

Manuscript Number:

Title: Sustainable Supply Chain Management: Confirmation of a higher-order model

Article Type: SI: SCP in Bus. DM Models

Keywords: Sustainable Supply Chain; Corporate Social Responsibility; Sustainable Development; Scale Development; Survey

Corresponding Author: Dr. Ying Kei Tse, PhD

Corresponding Author's Institution: University of York

First Author: Minhao Zhang

Order of Authors: Minhao Zhang; Ying Kei Tse, PhD; Bob Doherty; Si Li; Pervaiz Akhtar

Abstract: Despite the wide discussion of sustainable supply chain management (SSCM) with the triple bottom line, few empirical studies consolidate the social and environmental aspects of SSCM. Drawing from the research of green supply chain management (GSCM) and corporate social responsibility (CSR), this paper proposes a hierarchical structure of SSCM and develops a multi-item measurement scale to reflect the specific management practices of SSCM. In this research, SSCM is operationalised as a third-order factor reflected by three second-order factors, namely external GSCM, internal GSCM and CSR. Utilising a rigorous, multi-step scale development method and data from 293 Chinese manufacturers, we validate a 31-item measurement scale and approve the proposed third-order structure of SSCM. The results confirm the multidimensionality of SSCM, which suggests that it is necessary to consider both environmental and social issues in SSCM implementation. The valid measurement scales of SSCM provide managers with a "to do list" to make the specific business decisions to achieve sustainable development in the supply chain.

# Sustainable Supply Chain Management: Confirmation of a higher-order model

## Abstract

Despite the wide discussion of sustainable supply chain management (SSCM) with the triple bottom line, few empirical studies consolidate the social and environmental aspects of SSCM. Drawing from the research of green supply chain management (GSCM) and corporate social responsibility (CSR), this paper proposes a hierarchical structure of SSCM and develops a multi-item measurement scale to reflect the specific management practices of SSCM. In this research, SSCM is operationalised as a third-order factor reflected by three second-order factors, namely external GSCM, internal GSCM and CSR. Utilising a rigorous, multi-step scale development method and data from 293 Chinese manufacturers, we validate a 31-item measurement scale and approve the proposed third-order structure of SSCM. The results confirm the multidimensionality of SSCM, which suggests that it is necessary to consider both environmental and social issues in SSCM implementation. The valid measurement scales of SSCM provide managers with a “to do list” to make the specific business decisions to achieve sustainable development in the supply chain.

**Key Words:** Sustainable Supply Chain; Corporate Social Responsibility; Scale Development; Sustainable Development; Survey

## 1. Introduction

In today's business environment, as well as competing on cost and profitability, organisations have a new focus on sustainability (Tseng, 2013). Many studies suggest that companies with a “sustainability culture” perform better in the long run than other companies (Pagell and Wu, 2009, Lin et al., 2016). Certainly, sustainability is regarded as a key ingredient of competitive advantage. Recent researches indicate that the need for firms to be sustainable is due to pressure from stakeholders, such as government, customers and wider society (Sharfman et al., 1997, Christmann and Taylor, 2001, Perez - Sanchez et al., 2003, Zhu et al., 2007). For instance, since 2011, when Greenpeace identified Apple as the “least green” technology company because of the substantial energy consumption incurred by its cloud data service (Carus, 2011), the company has implemented a series of green management programs to reconstruct the business model towards sustainable consumption and production (Apple, 2015). Recently, Apple announced that 93% of its facilities are running on green energy (Kokalitcheva, 2016). This improvement in terms of sustainable management has been recognised by the market and by society.

In China as elsewhere, manufacturers have started to consider how to make their businesses more sustainable, so as to respond to environmental regulations put in place by government, the increasingly educated society and competitors, and their international customers (Govindan et al., 2014). Moreover, in China, tremendous economic growth has resulted in a precarious ecological situation (Zhu and Sarkis, 2007, Yardley, 2005), which reinforces the awareness of the need for sustainability. According to Zhang et al. (2002), Zhang and Wen (2008), China should implement a strategy of low resource consumption and stable and sustained economic growth. Nevertheless, the research on sustainable development in developing countries such as China is not extensive. Chinese managers still lack holistic guidance on business decision making to deal with the sustainability issues in the current highly competitive business environment.

Over the last decade, researchers have attempted to extend the boundary of sustainable development into the area of supply chain management (SCM), to investigate sustainable supply chain management

(SSCM) (Pagell and Wu, 2009, Seuring and Muller, 2008, Tseng et al., 2015, Tseng and Chiu, 2013). Based on the triple bottom line (TBL) standard, it is increasingly clear that SSCM should deal with both environmental and social issues (Kleindorfer et al., 2005, Corbett and Klassen, 2006, Tseng et al., 2008, Pagell and Wu, 2009). However, while an increasing number of firms are starting to adopt indicators such as environment, health and safety and social factors to measure the sustainability of production (Tseng, 2013, Tseng et al., 2009, Tseng et al., 2008, Tseng and Lin, 2009), most focus on the environmental dimension (Seuring and Muller, 2008). Researchers are keen to identify the best practices for improving environmental performance. There are two main research directions, namely examining the impact of existing management systems on companies' environmental performance, and conceptualising new environmental management practices (Pagell and Wu, 2009). For example, King and Lenox (2001) explore the linkage between lean production, measured by the adoption of ISO 9000, and environmental performance. On the other hand, Zhu et al. (2008b) developed an important measurement scale of Green Supply Chain Management (GSCM). Most recently, Esfahbodi et al. (2016) have empirically tested the relationship between SSCM practices and organisational performance according to two perspectives – environmental performance and cost performance. However, their model of SSCM is still a modification of the existing GSCM practices, which focus solely on the environmental dimension. Compared with the research of green/environmental issues, there is very little SSCM literature that considers social aspects (Seuring and Muller, 2008). Indeed, Kleindorfer et al. (2005) argue that the current studies of SSCM have ignored the social component of sustainability. Among the few exceptions, some authors have adopted four categories of the social pillar of responsibility, namely Labour Practices, Human Rights, Society and Product Responsibility, to develop social assessment indicators (Jorgensen et al., 2008). To the best of our knowledge, there is limited empirical research that consolidates social and environmental aspects in the investigation of SSCM. In order to close this research gap, this study aims to answer the following questions:

1. Does SSCM empirically comprise the environmental and social dimensions?
2. How can we measure SSCM?

In this research, we conceptualise and validate the constructs of SSCM in the context of the Chinese manufacturing industry. Drawing upon insights from the literature of GSCM and CSR, we synthesise a holistic structure of the SSCM and provide a measurement scale for practitioners and for future research. Based on the findings of an extensive literature review and structured interviews with experienced academics and practitioners, we model the SSCM as a third-order construct. We employ a rigorous scale development process, which has been widely adopted in the literature (such as Shah and Ward, 2007; Cao and Zhang, 2010; Oliveira and Roth, 2012), to validate the proposed structure of SSCM. This proposed structure establishes the key management practices that determine SSCM attributes of three crucial dimensions, namely external GSCM, internal GSCM and CSR.

