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Peas and carrots just because they are green? Operational fit between green supply chain management and green information system

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Abstract Green supply chain management (GSCM) and green information system (GIS) are two strategic endeavors of external and internal orientations for the sustainable development of an organization. This study identifies the common dimensions between the two IT-enabled innovations in terms of environment protection, process control and organization support, and conceptualizes their operational fit. Compared with the commonly used perceived fit to measure how well IT infrastructure supports business activities, the operationalization of GSCM-GIS fit is based on both fit-as-profile-deviation and fit-as-moderation approaches to capture the synergy of GSCM and GIS practices along their common dimensions. Empirical evidence supports that operational fit as the result of functional deployment has expected long-term implications on environmental and social performances; whereas the implementation of both GSCM and GIS as the result of strategic planning has relatively short-term impacts on operational and economic performances.

Keywords Green supply-chain management · Green information systems · Operational fit · Organizational performances · Sustainable development

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1 Introduction

Corporate sustainability pertains to the incorporation of social and environmental considerations in business activities together with economic concerns (Dyllick and Hockerts 2002). It involves multiple levels of endeavors not just limited to one organization but its stakeholders as well (Bansal 2005; Van Marrewijk and Werre 2003). The main intra- and inter-organizational efforts in forms of environmental management systems (EMS) and supply chain management (SCM) complement each other for sustainability (Darnall et al. 2008). Both aspects of business transformations depend on the use of information technology (IT) to make them innovative and successful (Melville 2010). Correspondingly, green information system (GIS) and green supply chain management (GSCM) are two IT-enabled innovations, internally- and externally oriented respectively, conducive to sustainable development (Chen et al. 2008; Chiou et al. 2011).

GSCM can be traced back to the concept of green procurement (Webb 1994), and after 20 years of development, the idea of GSCM is widely accepted in manufacturing, logistics and other industries. This gives rise to a new branch of supply chain management research on how to incorporate environment-consciousness in operation and production (Beckman et al. 1995; Lamming and Hampson 1996; Sarkis 1995). The concept of GIS was proposed only in recent years by Watson et al. (2008), but is already deemed as the change actant and driving force in environmental management and sustainability innovation (Bengtsson and Ågerfalk 2011; Molla 2013). GIS refers to the development and use of information systems (IS), such as groupware, teleconferencing, environment auditing systems, and automation systems to support and promote environment-friendly operations and sustainable development (Corbett 2013; Sarkis et al. 2013; Watson et al. 2008). It supports and optimizes organizational activities for sustainable development and green innovation (Chen et al. 2008).

Compared with green information technology (GIT) that mainly focuses on energy conservation related to computer use, GIS deals with wider-scope managerial issues (Coffey et al. 2013; Watson et al. 2008). Companies that implement GIS in different industries demonstrate its importance for ecology and sustainability (IBM 2009; IDC 2008; Ryoo and Koo 2013). Yet, there are still insufficient empirical studies on how to optimize the effectiveness of GIS, especially in the context of organizational green endeavors like GSCM (Jenkin et al. 2011; vom Brocke et al. 2013).

This gap is largely due to the fact that GIS and GSCM are both complex endeavors. GIS concerns ecological, technological, economic, social, cultural and political issues (Bai and Sarkis 2013; SIGGreen 2012; Thomas et al. 2016). For an organization, the implementation of GIS is never simple and separate but associated with corporate culture, vision, and strategy (Chen 2011; Jenkin et al. 2011). The implementation of GSCM also involves dramatic organizational changes as the supply chain in the eras of globalization and ecological movement goes beyond a product's entire life cycle to the collaboration with consumers, communities and other organizations on environment protection and sustainable development (Nelson et al. 2013).

The relationship between GIS and GSCM evolves over time. GSCM has become relatively mature business practices for over two decades (Srivastava 2007). The rise of GIS in recent years brings a new issue to corporate managers as well as academic researchers in terms of the alignment or misalignment between GSCM and GIS (Ryoo and Koo 2013). On one hand, GSCM and GIS are usually planned, implemented and managed by different sectors in an organization that concerns about different aspects of sustainable development and environment protection (Gunasekaran and Ngai 2004; Shah et al. 2002). On the other hand, GSCM and GIS activities are often mutually embedded as they are for the same ecological purpose.

For organizations, therefore, there is an urgent need to align the GIS implementation with existing GSCM practices to optimize green strategy. Due to their complexity as well as different stages of development, however, GSCM and GIS may not be naturally pea and carrot with each other. Rather, it remains a challenge to integrate both to achieve synergistic effects (Darnall et al. 2008). Most of the existing studies that address the issue of integration focus on the need (e.g. Pereira and Sousa 2005) and outcome (Jenkin et al. 2011; vom Brocke et al. 2013). Few however have examined the common dimensions along which GSCM and GIS may align with each other.

Separately for GSCM and GIS, researchers found that each incorporates multiple aspects of organizational efforts (Daugherty et al. 2005; Gholami et al. 2013; Lee et al. 2012; Zhu and Sarkis 2006). This study will further examine how they may align with each other through operational fit. The potential contributions have two folds. Theoretically, it may help bridge the gap in the current literature in terms of the mechanism through which GSCM and GIS may be aligned with each other. Practically, such an understanding yields insights on the best practices on the integration of GSCM and GIS for optimal outcome.

The rest of this article is organized as follows. First, it reviews the literature on the relationship between GSCM and GIS, and different alignment conceptualizations and operationalizations. Then, it proposes a research model that hypothesizes how GSCM, GIS and their operational fit affect various organizational performances. Based on the observations collected from a survey study, results are to be presented and discussed, followed by conclusion and implications.

2 Research background

2.1 Relationship between GSCM and GIS

From the perspective of resource-based view, IT infrastructure can be transformed into higher-value assets for corporate sustainability when it is integrated with internal operations and external logistics (Elliot 2011; Rai et al. 2006; Wu et al. 2006). In today's business environment, Internet-based technologies (e.g. cloud computing and social networks) and globalization make the integration more complex and challenging (Thun 2010). For instance, multi-national organizations are often criticized for transferring polluting production to underdeveloped countries, and IT-supported green supply chain operations (e.g. emission auditing) play critical roles in controlling environmental impacts (Caixin Staff 2011; Zhou 2014).

As the terms "GSCM" and "GIS" just add "green" before "supply chain management" (SCM) and "information systems" (IS), it is easy to draw a direct analogy between GSCM-GIS relationship and SCM-IS relationship. Whereas the IT side is mostly supportive in SCM-IS relationship (Gunasekaran and Ngai 2004), GSCM-GIS relationship is more balanced. On one hand, GSCM and GIS can function by themselves, on the other, they are likely to complement each other, leading to the "one plus one greater than two" effect. For instance, video conferencing is a GIS practice that can be used to facilitate not only GSCM efforts but all kinds of other organizational activities as well (Watson et al. 2008).

Many studies discuss GSCM and GIS separately, but not many examine how they affect each other due to their theoretical independence. In practice, however, their mutual influence cannot be ignored: when an organization plans GIS implementation, it is natural to take existing GSCM practices into account, and vice versa. For the same green purpose, GIS and GSCM represent complementary efforts of different orientations, leading to optimized allocation of organizational resources. Rather than the one-way fit in SCM-IS relationship, therefore, there is likely a mutual alignment between GSCM and GIS.

For instance, effective communication is one of the critical success factors that make supply chain management sustainable (Seuring and Müller 2008). It is possible that an organization establishes a relevant GIS function (e.g. virtual social network) internally first and then decide to extend it to stakeholders like suppliers and customers, leading to the establishment or enhancement of GSCM. Another scenario is that GSCM practices call for the implementation or upgrading of corresponding GIS function (e.g. from internal video conferencing to shared platforms like Skype and WeChat). Through such an iterative process of interaction and feedback, mutual alignment may be established between GSCM and GIS.

Despite the complexity of phenomenon, researchers start to put together the mosaic piece by piece. From a technology-push perspective, Dao et al. (2011) claimed that GIS has become an important means of achieving sustainability by helping organizations deliver environment-friendly values to relevant stakeholders, and gain long-term competitive advantage through the integration of supply chains. From a business-pull perspective, Vachon (2007) suggested that GSCM practices call for IT investment that goes beyond pollution prevention and control within organizations to inter-firm collaboration for efficiency enhancement and waste reduction in the whole supply chain.

