Informal Alignment in Digital Innovation for Corporate Sustainability

Completed Research

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Abstract

Sustainable development is the inevitable choice of enterprises, and they have to enhance their innovation capability with information and communication technologies (ICT). This paper examines digital innovation in form of the informal alignment between green supply chain management (GSCM) and green information systems (GIS). Unlike regular task-technology fit conceptualized as the necessary condition for technology use and task completion, informal alignment is hypothesized to enhance innovation capacities on top of GSCM and GIS. The results from a survey study suggest that GSCM-GIS fit renders full mediation for GIS but no mediation for GSCM in their enhancement of innovation capability, which are conducive to sustainable development. The findings suggest that informal alignment constitutes more of a necessary condition for the technology aspect but more of a sufficient condition for the task aspect of digital innovation.

Keywords

Digital innovation, informal alignment, innovation capability, sustainable development, green information systems, green supply chain management.

Introduction

Natural resource depletion highlights social and economic issues that impose serious threats to the sustainable development of the whole human society as well as millions of enterprises all over the world. In this case, organizational innovations to reduce material and energy consumption and waste emission in goods production and service delivery have drawn public attention. Building such a capability with the help of information technology becomes the inevitable trend and primary choice for enterprises to pursue corporate sustainability.

Organizational innovation is conducive to competitive advantages by expediting organizational reform, breaking structural barriers, and creating a pro-sustainability culture (Hoffman and Bazerman 2007). In addition to the improvement in resource efficiency and environment friendliness, enterprises are in a better position to meet consumer demands for environment-friendly products and expand market shares. As an important criterion to measure whether such activities can be smoothly and effectively carried out, innovation capability is a combination of all the organizational resources that contribute to sustainable development (Molla 2013).

The most common means to organizational innovation for sustainable development is to implement green supply chain management (GSCM) and green information systems (GIS) involving the employment of supply chain management and information technology for environment-related purposes, respectively

(Chen et al. 2008; Chiou et al. 2011). Respectively, GSCM and GIS correspond to the efficiency-oriented and technology-driven aspects of organizational innovation (Testa and Iraldo 2010). Within an organization, these two endeavors are usually initiated at different points of time by different departments. Most organizations pursue GSCM first as the concept precedes that of GIS and the resulted efficiency enhancement is more directly observable. To retain the edge in sustainable development, many find it necessary to implement GIS with latest technologies, such as paperless office, telecommuting and pollution monitoring (Watson, Boudreau, & Chen, 2010).

For the same sake of sustainable development, it is likely that employees adapt GIS functions to facilitate GSCM tasks. For instance, they may use paperless-office and telecommuting technologies for electronic workflow and virtual collaboration in supply chains (Melville 2010). Such technology facilitation is different from the use of dedicated information systems to complete certain tasks (e.g., inventory management). Regular task-technology fit is based on the top-down arrangement of system implementation to meet task demand, but the connection between GSCM and GIS is shaped through the spontaneous engagement of employees in both. This kind of informal alignment from day-to-day routines leads to digital innovation for sustainable development in which GIS functions are assimilated with GSCM activities (Yang et al. 2018b).

Lacking theoretical framework and empirical evidence, how the informal alignment between enterprise endeavor and information technology affects organizational innovation capabilities is yet to be examined. As an effort, this study examines how GSCM-GIS fit affects product innovation capability and process innovation capability. The findings may yield helpful insights into the best practices of digital innovation for corporate sustainability.

Research Background

Efficiency oriented, GSCM optimizes resource use and reduces environmental footprint in the supply chain process involving procurement, production, logistics and recycling (Huang 2009). The innovation comprises the major aspects of eco-design, supply chain processes and internal environmental management (Lee et al. 2012; Zhu and Sarkis 2006). Eco design directly targets the sustainability goal of organizational innovation, supply chain processes streamline the means to the end through business process reengineering, and internal environmental management provides critical organizational support. They correspond to the common dimensions of organizational innovation in terms of goal, process, and support(Davenport 1993).

