

The Role of Information Technology in Supply Chain Sustainability

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Abstract

Sustainability is an issue that is moving up the agenda of global organizations and attracts scholarly interest from diverse disciplines. Considerations regarding improvements in sustainability encompass numerous critical business functions including supply chain management. Supply chain managers are in a position to make a significant contribution to efforts aimed at improving the sustainability of enterprises. All three pillars of sustainable development – economic, environmental and social dimensions of sustainability – are effected by how supply chain processes work. Information technology, being both an enabler of sustainability initiatives and a supply chain driver, is an essential player in this equation. Through investments in information technology, collaboration between supply chain partners and performance of processes can be enhanced. This study attempts to develop a conceptual model to define and explore the effects of information technology investments on organizational and supply chain sustainability, with a focus on supply chain processes. The integrative framework has the potential to offer new insights to enrich theory on sustainable supply chain management research domain.

Keywords: supply chain management, sustainability, information technology, supply chain processes

INTRODUCTION

Sustainable supply chains are not only essential to delivering long-term profitability, but are also crucial environmental and social responsibility for organizations in the global marketplace. The concept of sustainable development plays an important role in today's organizations and how they perceive their supply chains (Chardine-Baumann and Botta-Genoulaz, 2014). Globalization of trade and thus globalization of production allows a wide variety of resources to be available and widely accessible. Among the advantages of increased globalization and international trade are lower prices and increased productivity due to economies of scale and specialization (Rodrigue, 2013). With increase in global trade, the requirement of accessibility between supply chain partners elevates the ever growing need of integration between production, distribution and consumption (Rodrigue, 2013). Due to this growth, demand for services provided by logistics and supply chain systems has risen. The issue then becomes how logistics and supply chain systems can be made more sustainable given the continued demand which exists for their services. Thus, supply chain professionals are in an outstanding position to impact sustainability practices (Carter and Rogers, 2008).

Information technology (IT) research in literature, on the other hand, is extensive and ever growing. Although there is much that learning in information systems can contribute to environmental sustainability research,

there is limited number of studies that consider this perspective while studying sustainability (Melville, 2010). The aim of this paper is to try to fill this gap by developing a model for how investments in IT, through improvements in supply chain processes, affect sustainability, specifically supply chain sustainability in organizations.

The plan of this paper is as follows. We begin by a brief literature survey on sustainability, discussing supply chain sustainability and information technology's role in sustainability issues specifically. Next, we present the model developed for exploring the role of IT in supply chain sustainability in the Conceptual Framework section. In the final sections of the paper, conclusions along with a summary of limitations and suggestions for further research are presented.

SUSTAINABILITY

Industrial sustainability is an issue that is moving up the management agenda of organizations (Paramanathan et al., 2004). For an encompassing definition of sustainability, we propose the following definition by WCED (1987): "Sustainability is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Also to be noted is the triple bottom line approach presented in Figure 1 referring to the social, environmental and economic dimensions of

sustainability, a term first coined by Elkington in 1994 and discussed since then in numerous work including Kleindorfer et al. (2005) and Porter and Kramer (2006) among others.

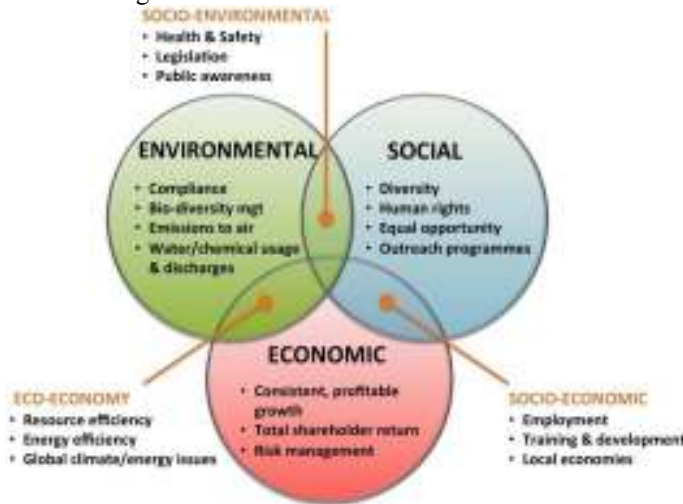


Figure 1. Triple Bottom Line Model

Benefits of sustainability initiatives include financial gains, improved corporate reputation, better government relations, increased skills in technology and innovation, brand loyalty and employee loyalty (Paramanathan et al., 2004). These benefits comprise drivers for companies to adopt sustainability programs. However, as Paramanathan et al. (2004) point out, significant barriers exist in implementing sustainability initiatives. In order to overcome these barriers, the creation of a specific company strategy and implementation framework as well as an effective change management program is necessary. Supply chain management, with its potential for creating sustainable competitive advantage in the global marketplace, is rising on the agenda of corporations that aim for higher sustainability (McIntyre, 2015).