Therefore, there is a need to examine how GSCM and GIS may align with each other as they inevitably interact with each other. As pointed out by El-Gayar and Fritz (2006), the information systems research community needs to address "relatively untapped research synergies existing between information systems and environmental management for sustainable development at the organizational and technical levels" (p.756). For GSCM and GIS to reach a synergy through mutual alignment, they need to cope with each other in pushing organizational changes toward the same direction, which is not necessarily comfortable in the transition.

On one hand, external GSCM practices rely on internal conditions and require stakeholders within each organization to make necessary adjustment (Zhu et al. 2013). On the other, GIS implementation needs to eventually go beyond organizational boundary to facilitate the information flow among all the parties involved in the supply chain network, or "network partners" (Narayanan and Raman 2004). Though the decisions to adopt GSCM and GIS start from different angles of strategic planning, they interact with each other during their implementations and usages (Handfield et al. 2005).

2.2 Conceptualizations of GSCM-GIS fit

As the literature suggests, there is likely a mutual interaction between GSCM and GIS, in contrast to the unilateral relationship in SCM-IS fit that IT infrastructure supports business activities. Not just providing software and hardware platforms, GIS comprises IT-enabled organizational practices as well. GIS practices may influence GSCM practices, instead of simply catering to the latter. Compared with SCM-IS fit, therefore, GSCM-GIS fit can be more dynamic due to mutual influences, especially in the contemporary era when both business practices and information technologies are changing rapidly (Avila et al. 2009; Chen et al. 2005; Wong et al. 2009).

To conceptualize and operationalize GSCM-GIS fit, this study consults the alignment literature regarding the relationship between technology-related and business-related practices. Researchers suggest that business-technology alignment can occur at both the strategic and operational levels among business strategy, IT strategy, organizational infrastructure and process, and IS infrastructure and process (Arvidsson et al. 2014; Henderson and Venkatraman 1993). Altogether, there can be six types of alignment: "intellectual alignment" between IT strategy and business strategy, "operational alignment" between IT infrastructure/process and business infrastructure/process, and four "cross-domain alignments" across the strategic and operational levels (Gerow et al. 2014).

Among them, the alignments at the same level are the most common, and the alignment between business strategy and IT strategy is referred to as strategic fit, and the alignment business operations and IT operations as operational fit (Chan and Reich 2007; Ullah and Lai 2013). Both IS and management literature distinguishes two levels of strategy-related efforts: strategic planning and functional deployment (Johnston and Carrico 1988; O'Regan and Ghobadian 2002). Strategic fit and operational fit can be viewed as the results of strategic planning and functional deployment respectively (Golsorkhi et al. 2010; Whittington 1996). Scholars call for more research on the practice side of alignment (Karpovsky and Galliers 2015) as most empirical studies on business-IT alignment focus on the strategic fit but few on operational fit (Chan and Reich 2007; Grant 2003; Reich and Benbasat 2000; Tallon 2007).

For the same "green" purpose, GSCM and GIS are supposed to be strategically compatible with each other, as between more general environmental management and supply chain strategies (Handfield et al. 2005). However, the operational fit between GSCM and GIS requires actual integration of their practices that involves the coordination of GSCM and GIS activities (Shah et al. 2002; Stadtler 2015; Wong et al. 2009). Such coordination is largely based on the functional deployment of corresponding SCM and IS capabilities in business operations (Bendoly et al. 2012; Mclaren et al. 2004). As shown in Fig. 1, the strategic fit between GSCM and GIS is the result of strategic planning that leads to the decision to implement both in an organization, and their operational fit is the result of functional deployment that allows them to mingle and mesh together. Compared with strategic fit, such

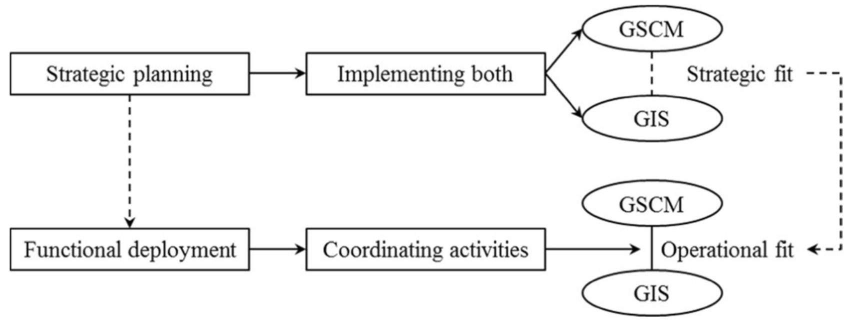


Fig. 1 Multi-level alignment between GSCM and GIS

operational fit takes a relatively long time to form after strategic planning, and needs to overcome many unforeseeable obstacles during functional deployment (O'Regan and Ghobadian 2002).

In the supply chain management literature, several studies have demonstrated the positive effects of GIS strategic initiative on organizations' sustainable development (Loos et al. 2011; Rao and Holt 2005; Velte et al. 2008). However, there is a lack of empirical studies on the operational fit between GSCM and GIS activities, mainly due to the difficulty in construct operationalization (Kwanroengjai et al. 2014; Wagner and Weitzel 2006). Generally speaking, there are six ways to operationalize fit in the literature: fit-as-moderation, fit-as-mediation, fit-as-matching, fit-as-covariation, fit-as-profile-deviation, and fit-as-gestalts (Venkatraman 1989). Among them, researchers mainly adopted fit-as-matching, fit-as-moderation and fit-as-profile-deviation approaches in the empirical studies of business-technology alignment, mostly at the strategic level (Chan and Reich 2007; Coltman et al. 2015; Furneaux 2012).

The most common fit-as-matching approach typically employs the construct of perceived fit. At the strategic level, for instance, researchers used it to study the organizational use of supply chain management (SCM) and enterprise resource planning (ERP) systems (Hong and Kim 2002; Ruppel 2004). At the operational level, it is used in the well-known task-technology fit model in which the fit between a task and a system influences individual performance (Goodhue and Thompson 1995). Researchers focus on the perception of alignment as an entity by itself rather than the specific technology and business/task involved. This leads to the common issue of IT black boxing that treats an organizational information system as a singular object rather than a complex of multiple functions (Koch 2011; Orlikowski and Iacono 2001).

Although the fit-as-matching approach is straightforward, its over-simplification may lead to issues such as common-method and social desirability biases. To address this issue, some IS researchers take a more objective approach to examine task-technology fit. For example, Chan et al. (1997) used a moderation model to calculate the product between business- and technology-related measures. Schniederjans and Cao (2009), on the other hand, derived the Euclidean distance between two types of measures to measure the misalignment. Respectively, they correspond to the fit-as-moderation and fit-as-profile-deviation approaches to study task-technology fit in contemporary organizations.

Both approaches require the separate measurement of user perceptions of business requirements and system functions. The fit-as-moderation approach generates the interaction terms between two sets of perceptions, and the fit-as-profile-deviation approaches calculates the Euclidian distances between them (Schniederjans and Cao 2009). On one hand, statistical interaction is a positive way to operationalize fit: the interaction term is maximized when both task- and technology-related values are the largest. On the other hand, the calculation of difference scores between two sets of measures captures misfit: the difference between a task measure and a technology measure is maximized when they are distinct. The main challenge for both approaches is that the measures on task requirements and system functions must be matched with each other, or the calculation of interaction terms and Euclidian distances makes little sense (Schniederjans and Cao 2009).

3 Theoretical framework

3.1 Operational fit between GSCM and GIS

The conceptualization of the alignment between GSCM and GIS, requires the examination of the underlying relationships between their activities. Such an understanding leads to the construct definition of GSCM-GIS fit for the development of its measurement. The instrument makes it possible to investigate how GSCM, GIS and their operational fit affect the sustainability-related performances of organizations.