As a technology-driven innovation, GIS recently emerges to utilize information systems for the ecological purpose (Bose and Luo 2011; Lei and Ngai 2013). There are some special systems like pollution monitoring, but many are general systems adopted for ecological purposes such as teleconferencing used to reduce travel reduction (Melville 2010). Based on employee engagement in their daily tasks, GIS is more autonomous and adaptive than most dedicated organizational systems, yielding far-reaching implications on how organizations run their business (Chen et al. 2011; Loos et al. 2011).

The flexibility and extensibility of GIS facilitate organizational innovations concerning pollution prevention, product stewardship, and sustainable development (Daugherty et al. 2005; Gholami et al. 2013). Similar to the dimensions of GSCM, they correspond to the goal, process, and support of organizational innovation as well. Pollution prevention minimizes emission and waste in production with information technologies (Darnall et al. 2008), such as computer-aided design and manufacturing (CAD/CAM) and 3-D printing. Product stewardship relies on real-time information capturing and processing to improve the efficiency of logistics involving acquisition, distribution, and recycling (Gholami et al. 2013), as in the case of just-in-time inventory management. Sustainable development uses various technologies like telecommuting and environment auditing to enhance managerial control for better environmental compliance (Watson et al. 2010; Watson et al. 2008).

Based on the alignment concept in the management literature, task-technology fit captures how well system characteristics meet task requirements to predict technology use and task accomplishment (Goodhue and Thompson 1995; Lin and Huang 2008). At the organizational level, it is used to assess the alignment between enterprise systems and organizational tasks, such as in the case of group decision support systems and team projects (Dymoke-Bradshaw and Cox 2005; Fuller and Dennis 2009; Strong and Volkoff 2010). Efficiency-oriented and technology-driven, GSCM and GIS can be considered as the task and technology sides of organizational innovation. Yet, they are relatively independent of each other and it is questionable to conceptualize their possible alignment as regular task-technology fit that assumes the interdependence between two sides, such as in the case of financial information systems for financial management.

When employees have the chance to engage in both GSCM and GIS endeavors, they are likely to make a complementary effort along the common goal, process and support dimensions, leading to a synergy between two endeavors. Compared with regular task-technology fit from formal top-down planning, this kind of alignment from everyday employee participation is rather informal in nature. Nevertheless, such spontaneous and constant involvement accounts for a significant proportion of resource utilization in organizations other than strategic planning (Guth and MacMillan 1986). Just like what weak ties mean to knowledge sharing (Granovetter 1983), therefore, informal alignment may play a critical role in digital innovation. This study attempts to examine the phenomenon from the perspective of how GSCM-GIS fit affects innovation capability.

Innovation capability concerns how well an organization is able to coordinate a variety of resources for successful innovation, especially sustainable development (Molla 2013). Infrastructure investment and employee participation are the two essential elements for innovation capability building (Zhen 2011). GSCM and GIS can be regarded as important organizational infrastructures and employee participation leads to their synergy through informal alignment. Flexible innovation capabilities from mutual adaptation allow organizations to address environmental uncertainties and stakeholder concerns that drive the changes (Lai et al. 2015).

Innovation capability is regarded as one of the most important factors that determine organizational performances (Calantone et al. 2002). Organizations mobilize managerial, technological and human resources to optimize production and operation, meet market demand, and reduce environmental impacts. In particular, technology play a critical role in organizational innovation to boost up short-term efficiency and achieve long-term sustainability (Xiaosong Peng et al. 2011; Yang 2012). Yet little is known about the dynamic process of capability building in digital innovation for sustainable development. The research question that this study investigates is, therefore, "What role does the informal alignment between GSCM and GIS play in organizational innovation for sustainable development?" The findings may contribute to the digital innovation literature regarding the informal alignment between enterprise endeavor and information technology.

Research Model

Most empirical studies on task-technology fit do not include task and technology characteristics in actual analyses as they are not supposed to affect the outcome variables by themselves but rely on the alignment construct that represents their union. As rather independent endeavors, GSCM and GIS need be taken into account for their direct impacts on the outcome variables. Their informal alignment is not the necessary condition for both to take effects, but captures their synergistic effect.