In what follows we present the scale development process for SSCM. In Section 2, we describe the theoretical background of SSCM and give the associated hypotheses in the proposed structural model. Section 3 presents the details of the scale development process. That section also provides the data analysis for the measurement model, including the results of content validity, unidimensionality, construct reliability and discriminant validity. Also in Section 3, we present the structural equation modelling (SEM) analysis of the hierarchical structure of SSCM. Section 4 discusses the managerial implications of the study, while conclusions and recommendations for future research are given in Section 5.

## 2. Sustainable Supply Chain Management

Although the debate regarding sustainable supply chain management (SSCM) is still ongoing, there is general agreement as to some key definitions. Sustainability is regarded as a normative notion of how human beings should treat the natural environment, and of how they carry responsibility for one another and future generations (Kates et al., 2001; Clark and Dickson, 2003; Clark, 2007). Evolved from the concept of sustainability, sustainable development is now being widely discussed in policy research (Swart and Raes, 2007, Jordan, 2008) and business management research (Hall et al., 2010, Steurer et al., 2005). Specifically, sustainable development is “*a development that meets the needs of the present without compromising the ability of future generations to meet their needs*” (WCED, 1987). Embracing the concepts of sustainability and sustainable development, SSCM has grown out of the traditional context of supply chain management (SCM), which aims at managing the supply chain relationship and the flow of materials and information to maximise operational performance and the profitability of the supply chain (Lummus and Vokurka, 1999, Li et al., 2006, Mentzer et al., 2001).

Compared with SCM, SSCM has multiple dimensions, and is not focused solely on profits (Seuring and Muller, 2008, Jennings and Zandbergen, 1995, Gladwin et al., 1995). Seuring and Muller (2008) state that a truly sustainable supply chain can produce long-term profitability without harming natural or social systems. The triple bottom line standard is used to operationalise the performance of a sustainable supply chain, which includes economic, environmental and social dimensions (Carter and Rogers, 2008). Thus the term SSCM has been defined by Carter and Rogers (2008, p. 368) as “*the strategic, transparent integration and achievement of an organization’s social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains*”, and by Seuring and Muller (2008, p.1700) as “*the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements*”. These definitions have in common their grounding on the triple bottom line concept of sustainability.

Building upon the GSCM and CSR research in the supply chain context, this research provides a new measurement scale that evaluates eight synergistic management practices. More specifically, this study views SSCM as a holistic and multidimensional construct that is measured by the following eight management practices from different disciplines:

1. Sustainable Product Design (SPD)
2. Environmental Procurement (EP)
3. Environmental Customer Collaboration (ECC)
4. Internal Green Management (IGM)
5. Investment Recovery (IR)
6. Diversity Management (DM)
7. Community Development and Involvement (CDI)
8. Safety Management (SM)

In order to explain the hierarchical structure of the concept, we operationalise SSCM as a third-order construct. According to Oliveira and Roth (2012), the notion of third-order construct is very useful to describe complex phenomena, and it is widely adopted in the marketing literature (Dabholkar et al., 1996, Brady and Cronin, 2001, Ko and Pastore, 2005, Ranjan and Read, 2014). The individual practices are represented by the indicators (i.e. questionnaire items) and the first-order management practices are measured by these related indicators. Based on the similarities of the first-order management

practices (i.e. dimensions), we conceptualise the second-order practices bundles. As Zhu et al. (2008b) have already validated the second-order structure of the GSCM, it is necessary to extend the concept of SSCM into a higher-order structure. According to the definition of SSCM and the triple bottom line standard, we consider that SSCM is a multidimensional concept that considers both environmental and social issues. Accordingly, in the following sections, we develop the hypothesised structure of SSCM with the hypotheses of its sub-dimensions from H1 to H3.

## 2.1 External GSCM

This research categorises GSCM into the external aspect and the internal aspect, based on the “*organisational boundary of a manufacturer*” (Zhu et al., 2013, p. 107). Zhu et al. (2013) argue that external GSCM refers to those practices that require a certain level of external cooperation with stakeholders and suppliers or customers. In this research, we define external GSCM as “*the environmental management practices that manage the cooperation with supply chain partners or stakeholders for the environmental objectives and solutions*” (Vachon and Klassen, 2008, Zhu et al., 2008a, De Giovanni, 2012, Zhu et al., 2013). In other words, the external GSCM reflects the collaborative implementation of sustainable practices in the supply chain in order to achieve environmental goals (Vachon and Klassen, 2008, De Giovanni, 2012). Typically, the focus of external GSCM is on collaboration with the supply chain partners (i.e. suppliers, second-tier suppliers and customers) to reduce the negative environmental impacts of processes and products (Geffen and Rothenberg, 2000, De Giovanni, 2012). Drawing from the research model of Zhu et al. (2013), the external GSCM is associated with the management practice bundles, which consist of SSM, SCC and IR. Because the focus of external GSCM is consistent with the environmental dimension of TBL, we hypothesise that:

*H1: External GSCM positively reflects the SSCM*

EP, or green purchasing, is an important dimension of the external GSCM, and focuses on the upstream suppliers. According to Nagel (2000), environmental key concepts, such as eco-labels, the avoidance of environmentally hazardous substances, the recyclability of supply materials and the environmental responsibility of suppliers, together provide the contents of EP. Certification and collaboration are two key elements in this dimension (Pagell and Wu, 2009). For example, in the automobile industry, some big enterprises, such as Ford, GM and Toyota, have required their Chinese suppliers to be certified with ISO 4000 (Zhu et al., 2007). It should be noted that EP is not confined to cooperation with direct suppliers but also considers the environmental responsibility of second-tier suppliers. In this research, we adopt the notion of Zsidisin and Siferd (2001, p. 69), to define EP as “*the set of purchasing policies held, actions taken, and supplier relationships formed in response to concerns associated with the natural environment*”. Consistent with previous research, EP is regarded as a critical component of the GSCM implementation (Gunther and Scheibe, 2006, Min and Galle, 1997, Zhu et al., 2008a, Zhu et al., 2013). Due to its externally focused characteristics, we hypothesise that:

*H1a: EP positively reflects external GSCM*

Like EP, ECC is an external environmental management practice, but one that focuses on the collaboration between the focal company and customers. It involves cooperating with the customers to environmentally manage the production, the flow of materials and maximise the use of logistics resource in distribution process. According to Vachon and Klassen (2008), environmental collaboration requires a close supply chain relationship to plan and establish the objectives for environmental performance. A large customer company will usually expect its suppliers to have better environmental performance. Therefore suppliers have great motivation to cooperate with the customer regarding the environmental requirements (GEMI, 2001; Zhu et al., 2008a). To achieve the environmental

objectives, ECC normally includes the supply chain joint activities regarding cleaner production, green packaging and logistics resources maximisation. Vachon and Klassen (2008) find that ECC can lead to better quality performance of the supply chain. In addition, ECC is found to be positively associated with environmental performance (Zhu et al., 2013). Empirically, previous researches have confirmed that ECC is a crucial dimension of GSCM (Zhu et al., 2008b). Moreover, combined with the practices of green purchasing (i.e. EP), the practices of ECC are also conceptualised as elements of external GSCM (Zhu and Sarkis, 2004, Zhu et al., 2008a). Therefore, we hypothesise that:

*H1b: ECC positively reflects external GSCM*

IR is an emerging environmental management approach used in both developed countries (Tibben-Lembke, 2004) and developing countries (Zhu et al., 2008c) to achieve a closed loop supply chain (CLSC). The practices of IR are developed from the concept of reverse logistics (RL), a process that takes back previously shipped products or components from the point-of-consumption for possible recycling, re manufacturing, or disposal (Lai et al., 2013). In addition to the reuse or recycling of unused or end-of-life products, RL should also consider the sale of surplus products and assets (Zhu et al., 2008b). In this research, IR is defined as the “*management practices that recover and recapture the value of unused or end-of-life assets through sales of excess inventories, scrap and used materials, excess capital equipment and refurbished products*” (Esfahbodi et al., 2016; Zhu et al., 2008b). Zhu et al. (2007) find that the positive impacts of IR on both environmental and economic performance are statistically significant. According to Zsidisin and Hendrick (1998), the enterprises of developed countries have widely considered IR as a critical aspect of GSCM (Zhu et al., 2008c). Using the data from Chinese manufacturers, Zhu et al. (2008b) also confirm that IR is one of the dimensions of GSCM. Because IR might require a certain level of customer cooperation, we consider it as an externally focused management practice. Hence, we propose:

*H1c: IR positively reflects external GSCM*

## 2.2 Internal GSCM

While external GSCM refers to management practices related to inter-organisational issues, internal GSCM focuses on improving the internal operations to achieve better environmental outcomes (Zhu et al., 2013). It aims at achieving the firm’s specific internal targets, as established by the management team or imposed by company policies (Rao, 2002, Wu and Dunn, 1995). Thus, the internal GSCM practices reflect the organisation’s capability to adopt a sustainable strategy aimed at reducing the negative environmental impact of its own operations, for example in terms of commitment from senior managers, cross-functional cooperation and eco-design (Rao, 2002, Walton et al., 1998, Bowen et al., 2001). In this research, internal GSCM is defined as “*the practices that can be implemented and managed independently by individual manufacturers with the purpose of improving environmental performance*” (Zhu et al., 2013, p. 107). It has an environmental focus, which is consistent with the environmental dimension of the sustainable TBL. Hence, we hypothesise:

*H2: Internal GSCM positively reflects SSCM*

In order to proceed with the implementation of GSCM practices such as EP, IR, GD and ECC, it is necessary for an organisation to ensure commitment from top and mid-level management on the adoption of environmental sustainability as a strategic imperative (Green et al., 2012). If the company is to achieve environmental excellence, top management must be totally committed to the implementation of the environmental practice (Rice, 2003; Zsidisin and Siferd, 2001; Green et al., 2012). Therefore, the green commitment of the management team should be a key element of IGM. In addition, IGM is related to key concepts such as regulation, training and cross-functional

cooperation within an organisation (Zhu et al., 2007, Zhu et al., 2013, Zhu and Sarkis, 2004, Hervani et al., 2005). In this study, we define IGM as *the practice of improving environmental excellence internally through management commitment, employee training, organisational regulation and cross-functional collaborations*. According to Carter et al. (1998), IGM is also a key driver to improve enterprises' performance. In the Chinese context, IGM is regarded as the most important GSCM practice, and has received particular attention from managers (Zhu and Sarkis, 2004). Following the classification of Zhu et al. (2013), we posit that:

*H2a: IGM positively reflects internal GSCM*

A number of environmental management studies have indicated the importance of SPD, or eco-design. Zhu et al. (2007) argue that green product design is the one of the most significant dimensions in sustainable production. Typically, SPD is about designing the product to be environmentally friendly and recyclable, for example by using greener materials and reducing the consumption of energy and resources (Min and Galle, 2001). Eco-design, also known as "Design for the Environment", can be defined as *"the systematic integration of environmental consideration into product and process design"* (Canada, 2003; Knight and Jenkins, 2009). In the context of an emerging market like China, if a local enterprise plans to establish a supply relationship with foreign customers, it might be required to integrate eco-design into its operations (Zhu et al., 2015; Zhu et al., 2007). According to Eltayeb et al. (2011), eco-design is an internally focused GSCM practice that enhances the environmental attributes of the products with little cooperation or interaction with external parties. Therefore, SPD can be regarded as a dimension of internal GSCM:

*H2b: SPD positively reflects internal GSCM*

### 2.3 Corporate Social Responsibility

According to Seuring and Muller (2008), apart from the economic and environmental aspects of organisational activities or actions, SSCM should also consider the social aspects. A growing body of research indicates that SSCM does focus on improving both environmental and social performance of firms in the supply chain context (Schaltegger and Burritt, 2014, Amann et al., 2014, Harms et al., 2013, Wittstruck and Teuteberg, 2012, Bai and Sarkis, 2010). Nevertheless, there is very limited research that integrates the management practices with regard to social aspects into the framework of SSCM. Moreover, Carter and Easton (2011) also urge the recognition of the interrelationships among topics such as environment, diversity, human rights and safety. These topics are key to conceptualising a holistic view of CSR and to understanding sustainability in the context of supply chain management (Carter and Rogers, 2004, Carter and Easton, 2011). Currently, companies are beginning to extend their CSR from internal production to their supply chain partners (Cruz and Wakolbinger, 2008, Emmelhainz and Adams, 1999, Kolk and Tudder, 2002). In this research, CSR is defined as *"meeting the economic, legal, ethical and discretionary responsibilities expected by society"* (Carroll, 1979, Carroll, 1991, Carter and Jennings, 2004). According to Chi (2011), the adoption of CSR activities is helpful for enterprises to establish a sustainable supply chain in the long term. Thus, we hypothesise that:

*H3: CSR positively reflects SSCM*

Managing diversity issues is a critical direction of CSR research. Kacperczyk (2009) finds that the corporate attention to diversity can positively influence long-term shareholder value. In particular, purchasing from minority/women-owned business enterprises (MWBE) is conceptualised as an important element of purchasing diversity (Carter and Jennings, 2004, Dollinger et al., 1991, Carter et al., 1999). Inoue and Lee (2011) provide a more holistic view, whereby diversity can be measured by

the extent of the appointment of women and minority (WM) executives, the promotion of WM and contracting with MWBE suppliers. Furthermore, the Kinder, Lydenburg, Domini (KLD) rate, a major method to measure CSR, also includes the consideration of diversity issues (Kacperczyk, 2009, Inoue and Lee, 2011, Berman et al., 1999, Hillman and Keim, 2001, Johnson and Greening, 1999). Thus, we propose that:

*H3a: DM positively reflects CSR*

According to Carter and Rogers (2004), CSR also encompasses the dimension of safety considerations. Under the concept of CSR with regard to supply chain functions, precautions to ensure employees' health and safety, and safety in warehousing and production, are vitally important activities (Ciliberti et al., 2008, Tekin et al., 2015). Wu et al. (2015) find that prominent international contractors give high priority to occupational health and safety in the CSR key benchmarking framework. Moreover, Saunders et al. (2015) use safety as a proxy for social sustainability factors, which is consistent with the social dimension of the TBL. Consequently, it is hypothesised that:

*H3b: SM positively reflects CSR*

The inclusion of CDI in CSR is supported by the social contract theory. According to Gray et al. (1996), a society can be described as a series of social contracts between members of society and society itself. There are two kinds of social contract: macrosocial contracts and microsocal contracts (Donaldson and Dunfee, 1999). Macrosocial contracts refer to a social expectation that commercial companies can provide support to their local community, while microsocal contracts are specific forms of social involvement (Moir, 2001). Through a thorough investigation of 115 companies, the CCPA (2000) found that three-quarters of the companies supported community development and that involvement is key to business sustainability. Moreover, the great majority of companies in the CCPA (2000) study regarded CDI as a form of CSR and as associated with long-term commercial outcomes. Therefore, the following hypothesis is developed:

*H3c: CDI positively reflects CSR*

### 3. Methodology

The research purposes of this study are to develop the hierarchical structure of the SSCM and to verify a reliable and valid scale to measure the concept of SSCM. According to Shah and Ward (2007), a rigorous and comprehensive scale development process is presented in this section. The verification process for the measurement scale comprises five steps: (1) generating questionnaire items and assessing content validity, (2) establishing the questionnaire, (3) data collection, (4) exploratory factor analysis and (5) confirmatory factor analysis and (6) hierarchical structure validation. The details of each step are provided in Figure 1.

#### 3.1. Generating Questionnaire Items

Based on a comprehensive literature review and comments from an expert panel, we aimed to generate items that accurately reflect the proposed constructs, thus ensuring content validity (Li et al. (2005). Therefore, the process of item generation comprised two steps. First, we reviewed the previous literature on GSCM and CSR in the supply chain context. From this we obtained the theoretical insights to compile the initial list of potential items.

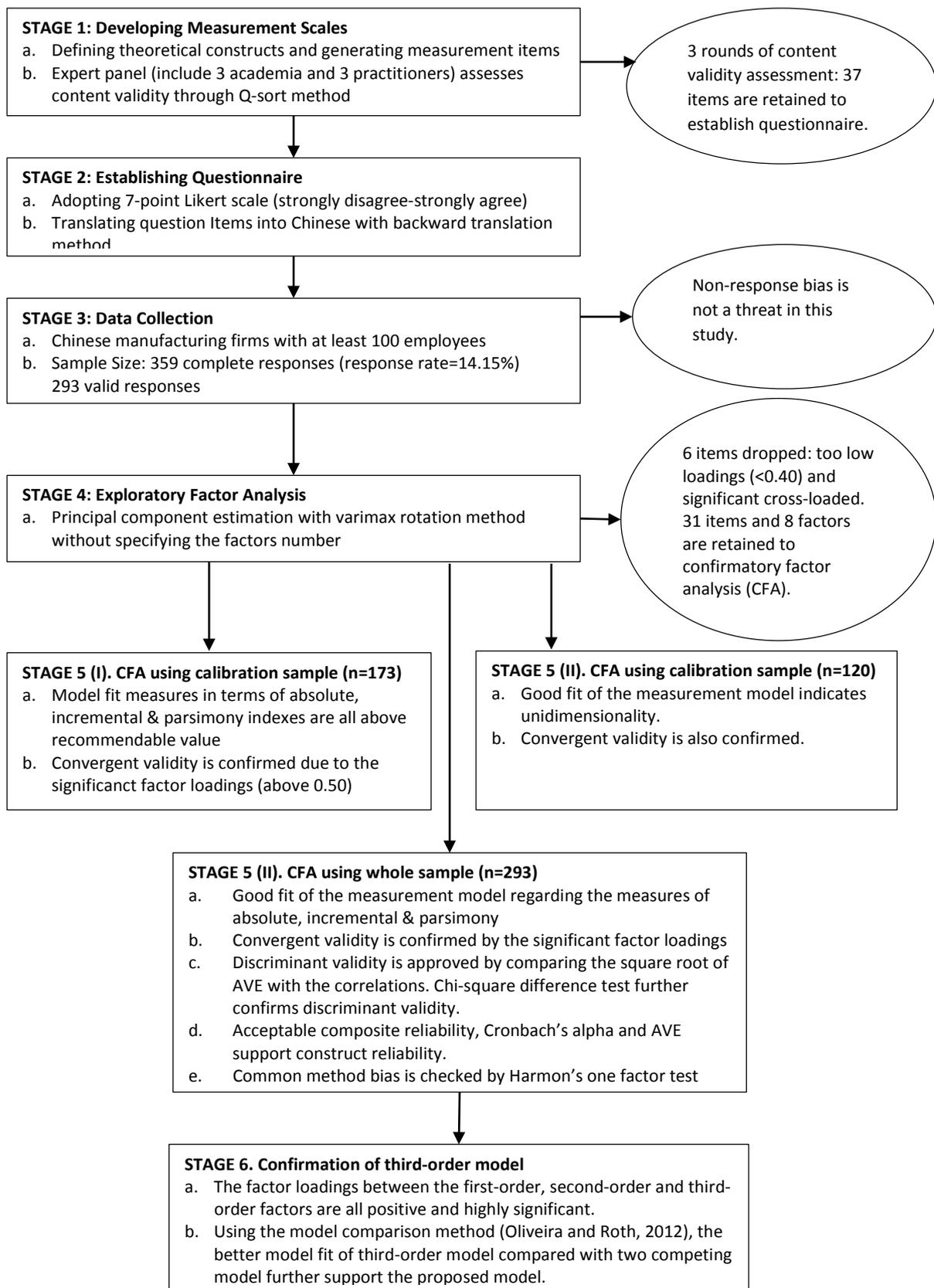


Figure 1. Scale development Structure

Developed from the work of Oliveira and Roth (2012) and Shah and Ward (2007)