Sustainable Supply Chains

A supply chain incorporates processes that move material and information to and from the manufacturing and service functions of a firm (Jacobs and Chase, 2014). Supply chain management (SCM) was defined in 1994 by The International Center for Competitive Excellence as “the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers”. Seuring and Müller (2008) define sustainable supply chain management (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”. Another definition of SSCM by Hassini et al. (2012) is “the management of supply chain operations, resources, information, and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impacts and maximizing the social well-being”. As seen from all these definitions, at the center of supply chain related issues lie processes. Chopra and Meindl (2013) identify three supply chain macro processes: Customer Relationship Management (CRM) which includes processes that focus on the interface between the firm and its customers, Internal Supply Chain Management (ISCM) which concerns processes internal to the firm, and Supplier Relationship Management (SRM) which focuses on interactions between the firm and its suppliers.

The processes that are considered the domain of SCM are an ideal starting point for sustainable development initiatives (McIntyre, 2015). The literature on SSCM is continuously growing (eg. Hassini et al., 2012; Alexander et al., 2014; Govindan et al., 2014) and the concept is getting center stage both in academia and business. Yet there is still insufficient theory on the connections between and drivers of sustainability and SCM.

INFORMATION TECHNOLOGY and SUSTAINABILITY

Information technology is crucial for achieving efficient and responsive supply chains (Shi and Chan, 2015). The members of a supply chain (suppliers, focal companies and customers) are linked by information, material and capital flows (Seuring and Müller, 2008; Chopra and Meindl, 2013). Chopra and Meindl (2013) refer to information as the glue that allows supply chain drivers to work together with the goal of creating an integrated, coordinated supply chain. Information unlocks supply chain responsiveness to demand (Mangan et al., 2008) and IT is a critical enabler of effective supply chain management (Simchi-Levi et al., 2009). Chopra and Meindl (2013) identify information as potentially the biggest driver of performance in the supply chain and state that it provides the foundation on which supply chain processes execute transactions and managers make decisions. The authors propose that information presents management with the opportunity to make supply chains more responsive and more efficient, and claim that good information is one of the biggest challenges to improved supply chain sustainability.

Nevertheless, IT investments to enhance supply chain performance may not deliver the improvements they are aimed for (Fawcett et al., 2011). Role of IT in supply chain performance improvement lies in better

information sharing to coordinate competitive initiatives and improve collaboration. Accurate, accessible information that is suitable for all levels across the supply chain must be shared. However what has happened in practice is making investments in advanced IT technologies while failing to use these to build non-imitable, value delivering supply chain competencies. Effective IT management may offer significant contributions both as a driver and as a tool to overcome implementation barriers.

Seuring and Müller (2008) point out the increased need for cooperation among partnering companies in sustainable supply chain management, and this is only possible with information technologies playing a vital role in the supply chain. In fact, information and communication technology infrastructure plays a critical role for sustainable development in any area for cooperation, collaboration, connectivity, processing and storage of knowledge (Mohamed et al., 2010).

CONCEPTUAL FRAMEWORK

As Melville (2010) points out, rigorous scholarly research is required to determine the extent of improvement in supply chain performance through adoption and/or advancement of information systems investments. Our study is an attempt to conceptualize the relationship between supply chain processes and sustainability performance, with an emphasis on effect of IT investments. Possessing the opportunity to observe the entire value creation along the supply chain from origin to final point of consumption, supply chain scholars are in an ideal position to develop a comprehensive model for this purpose. Hence, the initial purpose of this study is to explain the effects of IT on the collaboration between supply chain processes. Further, the impact of supply chain process improvements on supply chain sustainability along with organizational sustainability will be explored.

The model developed for the study has its origins in diverse areas. One of these is the process approach to SCM developed by Chopra and Meindl (2013). The authors define three supply chain macro processes, CRM, ISCM and SRM, and subsequently subdivide these macro processes into key micro processes. The macro processes rest on an IT framework of Transaction Management Foundation. This foundation supports the coordination of actions and decisions across the processes. Another domain for the model is literature in sustainability, especially the triple bottom line approach. Supply chain sustainability literature, on the other hand, still lacks pioneering work in the field that links sustainability to business processes. Finally, IT

literature constitutes another fundamental area. The model is presented in Figure 2.