As the management-side and technology-side endeavors, GSCM and GIS influence corporate sustainability by shaping various aspects of innovation capability (Chiou et al. 2011; Liao et al. 2007). The innovation capability for sustainable development has two main aspects: product innovation capability and process innovation capability (Bhupendra and Sangle 2015; Liao et al. 2007; Lin and Bhattacherjee 2010). What kinds of products and services that an organization provides to the market and society and how it makes and delivers them largely determine corporate sustainability. The relationships among all the relevant constructs are hypothesized in the research model shown in Figure 1.

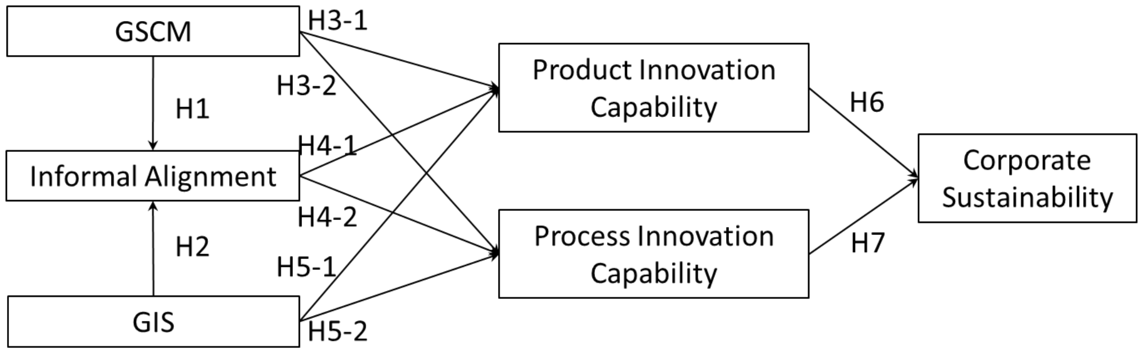

Figure 1. Research Model

Organizations often implement both GSCM and GIS, though not necessarily at the same time, for they are the most important means of organizational innovation for sustainable development (Mallidis et al. 2014; Sarkis et al. 2011). When employees have the opportunities to engage in two endeavors, they are likely to adapt one to the other: on one hand, supply chain management relies on the existing technology infrastructure (Darnall et al. 2008; Rai et al. 2006); on the other, evolving and emerging technologies continuously deepen supply chain integration and operation (Qrunfleh et al. 2012). There is likely a synergy between supply chain management and information systems when they complement each other in improving organizational performance (Wong et al. 2009).

H1: GSCM has a positive linear relationship with informal alignment.

H2: GIS has a positive linear relationship with informal alignment.

In addition to the environmental pressure, enterprises launch GSCM and GIS initiatives to gain competitive advantages by meeting market demands and keeping up with technological trends. Through product innovation and process innovation, such endeavors enhance corresponding aspects of innovation capability for sustainable development (Alexe and Alexe 2015; Lai et al. 2015). The mutual adaptation between two promotes organizations to build innovation capability with resource integration in innovation activities (Yang et al. 2018a).

H3-1: GSCM has a positive linear relationship with product innovation capability.

H3-2: GSCM has a positive linear relationship with process innovation capability.

H4-1: Informal alignment has a positive linear relationship with product innovation capability.

H4-2: Informal alignment has a positive linear relationship with process innovation capability.

H5-1: GIS has a positive linear relationship with product innovation capability.

H5-2: GIS has a positive linear relationship with process innovation capability.

Once formed, innovation capability plays an important role in sustainable development (Chiou et al. 2011; Khaksar et al. 2016). Both product innovation ability and process innovation ability are likely to have a positive impact on corporate sustainability.

H6: Product innovation capability has a positive linear relationship with corporate sustainability.

H7: Process innovation capability has a positive linear relationship with corporate sustainability.