Second, we conducted structured interviews with an expert panel, consisting of three academics and three practitioners, followed by a Q-sort procedure to assess the content validity of the questionnaire items within the initial list. We began by conducting structured interviews with one academic and one practitioner to review carefully the definition of each proposed construct and to clarify the wording or address redundancy problems for each question item. Then, we asked a different pair of manager and academic to finish the sorting task of “item-to-factor” (Menor and Roth, 2007). According to Moore and Benbasat (1991), the idea behind the Q-sort measure is to have experts act as judges and sort the items into several groups, with each group corresponding to a dimension based on an agreement between judges. In this study, we adopted three measure indices to conduct the content validity test: a) inter-judge agreement percentage, b) item placement ratio (i.e. hit ratio) and c) application of Cohen’s kappa (k) test. Specifically, the inter-judge agreement percentage is the number of items that expert judges agree to place into a certain category divided by the whole item pool (i.e. the total number of indicators). According to Hardesty and Bearden (2004), the threshold value for inter-judge agreement is from 60% to 75%. The hit ratio is the number of “items that are correctly sorted into the intended theoretical category divided by twice the total number of items” (Cao and Zhang, 2011, p. 168). Although there is no established standard to determine a “good” level of hit ratio (Moore and Benbasat, 1991), generally speaking, a hit ratio above 70% would be accepted (Moore and Benbasat, 1991, Stratman and Roth, 2002). The third measure index, Cohen’s kappa (k) indicates the index of beyond chance agreement among the judges of the expert panel (Armenakis et al., 2007, Stratman and Roth, 2002, Cohen, 1960). The results of the Q-sort measurement tests are available from the authors. Then, the final pair of academic and practitioner were responsible for reviewing and modifying the items adopted in the first two rounds of content validity confirmation. After following this process, 37 question items were sent out as the pilot study for the exploratory analysis.

### 3.2. Establishing the Questionnaire

The aim of this stage was to produce a well written and clear questionnaire. As suggested by Hinkin (1995), the researcher should give consideration to format issues, including the “use of negative wordings”, “number of items within a construct” and “justification of Likert scale”. In this study, each of the constructs has more than four measurement items. Our respondents were asked to measure their level of agreement for each of the construct items on a 7-point Likert scale (i.e. strongly disagree to strongly agree).

As our target respondents are Chinese managers, our questionnaire is in two versions: one in Chinese<sup>1</sup> and one in English. Therefore, the process of translation is critical for our research. Following Brislin (1980), we adopted the backward translation process to ensure the accuracy of the questionnaire presented to our target respondents. Once the questionnaire had been finalised, we invited two Chinese academics to help us fine-tune the wording and the structure of our questionnaire.

### 3.3. Data Collection

To obtain practical insights of SSCM, we targeted as our respondents practitioners with related knowledge and experience of manufacturing industry (SIC 20-39). Because SSCM focuses on the corporation’s practices with both suppliers and customers, we narrowed our research unit to the focal manufacturers of a supply chain. In addition, given that previous literature argues that bigger firms are more likely to achieve SSCM, we adhered to an important criterion whereby respondents must have at least 100 employees in their company (Shah and Ward, 2007). A Chinese business marketing and consultancy firm was employed to assist the administration of the formulated survey instrument. After refining the original mail-list by eliminating entries with incomplete records (such as lack of job

---

<sup>1</sup> The Chinese version questionnaire was further divided into two different written styles – Simplified Chinese and Traditional Chinese.

title or valid email address), our dataset contained 2537 valid potential samples. Employing a two-round data collection process, we began by sending out 2537 online surveys via email with an appropriate cover letter; then, two weeks later, we followed up this initial contact with phone and email reminders. According to Cao and Zhang (2011), web-based survey is an efficient method to collect responses. Finally, we received 359 completed responses, representing a 14.15 percent response rate. After removing responses that were invalid because the time taken to answer was too short (i.e. less than seven mins to complete the questionnaire<sup>2</sup>), or data were missing, we had 293 that were suitable to be analysed. The demographic information of our respondents and the results of non-response bias test are provided in Table 1. Due to the relatively low response rate compared with other survey-based research, our sample might contain non-response bias (Frohlich, 2002). Therefore, we conducted the  $X^2$  difference test to assess the difference between first-wave and second-wave respondents in terms of company size, regions and job titles. The non-significant results of the  $X^2$  difference test indicate that non-response bias was not a threat to our sample.

	Number of firms	First-wave frequency (n=143)	Second wave frequency (n=150)	Chi-square test for non-response bias	Total Percentage (%)
<b>The Position of Respondent</b>					
CEO	3	2	1	$X^2 = 4.698$ df = 4 $p = 0.320$	1.0
Vice President/Director	51	21	30		17.4
Purchasing Director	176	94	82		60.1
Supply Chain Manager	57	23	34		19.5
Others	6	3	3		2.0
<b>Firm Size (Number of Employees)</b>					
100 – 300	54	23	31	$X^2 = 3.759$ df = 2 $p = 0.153$	18.4
300 – 2000	176	94	82		60.1
> 2000	63	26	37		21.5
<b>Company Base Region</b>					
North China	67	35	32	$X^2 = 5.895$ df = 6 $p = 0.435$	22.9
Northeast China	13	7	6		4.4
Eastern China	91	40	51		31.1
Central China	18	11	7		6.1
South China	61	34	27		20.8
Southwest China	30	11	19		10.2
Northwest China	13	5	8		4.4

Table 1. Profile of the respondents (n = 293)

<sup>2</sup> In general, it should take respondents 7- 9 mins to complete the questionnaire.