Separately, researchers find that GSCM activities comprise eco design, supply chain processes, internal environmental management, and GIS activities include pollution prevention, product stewardship, and sustainable development (Daugherty et al. 2005; Gholami et al. 2013; Lee et al. 2012; Zhu and Sarkis 2006). As GSCM and GIS are for the same ecological purpose, these activities are likely to pertain to common dimensions. Figure 2 shows the underlying

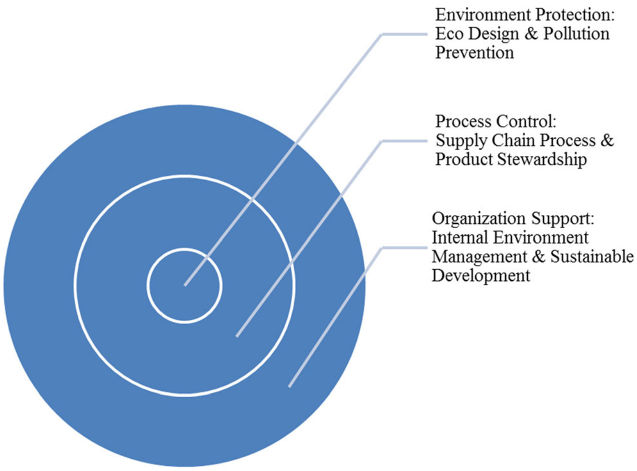


Fig. 2 Common dimensions of GSCM and GIS Activities

dimensions through which GSCM and GIS activities may align with each other.

Table 1 lists the construct definitions of GSCM and GIS activities from the existing literature to look further into their corresponding relationships. On the GSCM side, eco-design (ECO) devotes to environment-friendly products that lead to waste/emission reduction and energy conservation (Zhu et al. 2008a). The activity covers the whole product lifecycle, including initial idea development, product design and testing, production, usage and recycling (Gonzalez-Benito and Gonzalez-Benito 2005). Such a product-oriented activity has the most direct impact on the ecological goal of environment protection. On the other hand, the process view of GSCM holds how well the supply chain process (SCP) from upstream green purchasing, midstream remanufacturing to downstream customer collaboration is controlled and managed also influences environmental outcomes (Lamming and Hampson 1996). The joint effort inside and outside of an organization is essential to environmental provision compliance (Luo et al. 2014). Finally, internal environment management (IEM) provides the organizational support to GSCM endeavor through policy making, managerial control and environment auditing (Zhu et al. 2008b). Playing the supportive and facilitating role, this activity is equally important but has less direct impact on the ecological outcome.

On the GIS side, pollution prevention (PP) involves the use of specialized information systems (e.g.GaBi: http://www.gabi-software.com) for the purpose of reducing material waste and pollutant emission (Darnall et al. 2008; Iacob et al. 2013). Like eco-design of GSCM, such an activity of GIS has a direct effect on the environment. Product stewardship (PS) uses certain information systems (e.g. inventory management systems) to improve the efficiency in raw material acquisition, product distribution and product disassembly or remanufacturing, and a good example is just-in-time operation (Gholami et al. 2013). Reducing energy consumption and material waste throughout the supply chain, it is an important activity that is closely related to the process aspect of green endeavor. Finally, sustainable development (SD) relies on all kinds of information systems to facilitate green operation and management for the assurance of compliance, such as environment auditing (Butler and McGovern 2012; Watson et al. 2008; Watson et al. 2010). Similar to the internal environment management aspect of GSCM, sustainable development mainly supports other green activities.

The operational fit between GSCM and GIS, therefore, may form along three dimensions: environment protection dimension that contains core activities directly targeting the ecological goal, process control dimension that involves ancillary activities as the means to the end, and organizational

Table 1 Construct definitions of GSCM and GIS activities

Dimension	Construct	Definition	Source
Environment Protection	GSCM: Eco Design (ECO)	To design products that minimize consumptions, facilitate recycling, and avoid the use of hazardous materials	Green et al. (2012); Lee et al. (2012); Zhu et al. (2008b)
	GIS: Pollution Prevention (PP)	To adopt green IS for reducing overall emissions, wastes and hazardous materials	Gholami et al. (2013)
Process Control	GSCM: Supply Chain Process (SCP)	To cooperate with suppliers and customers for cleaner production processes that produce environmentally sustainable products with green packaging	Green et al. (2012); Lee et al. (2012); Zhu et al. (2008b)
	GIS: Product Stewardship (PS)	To adopt green IS for enhancing the environmental friendliness of upstream and downstream supply chain process	Gholami et al. (2013); Daugherty et al. (2005)
Organization Support	GSCM: Internal Environment Management (IEM)	To support the imperative of green supply chain management as an organizational strategy from senior and mid-level managers	Green et al. (2012); Lee et al. (2012); Zhu et al. (2008b)
	GIS: Sustainable Development (SD)	To adopt green IS for transforming business with management support	Gholami et al. (2013)

support dimension that includes broader managerial activities leading to structural provision (e.g. procedure, policy and culture). Such end-means-structure dimensions comprise the content domain of GSCM and GIS as two major organizational endeavors for sustainable development. Whereas Fig. 2 emphasizes the hierarchy of three dimensions, Fig. 3 illustrates how they form GSCM-GIS fit: eco-design (ECO) and pollution prevention (PP) match with each other along the dimension of environment protection, supply chain process (SCP) couples with product stewardship (PS) along the dimension of process control, and internal environment management (IEM) corresponds to sustainable development (SD) along the dimension of organization support.

An arrow from one circle to another indicates that a certain activity constitutes a part of GSCM or GIS endeavor. Meanwhile, an arrow from a line connecting two activities to operational fit indicates that how well these activities complement each other contributes to the alignment between GSCM and GIS from that dimension. An organization may do well in some activities but not others due to various reasons, leading to uneven alignment between GSCM and GIS, and mixed organizational performances. Based on the four criteria listed by Jarvis et al. (2003), therefore, GSCM, GIS and GSCM-GIS fit are formative constructs in terms of causality (from components to constructs), interchangeability (components of different dimensions), covariation (high correlation not necessarily among components), and nomological net (antecedents and consequences may vary).

Compared with the strategic fit between GSCM and GIS, their operational fit is more specific as it comprises corresponding activities along end-means-structure dimensions. Of course, GSCM and GIS are complex phenomenon, and this study focuses on their mutual alignment at the operational level. The discussion lays a theoretical foundation for a research model to examine the relationships between GSCM-GIS fit and other variables.

3.2 Research model and hypotheses

Previous studies demonstrate the close relationship between business-technology alignment/misalignment and organizational performances (Alaeddini and Salekfard 2013; Chan et al. 1997; De Leede et al. 2002; Kearns and Lederer 2003). In particular, an organization may align its IT strategy and operation with business strategy and operation to reach its goals (Grant 2003; Henderson and Venkatraman 1993; Madapusi and D'Souza 2005; Soh et al. 2003; Tallon 2007). Together with the business- and technology-related antecedents, such an alignment may yield outcomes of multiple aspects (Chan et al. 2006). As shown in Fig. 4, GSCM, GIS and GSCM-GIS fit influence different types of performances.

For general SCM, its alignment with IT is found to have a positive effect on economic and operational performances of suppliers (Sanders 2005; Seggie et al. 2006). In addition to such outcomes, the implementation of GSCM yields additional environment and social outcomes (Chiou et al. 2011; Rao and Holt 2005; Yang et al. 2013). Also the implementation of GIS has positive effects on environment and sustainable development (Watson et al. 2010). Therefore, GSCM, GIS and their operational fit are likely to enhance economic, operational, environmental and social outcomes.

In terms of GSCM, Chiou et al. (2011) found that its implementation enhances not only economic performance, but also environmental performance. Green et al. (2012) also found that manufacturers that implement GSCM enhance their operational performance. In addition, it is found that one major motivation of GSCM implementation is its potential impact on social performance, such as corporate image, brand equity and social responsibility (De Giovanni 2012; Greening and Turban 2000; Seggie et al. 2006). Hence the following hypotheses:

- H1a: GSCM implementation has a positive effect on economic performance.
- H1b: GSCM implementation has a positive effect on operational performance.
- H1c: GSCM implementation has a positive effect on environmental performance.
- H1d: GSCM implementation has a positive effect on social performance.