Methodology

To test the research hypotheses, survey observations were collected. The scale of GSCM came from Lee et al. (2012) (e.g., "We carry out green supply chain management to reduce material/energy consumptions"). GIS items were based on Gholami et al. (2013) and Daugherty et al. (2005) (e.g., "We use green information systems to reduce overall consumption and emissions"). Measures of Informal Alignment were adapted from Lin and Huang (2008) (e.g., "How we use green information systems is compatible with green supply chain management"). Product Innovation Capability was measured with the items based on Liao et al. (2007) and Bhupendra and Sangle (2015) (e.g., "Our new products and services are often perceived as very novel by customers"). The scale of Process Innovation Ability was adapted from Wang and Ahmed (2004), Bhupendra and Sangle (2015), and Akgün et al. (2009) (e.g., "When conventional methods cannot solve a problem, we improvise on new ones."). Corporate sustainability measures were derived from Gholami et al. (2013) and Chiou et al. (2011) (e.g., "Our sustainable development is enhanced in terms of resource consumption reduction").

Observations were collected using survey questionnaires based on contact lists compiled from a manager training center and an online MBA program in China. At the beginning, there is a filtering question asking whether each participant's organization has implemented both GSCM and GIS (if not, the participant was asked to simply answer "No" to that question and returned the questionnaire). A total of 275 questionnaires were distributed and 253 were returned with 214 valid responses. The response rate was 92.0% and the effective response rate was 84.6%. Among the effective responses, 125 (57.4%) were collected with paper questionnaires and 89 (41.6%) with online surveys.

To find out whether two data collection methods resulted in different response patterns, a MANOVA test was conducted to compare two sets of responses. The result showed no significant difference (Wilks' Lambda = 0.934, p-value = 0.164) between them, indicating that data collection methods did not cause noticeable deviation(Armstrong and Overton 1977).

The sample has a largely balanced gender distribution (48% females vs. 52% males). One third of participants stayed more than 5 years in jobs, whereas the rest had fewer years. In terms of their positions in organizations, 60% were at the operational level, 32% were at the middle level, and 8% were at the executive level.

Results

This study assessed common method bias (CMB) as all the responses were collected with a survey questionnaire (Podsakoff et al. 2003). Harman's single factor test found that the proportion of the first principal component in the unrotated factor matrix is less than 50%, which suggests that CMB is not a big concern. Furthermore, confirmatory factor analysis was conducted to compare method-only model, trait-only model, and trait/method model (Richardson et al. 2009). Table 1 shows that the trait-only model yielded the best goodness-of-fit, confirming that the trait-based variance was stronger than the common method variance.

Model	**$\chi2$**	***df***	**$\chi2/df$**	**RMSEA**	**CFI**	**TLI**
Method-Only (1-Factor)	3522.944	560	6.291	0.158	0.547	0.490
Trait-Only (10-Factor)	1038.211	515	2.016	0.069	0.920	0.902
Trait/Method (11-Factor)	873.982	480	1.821	0.062	0.940	0.921

Table 1. Unmeasured Latent Method Construct (ULMC) Model Comparison

Table 2 reports measurement response patterns. As expected, descriptive statistics of each construct indicate that the responses were relatively positive with moderate variability. The confirmative factor analysis (CFA) yielded acceptable fit indices for GSCM and GIS dimensions (χ^2 = 319.671; df = 120; χ^2/df = 2.664; RMSEA = 0.088; CFI = 0.935; TLI = 0.917) as well as first-order constructs including informal alignment, product innovation capability, process innovation capability and corporate sustainability (χ^2 = 250.585; df = 113; χ^2/df = 2.218; RMSEA = 0.076; CFI = 0.956; TLI = 0.947). Composite reliability (CR) coefficients were above 0.7 and average variance extracted (AVE) values were over 0.5, supporting convergent validity. In the correlation matrix, the smallest squared AVE value (0.87) on the diagonal was greater than the largest factor correlation (0.79), supporting discriminant validity.