Table 2. Exploratory Factor Analysis

	Factor Loadings							
	CDI	DM	IR	IGM	EP	SM	ECC	SPD
CDI1	<b>0.806</b>	0.076	0.139	0.091	0.110	0.040	0.041	0.101
CDI2	<b>0.722</b>	0.070	0.134	0.120	0.192	0.233	0.134	0.010
CDI5	<b>0.696</b>	0.192	0.040	0.165	-0.014	0.129	0.123	0.204
CDI3	<b>0.674</b>	0.190	0.223	-0.040	0.242	0.145	0.130	0.097
CDI4	<b>0.554</b>	0.234	0.091	0.155	0.125	0.174	0.197	0.320
DM1	0.059	<b>0.805</b>	0.094	0.149	0.104	0.158	0.074	-0.039
DM4	0.156	<b>0.766</b>	0.133	0.180	0.047	0.044	0.004	0.202
DM3	0.195	<b>0.737</b>	0.112	0.114	0.030	0.092	0.186	0.183
DM2	0.193	<b>0.705</b>	0.141	0.161	0.219	0.244	0.053	0.004
IR2	0.080	0.157	<b>0.755</b>	0.192	0.165	0.103	-0.012	0.090
IR1	0.095	0.054	<b>0.749</b>	0.180	0.122	0.065	0.193	0.207
IR4	0.210	0.077	<b>0.730</b>	0.124	0.052	0.017	0.093	-0.001
IR3	0.131	0.219	<b>0.640</b>	-0.038	0.142	0.141	0.265	0.212
IGM1	0.149	0.140	0.166	<b>0.785</b>	0.186	0.063	0.076	0.118
IGM6	0.058	0.243	0.099	<b>0.714</b>	0.221	0.121	0.148	0.152
IGM4	0.137	0.158	0.200	<b>0.612</b>	0.024	0.119	0.239	0.322
IGM5	0.125	0.195	0.127	<b>0.609</b>	0.170	0.016	0.331	0.186
EP2	0.152	0.121	0.154	0.133	<b>0.782</b>	0.088	0.192	0.093
EP1	0.219	0.087	0.118	0.298	<b>0.663</b>	0.050	0.127	0.263
EP3	0.074	0.142	0.171	0.141	<b>0.653</b>	0.286	0.207	0.187
EP5	0.272	0.099	0.125	0.132	<b>0.532</b>	0.120	0.312	0.243
SM2	0.055	0.046	0.099	0.134	0.246	<b>0.792</b>	-0.018	0.013
SM3	0.210	0.109	0.096	-0.005	0.010	<b>0.705</b>	0.247	0.056
SM5	0.171	0.230	0.011	0.022	0.123	<b>0.655</b>	0.228	0.212
SM4	0.198	0.221	0.089	0.142	0.021	<b>0.628</b>	-0.066	0.341
ECC3	0.097	0.178	0.198	0.202	0.219	0.139	<b>0.738</b>	0.133
ECC1	0.154	0.109	0.208	0.237	0.267	0.045	<b>0.732</b>	0.148
ECC6	0.244	0.013	0.095	0.191	0.179	0.187	<b>0.700</b>	0.152
SPD5	0.138	0.108	0.147	0.190	0.203	0.178	0.138	<b>0.735</b>
SPD4	0.257	0.072	0.154	0.205	0.188	0.092	0.137	<b>0.670</b>
SPD6	0.122	0.120	0.152	0.223	0.213	0.181	0.174	<b>0.667</b>
Eigenvalue	3.115	2.880	2.592	2.570	2.472	2.470	2.393	2.343
Total Variance Explained	67.21%							

### 3.4. Exploratory Factor Analysis (EFA)

Before assessing the measurement model, in order to obtain an overall picture of the factors structure for the 37 items, we conducted EFA. This is also a method to evaluate the unidimensionality (Zhao et al., 2008). Three criteria were adopted in EFA to purify the indicators: a) factor loading should be above 0.30, b) Eigenvalue should be above 0.10, and c) the variance of the measurement items extracted by the factors should be greater than 50% (Chen and Paulraj, 2004, Zhao et al., 2008). In this research, we applied the principle component method to estimate the EFA model with varimax rotation method, without specifying the number of factors. Three items were dropped (i.e. EP4, ECC4 and IGM2) due to the significant cross loading. Another three factors (i.e. IGM3, SPD1 and SM1) were eliminated due to the percentage of variance of the items extracted in commonality being smaller than 0.50. The result of Kaiser-Meyer-Olkin test was 0.941, which is greater than the recommended value of 0.60 (Worthington and Whittaker, 2006), and thus indicates the sample adequacy for conducting the EFA. Finally, the eight-factor solution was retained for the CFA analysis (Table 2).

### 3.5. Confirmatory Factor Analysis

To verify the 31 items remaining from EFA, we apply confirmatory factor analysis (CFA) using AMOS v22. We employ a covariance matrix model of these items with maximum likelihood estimation. Specifically, the eight dimensions' measurement scales are checked with regard to (1) unidimensionality, (2) reliability, (3) convergent validity, (4) discriminant validity and (5) third-order construct validity. To improve the model fitness to an acceptable level, we adopt the iterative method and drop the question items with standardised factor loading lower than 0.50 (Cao and Zhang, 2011, Hair et al., 2006). According to Cao and Zhang (2010), the model modification (i.e. dropping unreliable items) should be continued until all of the reliability and validity tests are confirmed.

To indicate how well a particular item measures a latent variable, the convergent validity is assessed by the significance of  $t$ -value of each indicator. If the indicators significantly load their representative factors with  $t$ -value above 2.58 and  $p$ -value significant at 0.01 level, the test provides evidence of convergent validity.

Unidimensionality is *"the existence of a single concept underlying a group of measures and is important to assess before structural model testing is done"* (as cited in Swafford et al., 2006: p. 179). In other words, unidimensionality is confirmed once its indicators only measure a single construct (Menor and Roth, 2007). The results of EFA have already confirmed the presence of unidimensionality. In this stage, we use the measurement model fit indices to assess the unidimensionality further (Cao and Zhang, 2011; Menor and Roth, 2007; Hair et al., 2006). We evaluate three types of fit indices, namely overall model fit (i.e. absolute measures), model comparison (i.e. relative fit measures) and model parsimony (i.e. parsimony fit measures) (Schumacker and Lomax, 1996). According to Shah and Ward (2007, p. 795), these model fit indices help to answer the question *"how well do the relationships estimated by the model match the observed data?"* For example, if the values of CFI and NNFI are above 0.9, the overall model is a good fit (Cao and Zhang, 2011, Hair et al., 2006, Bentler and Weeks, 1980). We report the result of three dimensions of fit indices with recommended cut-off values in the following sections.