Rather than a unidimensional construct, GSCM is formed by its three contributing factors: eco-design, supply chain processes, and internal environmental management. These activities do not individually influence the outcome variables, but interact with each other in their effects. If an organization does well on all these aspects, the overall GSCM effectiveness may

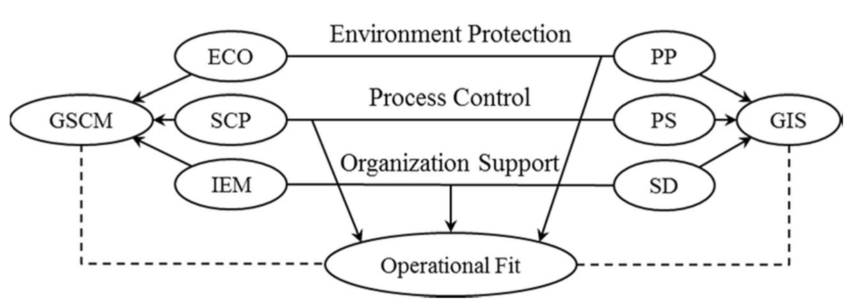
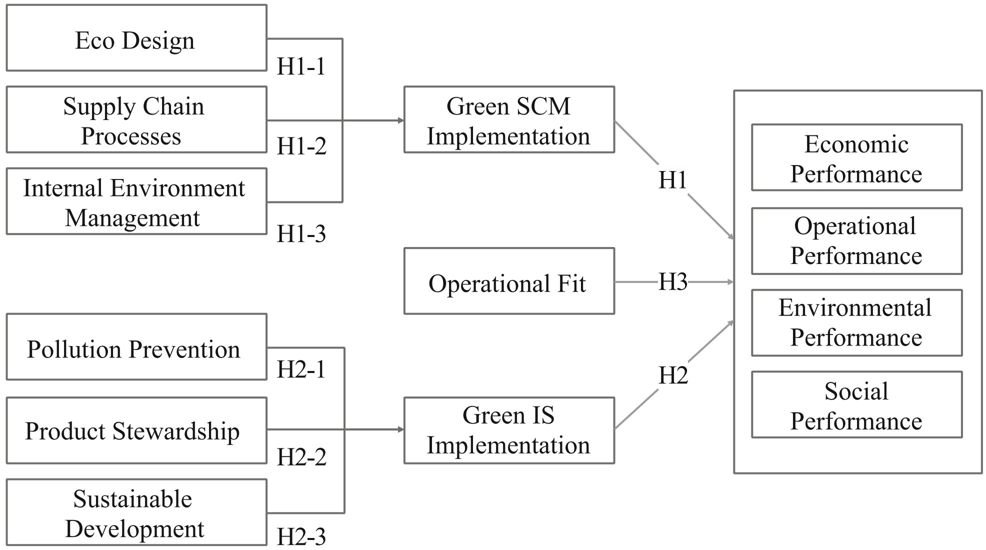


Fig. 3 Formation of GSCM, GIS and GSCM-GIS Fit

Fig. 4 Research model



get maximized. Therefore, the successful implementation of GSCM as a whole is found to depend on all of the following: 1) eco-design that leads to environmentally friendly products; 2) supply chain process that leads to ecological collaborations with upstream suppliers as well as downstream customers; and 3) internal environment management that leads to senior management support, zero-tolerance environment policy, and inter-department cooperation (Zhu and Sarkis 2006).

H1-1: Eco-design (ECO) positively contributes to GSCM implementation;
H1-2: Supply chain process (SCP) positively contributes to GSCM implementation;
H1-3: Internal environmental management (IEM) positively contributes to GSCM implementation.

On the GIS side, researchers found that its implementation improves the efficiency of organizations in terms of economic and operational performances by optimizing resource allocation and logistics for sustainable development (Daugherty et al. 2005). GIS also supports pollution prevention and control as well as business process management for the achievement of environmental goals (Loos et al. 2011). In addition to efficiency and effectiveness, GIS can be leveraged to achieve eco-equity, which is conducive to positive social image in the community and among customers (Chen et al. 2008).

H2a: GIS implementation has a positive effect on economic performance.
H2b: GIS implementation has a positive effect on operational performance.
H2c: GIS implementation has a positive effect on environmental performance.
H2d: GIS implementation has a positive effect on social performance.

Similar to GSCM activities, GIS activities including pollution prevention, product stewardship and sustainable development also interact with each other to have a synergetic effect (Gholami et al. 2013). Pollution prevention directly targets the environmental goal. Product stewardship concerns the core business in product lifecycle. Sustainable development emphasizes institutional procedure and organizational collaboration. Altogether, they contribute to the successful implementation of GIS.

H2-1: Pollution prevention (PP) positively contributes to GIS implementation;
H2-2: Product stewardship (PS) positively contributes to GIS implementation;
H2-3: Sustainable development (SD) positively contributes to GIS implementation.

As two different organizational endeavors, GSCM and GIS activities can only be aligned with each other through mutual adaptation and adjustment (Ruppel 2004). The resulted operational fit between GSCM and GIS enhances an organization's sustainable development capabilities (Sanders 2005; Seggie et al. 2006; Rai et al. 2006; Wu et al. 2006), and optimizes internal and external business processes (Dao et al. 2011; Darnall et al. 2008; Hertel and Wiesent 2013). In addition to the performances related to the organization in question and the environment at large, the alignment between GSCM and GIS is likely to bring good social outcome (Strong and Volkoff 2010).

H3a: GSCM-GIS fit has a positive effect on economic performance.
H3b: GSCM-GIS fit has a positive effect on operational performance.

H3c: GSCM-GIS fit has a positive effect on environmental performance.

H3d: GSCM-GIS fit has a positive effect on social performance.

4 Methodology

4.1 Operationalization of GSCM-GIS fit

Based on the fit-as-matching approach, Goodhue and Thompson (1995) proposed the task-technology fit (TTF) theory to explain how the perceived fit between a task and an information system affects individual user performance. Extending this model, a considerable number of studies examined task-technology alignment at the group and organization levels (Dymoke-Bradshaw and Cox 2005; Fuller and Dennis 2009; Maruping and Agarwal 2004). The perceived task-technology fit construct, however, only captures the relationship between a single system and one type of tasks (e.g. Dishaw and Strong 1999; Klopping and McKinney 2004; Lin 2012). Thus it is primarily used in the studies that address relatively simple user contexts (Strong and Volkoff 2010). However, information systems have become more and more complex to handle a variety of tasks in organizations. GSCM can be viewed as a strategic endeavor rather than a singular task, and GIS comprises a variety of systems (Azzone and Noci 1998). In such a circumstance, users may not be able to match various system functions with different tasks in form of perceived fit.

Instead of using fit-as-matching, therefore, this study adopts both fit-as-moderation and fit-as-profile-deviation approaches to capture GSCM-GIS fit. The calculation requires the coupling of two paired measures. As shown in the formula [1], the nominator comprises the interaction term between a GSCM-related measure 'A' and the corresponding GIS-related measure 'B′, and the denominator comprises the Euclidian distance between two (add 0.5 to avoid 0).

$$\frac{A*B}{|A-B|+0.5} \quad (1)$$

The calculation captures alignment and misalignment in terms of fit product (i.e. A*B) and misfit difference (i.e. |A-B|), respectively. The misfit difference between a GSCM measure and a GIS measure is minimized when two values are close to each other. The fit product is maximized when two values are high, but minimized when they are both low. It is possible that two fit product values are the same or close (e.g. 2*2 = 4, and 1*4 = 4), but their misfit differences are distinct. In this sense, the fit-as-moderation and fit-as–profile-deviation approaches are complimentary to each other in the operationalization of GSCM-GIS fit.

