportunism in industrial relationships. *Journal of Marketing Research, 33 (4)*, 431-441.

Tachizawa, E., & Wong, C. (2014). Towards a theory of multi-tier sustainable supply chain: A systematic literature review. *Supply Chain Management: An International Journal, 19 (5/6)*, 643-663.

WCED. (1987). *Our Common Future.* Oxford: Oxford University Press.

Webster, J. (1995). Networks of collaboration or conflict? Electronic data interchange and power in the supply chain. *Journal of Strategic Information Systems, 4 (1)*, 31-42.

Williamson, O. E. (1979). Transaction-Cost Economics: The Governance of Contractual Relations. *The Journal of Law & Economics, 22(2),* 233-261.
Williamson, O. E. (1985). *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting.* New York: Free Press.
Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management. *Journal of Operations Management, 22 (3),* 265-289.
Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research, 45 (18-19),* 4333-4355.

About the Authors

Xiyue Deng is a Ph.D. candidate of the Manufacturing and Technology Management of College of Business and Innovation at the University of Toledo. She holds an M.B.A in Information System and Finance from the University of Toledo. Her research interests are in Green Supply Chain Management and Sustainability, Supply Chain Disruption on Corporate Reputation, and Service Complexity Management.

Yuan Wang is an Assistant Professor at the Department of Strategic Management at the University of Houston-Victoria, School of Business Administration. She obtained a Ph.D. degree in Manufacturing Technology Management at the University of Toledo. Her primary research interest is in global supply chain management, innovation, project management, and the interface of supply chain management and human resources. Her journal publications include *International Human Resource Journal*.

APPENDIX A
Initial Measurement Instrument

Construct	Items	Literature
Green Supply Chain Management Strategy	Support from top management	Adopted from Henriques & Sadorsky (1999)
	The importance of environmental management	
	Environmental reporting	
	Employee environmental training and involvement	
Supply Chain Collaboration Practices: Inter-Organizational Activities	Joint decision making practices	Adopted from Barratt (2004)
	Openness and communication	
	Information exchange	
Supply Chain Collaboration Practices: Intra-Organizational Activities	Cross functional activities	Adopted from Kanda and Deshmukh (2008)
	Process Alignment	
	Collaborative culture	
Interorganizational Information Systems	The complexity of securing participation in the IOS	Adopted from Johnston & Vitale (1988)
	The maturity of implementing a system that meets the needs of participants	
	The depth of understanding other participants' business	
	The importance of the relationship between the participants	
Sustainable Performance: Economic	Reduction in cost of production	Adopted from Kazancoglu et al., (2018), Zhu & Sarkis (2007)
	Improvement in Total Revenue	
	Improvement in Quality	
	Improvement in efficiency	
Sustainable Performance: Environmental	Reduction in Air Emission	Adopted from Kazancoglu et al., (2018), Zhu & Sarkis (2007)
	Reduction in Energy consumption	
	Reduction in Solid waste	
	Reduction in Water waste	
	Reduction in Consumption for hazardous/harmful/toxic materials	

Construct	Items	Literature
	Reduction in Environmental accidents	
Sustainable Performance: Social	Reduction in the differences in compensation package admissible to the employees of different hierarchy to a significant level	Adopted from Das (2017)
	Reduction in inequity in remuneration and other perquisites given to the employees of the same level	
	Improvement in the morale of employees to a considerable level due to better working environment of the organization	
	Increase the proportion of time the surrounding people remain free from ailments due to improved health care facilities	
	Improvement in the opportunities of the surrounding community in respect of employment/business	
	Improvement in the literacy level/level of education of the surrounding people	