We also assess the construct reliability using three types of indices, namely composite reliability ( $p_c$ ), Cronbach's alpha ( $\alpha$ ) and average extracted variance (AVE). In order to ensure the construct reliability, the rule of thumb for Cronbach's alpha and composite reliability should be greater than 0.70 (Nunnally, 1978). However, Hair et al. (2006) argue that the Cronbach's alpha is still acceptable when the value is below 0.7 but above 0.6 (Tse et al., 2016). In this stage, IBM SPSS v22 is adopted to check the

construct reliability. If the AVE is above 0.5, the internal consistency of the latent variable is also achieved (Shah and Ward, 2007; Hair et al., 2006).

Discriminant validity is defined as “*the extent to which independent assessment methods diverge in their measurement of different traits (ideally, these values should demonstrate minimal convergence)*” (Byrne, 2013, p. 275). Typically, if the “*construct correlates with other constructs in the model are low*” and “*other measures are supposedly not measuring the same variables or concept*”, discriminant validity is indicated (Heeler and Ray, 1972, p. 32). To assess the discriminant validity, we compare the construct correlations with the square root of the AVE (Fornell and Larcker, 1981). If the square root of AVE for each construct is greater than the correlation between that construct and the other constructs, the result indicates discriminant validity (Flynn et al., 2010, Fornell and Larcker, 1981). We also adopt a pairwise CFA method using  $X^2$  difference test to assess the discriminant validity (Anderson and Gerbing, 1988; Zhu et al., 2008b). For each possible pair of the model, a model comparison is undertaken, comparing the paired factor model with a one-factor model. If the  $X^2$  difference between the two models is significant, discriminant validity is confirmed.

Following the CFA procedure suggested by Hausman et al. (2002) and Shah and Ward (2007), we apply the “split-sample” approach to test and refine the measurement model. We randomly divide our whole sample ( $n=293$ ) into two sub-datasets, the calibration sample ( $n=173$ ) and a validation sample ( $n=120$ ). Both sample sizes meet the minimum requirements of statistical power analysis (0.80 statistical power with 406 degrees of freedom and significant at the level of 0.05) (MacCallum et al., 1996; Shah and Ward, 2007). According to Shah and Ward (2007), the convergent validity and unidimensionality are assessed in all three samples (i.e. calibration, validation and whole sample), while the discriminant validity, construct reliability and validation of third-order structure are assessed in the whole sample only.

Finally, we use the model competition method to validate our third-order factor – SSCM (Oliveira and Roth, 2012). A second-order reflective model (i.e. where SSCM is treated as a second-order factor) and a formative model of dimensions of SSCM (Figure 3) are assessed to compete with the third-order model (i.e. the hypothesised model) regarding the model fitness (Goncalves, 2013, Oliveira and Roth, 2012). Moreover, to further validate the proposed hierarchical structure of SSCM (Figure 2), the standardised factor loading between the first-order, second-order and third-order factors should be above 0.5 with significant  $t$ -value, as required by the convergent validity test.

### 3.5.1 CFA analysis for the calibration sample

As shown in Table 3, the standardised factor loadings are all above 0.60, thus above the cut-off value of 0.50, and their corresponding  $t$ -values are all greater than 8.00, significant at the 0.001 level. Therefore, the convergent validity is confirmed in the calibration sample ( $n=173$ ). Also, the value of variance explained (i.e.  $R^2$ ) of indicators ranges from 0.369 to 0.769. For the measurement model with the calibration sample, three dimensions of the model fit indices are demonstrated to have an excellent fit (Table 4). First, regarding the overall model fit indices: NNFI=0.954, CFI=0.960 and IFI=0.961, which exceed the number of good model fit (i.e. 0.90). Moreover, the values of RMSEA, normed  $X^2$ , PNFI and RMR all indicate excellent fit of the measurement model in the calibration sample. Furthermore, we find that there are no absolute standardised residuals exceeding  $|2.58|$  and all the modification indices are below 0.10. In summary, the unidimensionality of the measurement model in the calibration sample is ensured (Shah and Ward, 2007).

Table 3. Measurement Model Fit for the Calibration, Validation and Whole Sample

Indicator	Latent Variable	Calibration Sample (n=173)		Validation Sample (n=120)		Whole Sample (n=293)	
		$\beta$ (C.R.) <sup>a</sup>	$R^2$	$\beta$ (C.R.) <sup>a</sup>	$R^2$	$\beta$ (C.R.) <sup>a</sup>	$R^2$
SPD2	SPD	0.758(-) <sup>b</sup>	0.575	0.685(-)	0.47	0.724(-)	0.514
SPD3	SPD	0.823(10.481)	0.677	0.685(6.150)	0.469	0.771(11.752)	0.377
SPD4	SPD	0.766(9.783)	0.586	0.736(6.465)	0.541	0.758(11.588)	0.476
EP3	EP	0.803(-)	0.645	0.763(-)	0.582	0.794(-)	0.519
EP2	EP	0.723(9.845)	0.523	0.664(6.991)	0.441	0.702(12.132)	0.561
EP1	EP	0.744(10.193)	0.554	0.731(7.731)	0.534	0.742(12.924)	0.608
EP5	EP	0.821(11.420)	0.674	0.741(7.839)	0.549	0.793(13.932)	0.524
CDI1	CDI	0.69(-)	0.476	0.724(-)	0.525	0.708(-)	0.664
CDI5	CDI	0.721(8.442)	0.52	0.679(6.771)	0.461	0.693(10.697)	0.48
CDI2	CDI	0.729(8.527)	0.532	0.743(7.363)	0.552	0.732(11.242)	0.498
CDI3	CDI	0.709(8.313)	0.503	0.749(7.413)	0.56	0.728(11.189)	0.53
CDI4	CDI	0.756(8.800)	0.572	0.617(6.182)	0.381	0.706(10.881)	0.536
ECC3	ECC	0.849(-)	0.722	0.734(-)	0.538	0.815(-)	0.401
ECC1	ECC	0.877(13.740)	0.769	0.762(7.715)	0.581	0.836(14.938)	0.624
ECC2	ECC	0.786(11.911)	0.618	0.57(5.571)	0.325	0.728(12.880)	0.495
IGM1	IGM	0.759(-)	0.577	0.695(-)	0.484	0.743(-)	0.534
IGM6	IGM	0.746(9.647)	0.557	0.724(6.705)	0.524	0.742(11.937)	0.542
IGM4	IGM	0.76(9.837)	0.577	0.634(5.998)	0.401	0.72(11.585)	0.426
IGM5	IGM	0.772(10.001)	0.596	0.666(6.262)	0.443	0.724(11.648)	0.564
DM1	DM	0.74(-)	0.547	0.743(-)	0.552	0.749(-)	0.501
DM2	DM	0.844(10.700)	0.712	0.533(4.908)	0.284	0.78(12.55)	0.629
DM3	DM	0.753(9.563)	0.566	0.696(4.019)	0.484	0.736(11.851)	0.55
DM4	DM	0.794(10.099)	0.631	0.621(5.587)	0.386	0.751(12.079)	0.493
SM4	SM	0.783(-)	0.613	0.553(-)	0.305	0.69(-)	0.595
SM3	SM	0.68(8.500)	0.462	0.594(4.526)	0.353	0.653(9.327)	0.575
SM5	SM	0.715(8.946)	0.512	0.731(4.998)	0.535	0.73(10.146)	0.524
SM2	SM	0.64(9.091)	0.41	0.634(4.697)	0.402	0.633(9.091)	0.63
IR4	IR	0.607(-)	0.369	0.615(-)	0.378	0.614(-)	0.699
IR2	IR	0.753(9.341)	0.567	0.591(5.015)	0.35	0.717(9.341)	0.552
IR3	IR	0.781(9.225)	0.61	0.551(4.754)	0.304	0.703(9.225)	0.53
IR1	IR	0.822(9.872)	0.676	0.73(5.739)	0.533	0.79(9.872)	0.551