The range of the calculated fit value is between 5*1/(5–1 + 0.5) = 1.11 for minimum fit and 5*5/(5–5 + 0.5) = 50 for maximum fit. Even though the low levels of GSCM and GIS implementations are close in values, they do not interpret to high level of operational fit. When both are at the lowest level, the fit value is: 1*1/(1–1 + 0.5) = 2, which is just a little bit higher than the minimum fit. Using the fit-as-profile-deviation approach alone, it will be a "perfect" fit (i.e. 1–1 = 0). However, the value will be the smallest with the fit-as-moderation approach (i.e. 1*1 = 1). The use of both approaches in the calculation of operational fit reconciles the contradiction between them. Of course, the distribution of fit values is not normal, and power transformations (Box and Cox 1964) was used to convert them into the same scale (i.e. one through five) as other variables.

4.2 Measurement

A survey questionnaire was developed, and all measures were five-level Likert items adapted from existing scales. Scales from Lee et al. (2012) study were used to capture the eco-design (ECO), supply chain processes (SCP) and internal environment management (IEM) aspects of GSCM. The pollution prevention (PP), product stewardship (PS) and sustainable development (SD) items from Gholami et al. (2013) and Daugherty et al. (2005) studies comprise GIS measures. Table 2 lists the GSCM and GIS items side by side to illustrate their corresponding relationships. The leading question reads "The implementation of GSCM/GIS practices helps my company: …".

Table 3 gives the measurement items of outcome variables. Economic performance was measured with the scale developed by Daugherty et al. (2005). Operational performance items were originally developed by Green et al. (2012) and Lee et al. (2012). The measurement of environmental performance was based on Gholami et al. (2013) and Chiou et al. (2011) instruments. Social performance was captured with items adapted from Albinger and Freeman's (2000) and Greening and Turban's (2000) studies. The leading question reads: "Performance is enhanced in terms of: …".

4.3 Sample

The questionnaires were sent to 450 organizations in China based on snow-ball and cluster sampling in several metropolitan areas. The country faces the challenge to strike a balance between development and environment, and is strengthening the legislation and regulation on sustainability: organizations need to either reduce consumption and emission or be phased out (Zhang 2011). Most of the organizations in the sample managed supply chains in the fields of manufacturing, real estate, energy, logistics, IT and other services. Table 4 gives the profiles of participating organizations.

Table 2 Matched GSCM and GIS items

GSCM Item	Corresponding GIS Item	Common Focus	Fit Item
ECO1: reduce material/energy consumption.	PP1: reduce overall consumption and emission.	Consumption	PP1-ECO1
ECO2: reuse, recycle, and recover materials.	PP2: reduce overall waste.	Waste	PP2-ECO2
ECO3: reduce the use of hazardous/toxic materials.	PP3: reduce overall use of hazardous and toxic materials.	Hazardous/toxic materials	PP3-ECO3
SCP1: collaborate with suppliers for environmental objectives.	PS1: make material sourcing and acquisition more environmentally friendly.	Sourcing	PS1-SCP1
SCP2: collaborate with customers for green delivery.	PS2: make product distribution and delivery more environmentally friendly.	Distribution	PS2-SCP2
SCP3: facilitate products disassembly and remanufacturing.	PS3: make product disassembly and remanufacturing more environmentally friendly.	Product disassembly and remanufacturing	PS3-SCP3
IEM1: enhance cross-functional cooperation for environmental improvements.	SD1: facilitate green operations across the organization.	Internal cooperation	SD1-IEM1
IEM2: obtain management commitment and support for green operations.	SD2: facilitate management support and control for sustainable development.	Management support	SD2-IEM2
IEM3: implement environmental compliance and auditing programs.	SD3: facilitate environmental compliance and auditing.	Compliance and auditing	SD3-IEM3

There were two methods of data collection: onsite interviews (about 60 %) and online survey with follow-up email reminders. Altogether, 356 responses were collected, leading to the response rate of 79 % (i.e. 356/450). Among them, 311 were valid as respondents confirmed the use of information systems for green purposes. Thus the final valid response rate was 69 % (i.e. 311/450). The non-response rate (i.e. 1–79 % = 21 %) and invalid response rate (i.e. (79 %–69 %)/79 % = 15 %) were close. Many organizations indeed indicated that they did not respond as they had not implemented GIS and/or GSCM yet. Thus the non-response is mostly due to eligibility filtering rather than systematic bias.

Among the participants, 57 % were operational-level managers, 33 % were middle-level managers and 10 % were executive managers. The composition is appropriate for this study that focuses on the operational fit between GSCM and GIS. In terms of organizational departments, 50 % were from functional areas (e.g. IT support, logistics, and customer service), 22 % from research and development, 16 % from manufacturing, and 12 % from sales. The diversity of participant backgrounds enhances the generalizability of findings.

5 Results

Before testing the research model, measurement validity was assessed in terms of face validity, construct validity, and nomological validity (Hair et al. 2009; Straub et al. 2004). Face validity requires a careful examination of each measure's wording. The operationalizations of GSCM, GIS and their alignment in this study were based on the thorough understanding of two sets of measures involved. Not only was the semantic association between each item and its factor reassured for GSCM and GIS scales, but also the content correspondence between paired items across two scales was established for GSCM-GIS fit. Regarding four performance scales, each item was examined to make sure that it captures environmental, social, economic or operational aspect.

Unlike construct validity and nomological validity, face validity cannot be directly assessed using statistical methods. Nevertheless circumstantial evidence may still be obtained by examining the response patterns. For first-order reflective constructs, Table 5 reports descriptive statistics of responses including average and variability, among the other indices for measurement validation. Among the GSCM components, Eco Design (ECO) responses had the highest average and Supply Chain Processes (SCP) had the lowest, with Internal

Table 3 Performance measures

Economic	Operational	Environmental	Social
EcP1: investment recovery	OpP1: product delivery	EnP1: material reuse	SoP1: product liability and safety
EcP2: cost containment	OpP2: product quality	EnP2: environmental compliance	SoP2: product recycling
EcP3: profitability	OpP3: capacity utilization	EnP3: environment preservation	SoP3: community outreach
EcP4: labor productivity	OpP4: cycle time reduction	EnP4: reduction of hazardous wastes and emissions	
EcP5: inventory reduction	OpP5: customer service	EnP5: reduction of resource consumptions	

Table 4 Profile of participating organizations

Characteristic	Count	% (*N* = 311)
Size (# of employees)		
1–99	77	24.76
100–499	69	22.19
500–1000	40	12.86
Above 1000	122	39.23
Not reported	3	0.96
Industry		
Manufacturing	45	14.47
Energy	41	13.18
Real Estate	37	11.90
Logistics	15	4.82
IT	65	20.90
Service	56	18.01
Other	49	15.76
Not reported	3	0.96
Years in business		
1–10	87	27.97
11–20	115	36.98
Above 20	96	30.87
Not reported	13	4.18

Environment Management (IEM) in between. The corresponding GIS components followed the same pattern: Pollution Prevention (PP) saw the highest average, Product Stewardship (PS) saw the lowest, and in the middle was Sustainable Development (SD). This coincided with the operational fit between GSCM and GIS along the ECO-PP, SCP-PS and IEM-SD dimensions. Compared with these predicting variables, all the outcome variables had lower averages but higher standard deviations. Such a "lagging" is explainable as it takes time for the green endeavors like GSCM and GIS to make a difference to organizational performances.

Whereas face validity concerns the content of measures, construct validity pertains to their factorial relationships in terms of how the items of each factor covary (i.e. convergent validity), and how factors are distinct from each other (i.e. discriminate validity) (Straub et al. 2004). As shown in Table 5, all Cronbach alpha (α) values were above 0.7, indicating acceptable internal consistency of responses. Similarly, the Average Variance Extracted (AVE) values were well above the 0.5 threshold, suggesting that common variance explained outweighed error variance. For all the constructs in question, therefore, their responses were reliable, supporting convergent validity.

For discriminant validity, there is supportive evidence if the squared value of correlation coefficient between two constructs is less than their respective AVE values, indicating that the shared variance between two constructs does not outweigh the average variance explained by their indicators (Fornell and Larcker 1981). Table 5 gives the square roots of AVE's on the diagonal of correlation matrix, and the smallest value was 0.83, greater than all correlation coefficients. This indicates that all constructs were perceived distinct from each other.