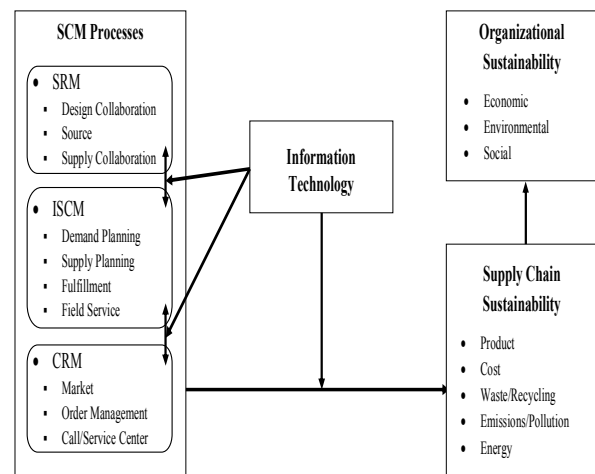


Figure 2. Proposed research model

The research model has three main components – SCM processes, IT and sustainability. The first of these comprises the three supply chain macro processes as three dimensions. Each dimension further takes into consideration the micro processes that are relevant to an organization's sustainability as constructs. Originally, Chopra and Meindl (2013) propose 5 micro processes for SRM, 5 micro processes for ISCM and 4 micro processes for CRM. Not all of these micro processes are directly related to sustainability and/or affected by IT investments. Thus, only those micro processes that are relevant to this study are considered in the research model.

Organizational sustainability is the dependent variable of the model. As stated above, organizational sustainability literature is much broader than supply chain sustainability literature. The triple bottom line approach, despite the difficulty of quantifying the social dimension (Branderburg et al., 2014), is comparatively more established and continues to be the best tool for measuring organizational sustainability. Thus, the model incorporates this approach. However, as at the focal point of the study is supply chain processes, it is imperative to deal with supply chain sustainability as a separate variable that further effects organizational sustainability. It is hypothesized that improvements in SCM processes will enhance supply chain sustainability. We propose the following dimensions for supply chain sustainability: product, cost, waste/recycling, emissions/pollution, and energy.

Product refers to product characteristics and issues related to design and redesign of products. Cost refers of all supply chain costs including environmental costs. Waste/recycling dimension concerns waste generated by the processes and recycling activities; emissions/pollution refers to all emissions such as greenhouse gas emissions as well as issues related to the control and prevention of pollution. Lastly, energy dimension is about use and sustainability of energy resources.

Finally, the model depicts IT both as an independent and a moderating variable. As Fawcett et al. (2011) state, IT investments are an important enabler of organizations' collaboration capability. The authors find that both IT and supply chain collaboration have a positive impact on firm performance in terms of profitability and growth. The three macro processes inevitably require collaboration among suppliers, focal companies and customers. Previous literature has established IT as having a positive effect on supply chain process performance (Yu, 2015). Considering IT an independent variable, we aim to confirm this positive effect. The promoting effect of IT investments on supply chain collaboration is incorporated into the model through hypothesized effects on the interaction between the macro processes. Additionally, a moderating role of IT is proposed on the relationship between the SCM processes and supply chain sustainability; i.e. with an increasing level of investment in IT tools aimed at improving supply chain processes and collaboration, the positive relationship between SCM processes and supply chain sustainability will be enhanced.

CONCLUSION

This study is a first attempt at building an integrative framework for examining the role of IT investment in the sustainability of organizations from a supply chain perspective. Previous literature includes studies that investigate the relationship between IT and supply chain performance (eg. Fawcett et al., 2011; Yu, 2015; Zhang et al., 2011), IT and sustainability of organizations (eg. Melville., 2010; Mohamed et al., 2010), and SCM and organizational sustainability (eg. Govindan et al., 2014; McIntyre, 2015). However, there is yet to be developed a comprehensive model that covers all three concepts of IT, SCM and sustainability. Thus, the model developed may have important implications for scholars in all three areas.

The study introduces a novel conceptualization of supply chain sustainability. This operationalization of supply chain sustainability through the five dimensions of product, cost, waste/recycling, emissions/pollution,

and energy is one of the study's main contributions to literature. Through these dimensions, a comprehensive set of metrics to assess the antecedents and consequences of supply chain sustainability can be developed.

Also to be noted is the hypothesized yet, to the best of our knowledge, formerly unvalidated effect of supply chain sustainability on organizational sustainability. Through the operationalization of supply chain sustainability, we hope to confirm that improved supply chain sustainability will lead to advances in all three dimensions of organizational sustainability.

In conclusion, this study presents a new window in the ongoing endeavor of studying sustainability, investigating effects of supply chain processes and illustrating the importance of proper IT investments to achieve organizational performance excellence.

LIMITATIONS AND FURTHER RESEARCH

As with all research, the findings of this study are subject to certain limitations. However, one should also bear in mind that these limitations may point to areas for future research. The most apparent path for future research is empirical testing of the model. When the model is tested, possible effects of developed vs. developing economies, external environment (industry specific conditions such as dynamism, competition characteristics, presence of economic crises, etc) as well as organizational characteristics may be incorporated.

One of the major limitations of the model is the lack of measures that are relevant and validated through previous research to operationalize dimensions of the triple bottom line approach; especially the social dimension (Branderburg et al., 2014) and partly the environmental dimension. However, with the current pace of growth in sustainability literature, it is only a matter of time for a comprehensive set of metrics for all three dimensions to be developed.

Despite these limitations, this study is a contribution to the continuous quest for defining the SSCM domain and presents itself as a potential frame of reference for future research.

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