Construct	Mean(SD)	CR	AVE	1	2	3	4	5	6	7	8	9	10
1. GSCM-Ecological design	6.03(1.19)	.90	.75	.87									
2. GSCM-Supply chain process	5.65(1.25)	.91	.77	.72	.88								
3. GSCM-Internal env. mgmt..	5.64(1.30)	.93	.80	.75	.79	.90							
4. GIS-Pollution prevention	6.03(1.11)	.91	.78	.67	.49	.59	.88						
5. GIS-Product stewardship	5.79(1.14)	.91	.78	.48	.56	.52	.70	.88					
6. GIS-Sustainable development	5.79(1.17)	.95	.85	.54	.47	.56	.77	.77	.92				
7. Informal Alignment	5.23(1.16)	.94	.77	.39	.43	.40	.51	.55	.55	.88			
8. Product Inno. Capability	5.27(1.26)	.93	.78	.46	.42	.45	.41	.47	.47	.59	.88		
9. Process Inno. Capability	5.25(1.26)	.95	.83	.47	.48	.49	.42	.44	.45	.57	.79	.91	
10. Corporate Sustainability	5.67(1.21)	.90	.80	.47	.40	.49	.58	.46	.55	.53	.49	.52	.89

Table 2. Measurement Responses

In this study, GSCM and GIS are first-order-reflective-and-second-order-formative constructs. Variance inflation factor (VIF) was used to determine whether there is high collinearity among the components of GSCM and GIS. The maximum VIF of each constituent variable was 3.207, which is less than 10, the threshold of salient multi-collinearity. In addition, the outer weights GSCM and GIS components were all above 0.3, suggesting the salient contribution of each to the formation of second-order constructs.

Compared with covariance-based structural equation modeling (SEM), the partial least square (PLS) method is able to handle both reflective and formative constructs (Hair et al. 2016). This study used the Smart PLS 3.0 to test the research model, and Figure 2 reports the estimated path coefficients. First of all, the formative indicators of GSCM (ecological design: 0.345, supply chain process: 0.362, and internal environmental management: 0.387) and GIS (pollution prevention: 0.339, product management: 0.358, and sustainable development: 0.400) were all salient at the level of 0.001, confirming the contribution of each indicator. Whereas GSCM had mainly direct impacts on Product Innovation Capability and Process Innovation Capability, GIS had only indirect effects on them through the mediation of Informal Alignment. Both aspects of innovation capability enhanced Corporate Sustainability. GSCM and its alignment with GIS explained about 40% of the variance in the product and process aspects of innovation capability, which contributed to a little bit less than 30% of corporate sustainability. Of course, there are many non-innovation factors that make differences in organizational performances, leading to the relatively low effect size of innovation-performance relationship (Rai et al. 2006).

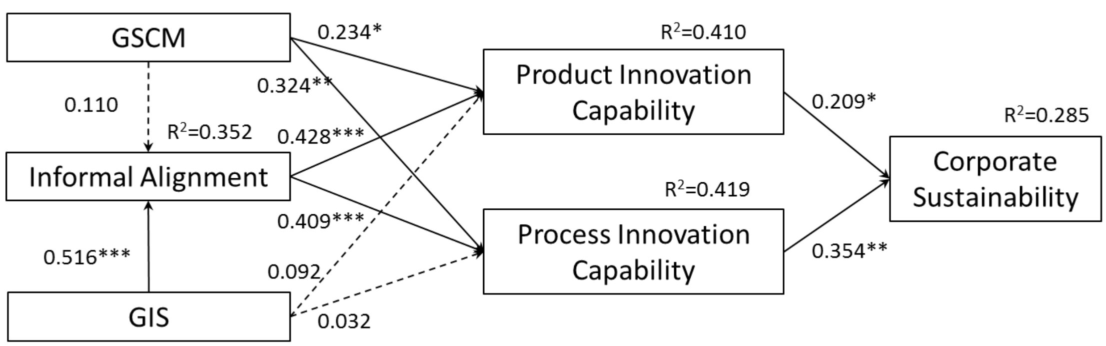

Figure 2. Estimated Model (*: *p*-value < 0.1; **: *p*-value < 0.05; ***: *p*-value < 0.01)

Discussion

The results support most of the research hypotheses and yielded interesting insights. The informal alignment between GSCM and GIS is non-mediator for the former but a full-mediator for the latter in how each affects innovation capability. The significant direct impacts of GSCM confirm the intended role it plays in organizational innovation to enhance operational efficiency and reduce environmental footprint through different activities (Chiou et al. 2011; Khaksar et al. 2016; Younis et al. 2016).