When all constructs are considered, their potential common method bias due to survey data collection may be assessed using Harman's single-factor test with both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) (Podsakoff et al. 2012). The result of EFA indicated that the first common factor accounted for just one third (33.93 %) of the total variance. In CFA when all measurement items were loaded onto a single factor rather than their own constructs, model fit deteriorated significantly (χ^2 from 1090.27 to 7972.44, and χ^2/df from 1.99 to 12.66). As there was not

Table 5 Measurement Validation for first-order reflective constructs

Construct	Mean (Std)	α	CR	AVE	ECO	SCP	IEM	PP	PS	SD	EcP	EnP	OpP	SoP
Eco Design (ECO)	4.19 (.73)	.79	.88	.70	.84									
Supply Chain Process (SCP)	3.85 (.76)	.82	.89	.74	**.56****	.86								
Internal Environment Management (IEM)	3.94 (.77)	.82	.89	.74	**.56****	**.74****	.86							
Pollution Prevention (PP)	3.93 (.72)	.81	.89	.72	*.44***	.47**	.46**	.85						
Product Stewardship (PS)	3.83 (.68)	.81	.89	.72	.39**	*.53***	.52**	**.77****	.85					
Sustainable Development (SD)	3.84 (.72)	.80	.88	.72	.34**	.52**	*.56***	**.68****	**.77****	.85				
Economic Performance (EcP)	3.32 (.94)	.90	.93	.72	.17**	.24**	.25**	.20**	.23**	.25**	.85			
Environment Performance (EnP)	3.40 (.91)	.89	.92	.68	.21**	.19**	.27**	.25**	.26**	.29**	**.71****	.83		
Operational Performance (OpP)	3.21 (.94)	.91	.94	.74	.12*	.22**	.22**	.21**	.27**	.28**	**.75****	**.62****	.86	
Social Performance (SoP)	3.23 (.99)	.86	.91	.77	.10	.22**	.27**	.19**	.25**	.26**	**.69****	**.64****	**.65****	.88

Std Standard Deviation, α Cronbach's Alpha, *CR* Composite Reliability, *AVE* Average Variance Extracted, The diagonal elements are the square roots of AVEs. The bold indicates the correlation coefficents among grouped constructs, and the italic indicates those along GSCM-GIS fit dimensions

[*] Significant at 0.05 level

[**] Significant at 0.01 level

one dominant source of variance, the concern of common method bias can be largely dismissed.

Nomological validity of first-order reflective constructs may be assessed by examining their correlations to see whether the strengths of associations are consistent with theory (Hair et al. 2009; Straub et al. 2004). In the study, the constructs in the correlation matrix were grouped into GSCM-, GIS- and performance-related constructs. Bolded in Table 5, the correlation coefficients among related constructs (the smallest close to 0.56) were greater than other correlation coefficients as expected.

The only exception is the correlation between internal environment management (IEM) and sustainable development (SD), which was also close to 0.56. It is one of three italic correlation coefficients corresponds to GSCM-GIS fit dimensions, which were all relatively large compared to their off-diagonals. This actually supported the operationalization of GSCM-GIS fit. Among its underlying dimensions, environment protection (ECO-PP) had the lowest coefficient, process control (SCP-PS) had higher value, and organizational support (IEM-SD) had the highest. The result is consistent with the aforementioned narrow-to-broad hierarchy of these end-means-structure dimensions, as GSCM and GIS practices along a broader dimension tend to overlap.

The correlation coefficients between the components of GSCM and GIS were all relatively large compared to their correlations with performance measures. This supports the necessity to study the alignment between GSCM and GIS on the premise that their practices are closely related with each other. Deserving a closer look is the fact that the pollution prevention (PP) component of GIS had even slightly higher correlations with the other two GSCM components (i.e. SCP and IEM) than its corresponding component (i.e. ECO). One possible explanation is that GIS is more general than GSCM as it may be applied to all kinds of business activities. As the core GIS component for the goal of environment protection, pollution prevention (PP) may as well pertain to all GSCM practices.

Of course, the correlational relationships among GSCM and GIS components does not directly map to the sematic relationships between their paired measures in the operationalization of GSCM-GIS fit. Compared with other reflective constructs, such a formative construct has different requirements for measurement validation, which is indispensable from the explanation of outcome variables (Hair et al. 2013). In this study, all the subsequent analyses involving formative constructs are to employ partial least square (PLS) that is more capable of handling formative latent variables than covariance-based structural equation modeling (SEM) (Chin and Todd 1995; Hair et al. 2013; Henseler et al. 2009). Table 6 reports the multicollinearity, weights and outer loadings of individual GSCM-GIS fit indicators for economic, environmental, operational and social performances. The distinctiveness among the formative indicators may be assessed with the collinearity analysis (Petter et al. 2007). All the variance inflation factors (VIFs) were well below 5, which is the threshold for salient multicollinearity (O'Brien 2007).

Similar to the regression weights in multiple regression analyses, indicator weights tell the relative importance of formative indicators in their predictions of an outcome variable. Observed significance levels are based on right-tailed tests as fit indicators are supposed to have positive effects on performance measures. The first indicator along the environment protection dimension (PP1-ECO1) and the first indicator of the organization support dimension (SD1-IEM1) were significant across all four performance measures. For social performance, the third indicator of the organization support dimension (SD3-IEM3) also contributed to its explanation.

Three weights were negatively significant: two (PP2-ECO2 and PS2-SCP2) for social performance and one (PS3-SCP3) for environmental performance. Such a sign flip is not uncommon for formative measurement due to suppression effects when some indicators explain a significant proportion of common variance with an outcome variable that other indicators exhibit weaker or even negative effects (Cenfetelli and Bassellier 2009). Not surprisingly, PP2-ECO2 belongs to the environment protection dimension in which there was a dominant indicator PP1-ECO1, and PS2-SCP2 and PS3-SCP3 belong to the process control dimension in which all weights were more or less suppressed. For the organizations in this study, GSCM-GIS fit seemed to be more effective along the environmental protection and organization support dimensions than the process control dimension.

Most other weights were insignificant but that does not mean that those indicators are not important. In addition to the relative importance as indicated by weights, the absolute importance free of suppression effects needs to be examined in terms of outer loadings. An outer loading is obtained by using only one indicator to predict the outcome variable at a time, equivalent to the bivariate correlation between them. When the weight of an indicator is not significant but its outer loading is, the indicator is still absolutely important (Hair et al. 2013). In this study, all outer loadings were significant except for the two associated with significantly negative weights (i.e. negative effects were not real but due to suppression). The examination of both indicator weights and outer loadings confirms the measurement validity of GSCM-GIS fit as a formative construct.

At a higher level, GSCM and GIS are formative constructs comprising corresponding lower-order constructs, making each a reflective first-order and formative second-order construct (Jarvis et al. 2003). The validation of such hierarchical constructs can be assessed by embedding them in nomological networks with outcome variables (Wetzels et al. 2009). As shown in Table 7, the components of each (i.e. ECO, SCP and IEM for GSCM, and PP, PS, and SD for GIS) did not exhibit a high level of interdependence as all the VIF values were way below the threshold of 5. The fact that GSCM or

Table 6 Multicollinearity, weights and outer loadings of formative indicators of GSCM-GIS fit

Indicator	VIF	Performance			
		Economic	Environmental	Operational	Social
PP1-ECO1	1.754	.472** (.786***)	.598*** (.827***)	.466** (.806***)	.398** (.596***)
PP2-ECO2	1.4	-.137 (.359**)	-.046 (.400***)	-.152 (.377**)	-.465† (.034)
PP3-ECO3	1.53	.185 (.576***)	.210 (.576***)	.065 (.533**)	-.002 (.332**)
PS1-SCP1	1.91	.125 (.682***)	.139 (.618***)	.199 (.723***)	.269 (.492***)
PS2-SCP2	1.751	.255 (.673***)	.060 (.508***)	.184 (.681***)	-.464† (.188)
PS3-SCP3	1.547	-.273 (.347**)	-.455† (.201)	.027 (.550***)	.078 (.438***)
SD1-IEM1	1.666	.444** (.758***)	.405** (.680***)	.334* (.733***)	.545*** (.705***)
SD2-IEM2	1.853	.025 (.586***)	.001 (.528***)	-.135 (.557***)	.029 (.572***)
SD3-IEM3	1.769	.100 (.571***)	.185 (.553***)	.279 (.694***)	.439** (.682***)

VIF variance inflation factor. The outer loading of each indicator is given in the parentheses beside its weight on a performance measure. Observed significance levels are based on right-tailed test

* Significant at 0.1 level

** Significant at 0.05 level

*** Significant at 0.01 level

† negatively significant at 0.05 level (two-tailed)

GIS components were just moderately correlated with each other corroborates the rationale of formative modeling. In the nomological networks of both GSCM and GIS with different performance measures, all the path coefficients were significant. This supports the nomological validity of GSCM and GIS as higher-order formative constructs.

In the research model, there are three main predictors of each performance variable, GSCM, GIS and GSCM-GIS Fit. GSCM and GIS are second-order formative latent variables comprising the same number of first-order reflective components (i.e. three for each), making it appropriate to model them with repeated-indicator approach for higher-order constructs of reflective-formative type (Hair et al. 2013). GSCM-GIS Fit is a first-order formative latent variable, of which the indicators are derived from GSCM and GIS measures. Similar to a hierarchical regression analysis, predicting variables are to be entered by stages to explain each performance variable. The purpose is to find out how GSCM, GIS, and their alignment contribute to different performance measures, respectively, controlling organization characteristics. The control variables include the age, size and type of participating organizations. There were six types of industries listed in the questionnaire plus the category of "others", which was used as the baseline in the coding of dummy variables.

Table 7 Validation of GSCM and GIS as second-order formative constructs

Nomological Network	VIF	Performance			
		Economic	Operational	Environmental	Social
GSCM➔Performance		0.263*	0.221*	0.264*	0.244*
ECO➔GSCM	1.556	0.339*	0.336*	0.344*	0.333*
SCP➔GSCM	2.351	0.406*	0.408*	0.399*	0.407*
IEM➔GSCM	2.371	0.409*	0.409*	0.411*	0.413*
R-Square		0.069	0.049	0.070	0.060
GIS➔Performance		0.251*	0.282*	0.306*	0.276*
PP➔GIS	2.528	0.359*	0.357*	0.361*	0.358*
PS➔GIS	3.360	0.378*	0.379*	0.376*	0.378*
SD➔GIS	2.573	0.364*	0.365*	0.364*	0.364*
R-Square		0.063	0.079	0.094	0.076

VIF variance inflation factor, *GSCM* Green Supply Chain Management, *ECO* Eco Design, *SCP* Supply Chain Process, *IEM* Internal Environment Management, *GIS* Green Information Systems, *PP* Pollution Prevention, *PS* Product Stewardship, *SD* Sustainable Development

* Significant at 0.01 level

Table 8 gives the estimates of hierarchical PLS analysis. For each performance variable, there are four models entering control variables (Model 0), GSCM (Model 1), GIS (Model 2) and GSCM-GIS fit (Model 3) respectively. On average, Model 0 explained 4.48 % of the total variance, Model 1 explained 9.85 % of the total variance, Model 2 explained 12.38 %, and Model 3 explained 13.08 %. Among the four sets of independent variables, control variables accounted for 34.25 % of explained variance (i.e. 4.48 %/13.08 %), GSCM components added 41.06 % (i.e.(9.85 %–4.48 %)/13.08 %), GIS components explained another 19.34 % (i.e. (12.38 %–9.85 %)/13.08 %), and GSCM-GIS fit contributed the remaining 5.35 % of the (i.e. (13.08 %–12.38 %)/13.08 %). Considering that GSCM-GIS fit did not contribute much to the explanation of economic and operational performances, its contributions to the explanation of environmental and social performances were assessed. For those two outcome variables, Models 0 through 3 explain on average 4.25 %,10.00 %,12.75 % and 14.15 % of their variance. Accordingly, the proportions of variance explained by control variables, GSCM, GIS and their fit were close to 30 % (i.e. 4.25 %/14.15 % = 30.04 %), 40 % (i.e. (10.00 %–4.25 %)/ 14.15 % = 40.64 %), 20 % (i.e. (12.75 %–10.00 %)/ 14.15 % = 19.43 %) and 10 % (i.e. (14.15 %–12.75 %)/ 14.15 % = 9.89 %).

In Model 0, organization age and size were significant only for economic performance, which is expected: younger and bigger organizations are likely to do well economically. Organizational types, on the other hand, are relevant to all performance measures. In particular, traditionally more polluting industries including manufacturing, energy and real estate had better environmental performance than IT, logistics and service industries, yet there was not much difference among them for social performance. Manufacturing, real estate and service industries were stronger in economic performance, whereas real estate and IT industries excelled in operational performance. The control variables made a difference, supporting their use to filter out the extraneous variance for estimation of main effects.

In Model 1, the hypothesized relationships between GSCM and all four performance variables were found highly significant at the 0.01 level, supporting H1a-d. In addition, Eco Design (ECO), Supply Chain Process (SCP), and Internal Environment Management (IEM) significantly contributed to GSCM, supporting H1–1, H1–2, and H1–3.

In Model 2, GIS was found to have one significant and three highly significant effects on four performance variables, supporting H2a-d. Also, Pollution Prevention (PP), Product Stewardship (PS), and Sustainable Development (SD) were salient components of GIS, supporting H2–1, H2–2, and H2–3. When GIS was added, GSCM Implementation became less significant for economic and social performances, and insignificant for environmental and operational performances. This supports the premise that GIS enhances organizational performances partly by itself and partly by facilitating GSCM, as suppression effects usually indicate mediating relationships (MacKinnon et al. 2000).

In Model 3, the inclusion of operational fit enhanced the explanatory power for environmental performance (R-square from 0.135 to 0.152) and social performance (R-square from 0.120 to 0.131), but not much for economic performance and operational performance. Correspondingly, the paths from GSCM-GIS fit to Environmental Performance and social Performance were significant at the 0.01 and 0.05 levels. Supporting H3c and H3d but not H3a and H3b, the results suggest that the operational fit between GSCM and GIS have stronger impacts on environmental and social performances than economic and operational performances.

6 Conclusion and implications

Organizations in the contemporary business environment face the challenge of integrating GSCM and GIS to obtain competitive advantage and support sustainable development. Based on a literature review, this study conceptualizes and operationalizes the alignment between the different aspects of GSCM and GIS. This effort responds to the call for research on the practice side of alignment in addition to the strategy side (Karpovsky and Galliers 2015). Operational fit between GSCM and GIS can be viewed as the result of functional deployment to align them in operations, following the strategic planning that leads to their strategic fit when both are implemented. The empirical results support most of the hypothesized relationships in the research model. In particular, the findings suggest that GSCM plays the primary role in achieving sustainability goals in terms of economic, operational, environmental and social performances. Meanwhile, GIS plays important supporting role to GSCM in all regards. Furthermore, the operational fit between GSCM and GIS enhances the environmental performance and social performance.