As a rather general and broad category of technologies, GIS manifests its values when employees use the functions in their daily activities related to sustainable development. Such digital innovation explains why GIS does not have direct impacts on innovation capability building but through its informal alignment with GSCM. During the process, people's effort to assimilate GIS functions in their routines exhibit the goal, process and support dimensions, similar to those of GSCM activities.

Compared with GSCM literature, there are not many studies on how GIS influence corporate sustainability and the results are somewhat mixed. In a study on the relationship between GIS and environmental performance, for example, only long-term implementation was found to have an effect (Gholami et al. 2013). Instead of the direct relationship, the Natural Resource-Based Perspective (NRBV) suggests that the adoption of GIS can optimize resource allocation and utilization, which positively affect business performance (Nishant 2012). Such a perspective is consistent with the conceptualization of informal alignment in this study. Through its facilitation of daily routines, GIS changes the way how employees carry out organizational tasks.

The informal alignment between GSCM and GIS from employee engagement in both leads to a synergistic effect. Though an organization may just implement one, the benefits are more profound when both are in place. Nevertheless, it is preferable to initiate GSCM first and then follow up with GIS. This will lead to smoother digital innovation as the management side of organizational innovation will set the tone for the technology side. With the tasks at hand, employees will explore the use of technologies in a meaningful way and provide valuable feedback to managers so that they can provide needed resources and support (e.g., helpdesk). The findings of this study provide the supporting evidence of digital innovation capability building through such an informal alignment between GSCM endeavor and GIS technology for sustainable development.

Conclusion and Implications

From an informal alignment perspective, this study investigates digital innovation for sustainable development. It conceptualizes that spontaneous employee participation in both GSCM and GIS endeavors leads to their mutual adaptation in favor of innovation capability building. In contrast to regular task-technology fit from the top-down arrangement, such an informal alignment does not take effects by itself but in combination with main endeavors. The findings suggest that it fully mediates the effects of GIS on product and process aspects of innovation capability, but not for GSCM. In this sense, informal alignment mainly serves as the necessary condition from the technology aspect but the sufficient condition from the task aspect for digital innovation to succeed.

This study goes beyond the single-solution approach in the current research. Many studies either focus on GSCM or GIS as the main means for enterprises to attain corporate sustainability. Yet the interaction between different innovation endeavors is likely to generate a one-plus-one-greater-than-two result. This study addresses such synergistic effect from the perspective of informal alignment, in contrast to regular task-technology fit that assumes interdependence. Based on the spontaneous participation of employees, such a form of digital innovation occurs on a daily basis and is highly flexible to meet the challenges of the fast-changing business and technology environment.

Compared to the task-technology fit model in which the alignment construct directly influences performance, this study includes an intermediate layer of innovation capability. The findings suggest that GIS enhances innovation capability through its informal alignment with GSCM, which have direct impacts instead. The difference reveals the role that bottom-up digital innovation plays in organizational innovation for sustainable development. That is, informal alignment enhances innovation capability with employee spontaneity and creativity. In the long run, it is such innovation capability that leads to corporate sustainability and eventual competitive advantage. For instance, big data and artificial intelligence have great potentials for sustainable development. If employees are accustomed to exploring emerging technologies, they are likely to come up with innovative ideas to make use of them in their jobs.

For managers, the findings yield useful insights into the best practices of digital innovation for corporate sustainability. Rather than designating specific systems to particular groups of users, organizations may encourage all the employees to try different technologies in their work. Over time, people will develop the capability to absorb emerging technologies, which will make the organization innovation itself sustainable. In this way, the informal alignment will become the main mechanism of digital innovation, similar to the role that weak ties play in social networking.

This study is limited in the fact that all the observations were collected from a single country. The sample from China is appropriate for testing the general framework due to the development stage that the country is at and the sustainability challenge that it faces. The generalization of specific findings, however, demands caution as it would be oversimplified to assume that organizations in other countries are similar. Rather, the differences in national factors like culture and policy need to be taken into account. In future studies, such variables may be included in cross-country analyses.

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