The operational fit construct comprises the corresponding relationships between GSCM and GIS components, and implies the mechanism through which their alignment may be formed. What is limited, however, is that the observations collected in this study do not provide further clues on whether such alignment is intentionally carried out or just happened in such a way. It would be more helpful if at least some of the participants were interviewed with questions regarding whether they purposefully align GSCM and GIS practices or not. Future studies may collect such qualitative data to supplement quantitative results. Also, it is preferred that at least one outcome variable such as economic performance be measured with objective indicators like revenue growth from public companies to cross-validate the findings from survey data. Finally, all the data in this study were collected from a single

Table 8 Hierarchical PLS estimates

	Model 0				Model 1				Model 2				Model 3			
	EcP	EnP	OpP	SoP	EcP	EnP	OpP	SoP	EcP	EnP	OpP	SoP	EcP	EnP	OpP	SoP
R-Square	.071	.041	.023	.044	.126	.100	.068	.100	.139	.135	.101	.120	.139	.152	.101	.131
Organization Age	-.163**	-.030	-.062	-.116	-.156**	-.030	-.058	-.112	-.147**	-.020	-.047	-.102	-.148**	-.013	-.047	-.090
Organization Size	.208***	.110	.073	.085	.197***	.105	.065	.080	.203***	.118*	.077	.091	.204***	.111*	.077	.088
Type: Manufacturing	.206***	.169**	.098	.142*	.174***	.144**	.074	.114	.172***	.144**	.071	.108	.175***	.130*	.071	.100
Type: Energy	.068	.152**	.096	.153**	.049	.132**	.077	.134*	.043	.119*	.069	.126*	.043	.114*	.069	.117*
Type: Real Estate	.141**	.166**	.136*	.156**	.123*	.147**	.121*	.139**	.125*	.149**	.124*	.141**	.125*	.149**	.124*	.146**
Type: Logistics	.001	.025	.017	.106*	.010	.034	.028	.116	.004	.024	.019	.108*	.004	.024	.019	.102
Type: IT	.067	.070	.132*	.156*	.076	.077	.136**	.166**	.070	.068	.124*	.158**	.071	.065	.124*	.157**
Type: Service	.183***	.097	.122	.210***	.158**	.076	.104	.191***	.149**	.065	.095	.180***	.149**	.070	.095	.171**
H1: GSCM➔Perf					**.245*****	**.246*****	**.217*****	**.239*****	**.153****	**.102**	**.072**	**.130****	**.163****	**.051**	**.080**	**.099**
H1–1: ECO➔GSCM					.339***	.344***	.336***	.333***	.339***	.344***	.337***	.333***	.339***	.344***	.337***	.333***
H1–2: SCP➔GSCM					.406***	.399***	.408***	.407***	.406***	.400***	.408***	.407***	.406***	.400***	.408***	.407***
H1–3: IEM➔GSCM					.409***	.411***	.409***	.413***	.409***	.411***	.409***	.413***	.409***	.411***	.409***	.413***
H2: GIS➔Perf									**.151****	**.238*****	**.234*****	**.181*****	**.166****	**.146****	**.244*****	**.131****
H2–1: PP➔GIS									.359***	.361***	.357***	.358***	.359***	.361***	.357***	.358***
H2–2: PS➔GIS									.378***	.376***	.379***	.378***	.378***	.376***	.379***	.378***
H2–3: SD➔GIS									.364***	.364***	.365***	.364***	.364***	.364***	.365***	.364***
H3: Fit➔Perf													**-.032**	**.185*****	**-.021**	**.124****

Organization Age was normalized using logarithm transformation. Observed significance levels are based on two-tailed test for control variables, and right-tailed test for hypothesized relationships. The bold indicates major structural paths in the research model

GSCM Green Supply Chain Management, *ECO* Eco Design, *SCP* Supply Chain Process, *IEM* Internal Environment Management, *GIS* Green Information Systems, *PP* Pollution Prevention, *PS* Product Stewardship, *SD* Sustainable Development, *Fit* GSCM-GIS fit, *Perf* Performance, *EcP* Economic Performance, *EnP* Environment Performance, *OpP* Operational Performance, *SoP* Social Performance

* Significant at 0.1 level

** Significant at 0.05 level

*** Significant at 0.01 level

country, which limits the generalizability of findings. Further insights may be obtained with observations from multiple countries, which may allow comparative analyses across cultures and development stages.

Nevertheless, the study yields some important theoretical and practical implications. First, it suggests that the integration of GSCM and GIS can be regarded as an organizational effort to match their goals and capabilities in the deployment of both. Compared with the common perceived fit conceptualization, this operational fit conceptualization digs into different aspects of GSCM and GIS and examines their relationships with each other. Rather than directly asking subjects how they perceive the fit between GSCM and GIS, the operational fit instrument provides a more "objective" way to assess their alignment. This largely avoids issues like social desirability bias and common-method bias.

There have been some studies on the alignment between green practices and information systems (e.g. Gunasekaran and Ngai 2004; Ryoo and Koo 2013), but they hold the traditional view that technology plays a supportive role as in business-IT and SCM-IS relationships. In conceptualizing GSCM-GIS fit, this study takes a more balanced perspective that GIS does not only support other green endeavors like GSCM but comprises technology-enabled business practices by itself. Compared with higher-level organizational phenomenon such as green culture and green strategy, GSCM and GIS involve specific practices at the operational level. At the same level of analysis, GSCM and GIS activities deserves a close look for potential alignment.

This study focuses on the operational fit between GSCM and GIS, which extends the common conceptualization of business-technology fit at the strategic level. Most existing studies on the relationships between GSCM and GIS address their strategic fit without digging deeper to their specific practices (e.g. Gunasekaran and Ngai 2004; Ruppel 2004; Sanders 2005; Seggie et al. 2006; Shah et al. 2002; Thun 2010; Wong et al. 2009). To operationalize GSCM-GIS fit, this study identifies the common dimensions of GSCM and GIS practices in terms of environment protection (end), process control (means) and organization support (structure).

Along these dimensions, GSCM and GIS practices can be coupled together into matching components. Thus, the main content domain of operational fit between GSCM and GIS comprises their end, means, and structure. The correlations among GSCM and GIS components exhibited a hierarchical pattern consistent with the assumption that environment protection alignment is the most direct to the ecological goal but the narrowest in scope, and organization support alignment is the most indirect but broadest, with process control alignment in between.

For the operationalization of GSCM-GIS fit, this study proposes a method to combine both fit-as-profile-deviation and fit-as-moderation approaches. Compared with the commonly used fit-as-matching approach based on overall perceived fit, such an operationalization captures the alignment in a more objective way. This method is not just limited to the study of operational fit between GSCM and GIS, but applicable to other types of alignment as long as the two sets of measures can be matched with each other. The combinational use of two approaches remedies their limitations and synergizes their strengths.

The statistical modeling based on such a conceptualization also leads to more concrete and meaningful findings that have practical implications for organizations. Based on the effect of each fit variable on different performance measure, organizations can figure out which aspect of GSCM-GIS fit needs improvement to optimize certain performances. First of all, it is important for organizations to implement both GSCM and GIS if they are serious about sustainable development, and such efforts pay off for all aspects of organizational performance. The suppression effects suggest that GIS may greatly optimize GSCM's effects on environmental and operational performances, and largely enhance GSCM's effects on economic and social performances. Thus GIS provides important technological facilitation for GSCM, especially its core ecological and operational functions.

Among the GSCM-GIS fit indicators, those of the process control dimension were not as significant as those of the other two dimensions, yet their outer loadings were still salient. Such suppression effects suggest that environment protection alignment and organization support alignment are somewhat more effective to enhance organizational performances than process control alignment. There are two possibilities: the former two aspects of alignments are either easier to form or more directly related to outcome variables than the latter. Whereas exact answers require qualitative observations (e.g. longitudinal case study), the use of operational alignment makes such an in-depth understanding possible.

The results regarding GSCM-GIS fit suggest that their operational fit further enhances environmental and social performances, but not necessarily economic and operational performances. Researchers found that it takes an organization long-term effort to fulfill its externally-oriented social and environmental responsibilities, in contrast to more immediate economic and operational goals that largely concern the organization in question (Babiak and Trendafilova 2011; Kogg and Mont 2012). The hierarchical PLS analyses suggest that the GSCM implementation and GIS implementation are able to assure operational and economic performances by themselves but their operational fit still matters for social and environmental performances. On one hand, strategic planning leads to the implementation of both GSCM and GIS, and such a strategic fit is usually good enough for reaching short-term organizational goals. On the other hand, the functional deployment of GSCM and GIS leads to their operational fit that is important for fulfilling long-term and external responsibilities.

This supports rationale behind the development of operational fit construct in addition to strategic fit.

The operational fit between GSCM and GIS requires organizations to spend additional resources on top of their own implementations. The capital and human cost for communication and coordination (e.g. set up a new department to organize GSCM and GIS implementations) may offset the effects of GSCM-GIS fit on economic and operational performances. At the beginning, organizations may focus on GSCM and GIS implementations without spending too much resource on the pursuit of their alignment. But in the long run, organizations need to pay attention to the operational fit between them in order to realize their full potentials.

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