Note: a. Standardised factor loading is denoted as  $\beta$  and t-value is denoted as C.R.  
b. This regression weight was fixed as 1.0

### 3.5.2 CFA test for the validation sample

To assess the measurement scales for the validation sample, we use the same CFA approaches as for the calibration sample. We find that the standardised factor loadings and their  $t$ -values are lower than the associated numbers in the calibration sample, but still exceed the cut-off value. Therefore, the measurement model of the validation sample indicates convergent validity (Column 5 in Table 3). The model fit indices for the validation model are provided in Table 4. Notably, the normed  $\chi^2$ , RMSEA, RMR and IFI meet the “rules of thumb” for a good model fit. The scores of CFI and NNFI are slightly lower than the recommended values, but they are still reasonable (Segars and Grover, 1998). In addition, we find that there are four absolute standardised residuals  $> |2.58|$ , representing a proportion of 0.8%<sup>3</sup> (4 out of 465). All the modification indices are below 20. Therefore, the validation sample also indicates that the measurement model has a good fit. According to Shah and Ward (2007), the CFA results for these two samples (i.e. calibration and validation) indicate “invariance of form”.<sup>4</sup>

<sup>3</sup> A value of  $|2.58|$  lying in the extreme 5% of the distribution.

<sup>4</sup> Where there is invariance of form, “using the same mapping of manifest variables to latent variables in two sub-samples is appropriate” (Shah and Ward, 2007, p. 798).

Indices	Shorthand	Calibration Sample (n=173)	Validation Sample (n=120)	Whole Sample (n=293)	Rule of thumb
<b>Absolute</b>					
Chi-square Test (degree of freedom)	$X^2(d.f.)$	518.761(406)	535.860(406)	554.28(406)	NA
Root mean square error of approximation	RMSEA	0.040	0.052	0.035	$\leq 0.08$
RMSEA, 90% confidence interval	/	(0.029; 0.050)	(0.039; 0.063)	(0.028; 0.042)	(0; 0.08)
p value $H_0$ : close fit ( $RMSEA \leq 0.05$ )	/	0.948	0.393	0.98	$\geq 0.05$
Standardised root means square residual	RMR	0.061	0.076	0.052	$\leq 0.10$
<b>Comparative fit</b>					
Non-Normed fit index	NNFI	0.954	0.885	0.959	$\geq 0.90$
Incremental fit index	IFI	0.961	0.904	0.964	$\geq 0.90$
Comparative fit index	CFI	0.960	0.899	0.964	$\geq 0.90$
<b>Parsimonious fit</b>					
Normed Chi-square	$X^2/d.f.$	1.278	1.320	1.365	$\leq 0.30$
Parsimony normed fit index	PNFI	0.735	0.606	0.767	$\geq 0.70$

Table 4. Model fit indices (Shah and Goldstein, 2006; Schreiber et al., 2006)

### 3.5.3 CFA test for the whole sample

For the entire sample, the unidimensionality and convergent validity are assessed using the same approach as for the two sub-datasets; in addition, the discriminant validity and construct reliability are examined. As shown in Table 3, the standardised path coefficient between the indicators and latent variables ranges from 0.614 to 0.836, and their  $t$ -values are significant at the level of 0.001. Therefore, the convergent validity is confirmed. Furthermore, the unidimensionality of the whole sample is also confirmed, because of the excellent model fitness (Table 4). There are no absolute standardised residuals greater than  $|2.58|$  and the modification indices are all below 0.20.

		$p_c^a$	$\alpha^b$	Items	AVE	SM	SPD	EP	CDI	ECC	IGM	DM	IR
1	SM	0.772	0.772	4	0.459	<b>0.678</b>	94.36	123	108.75	152.566	148.683	133.41	147.946
2	SPD	0.795	0.794	3	0.564	0.610 <sup>c</sup>	<b>0.751</b>	108.38	127.26	119.308	80.253	184.869	140.684
3	EP	0.844	0.842	4	0.576	0.517	0.679	<b>0.759</b>	193.043	128.074	158.236	323.674	202.312
4	CDI	0.838	0.836	5	0.509	0.614	0.624	0.635	<b>0.714</b>	197.144	229.551	234.855	200.994
5	ECC	0.836	0.834	3	0.631	0.485	0.644	0.707	0.569	<b>0.794</b>	120.943	261.019	172.048
6	IGM	0.822	0.819	4	0.536	0.464	0.726	0.642	0.531	0.696	<b>0.732</b>	189.678	172.153
7	DM	0.841	0.839	4	0.569	0.560	0.482	0.440	0.559	0.452	0.599	<b>0.754</b>	225.115
8	IR	0.800	0.797	4	0.502	0.427	0.580	0.541	0.532	0.587	0.584	0.477	<b>0.709</b>

Note: a. Composite reliability for the latent variable is denoted as  $p_c$ .

b. The Cronbach's alpha is denoted as  $\alpha$ .

c. The lower triangle shows the correlation.

d. The upper triangle shows the  $X^2$  difference between the pairwise factor model and single factor model. All  $X^2$  difference test with 1-degree freedom, so if  $X^2 > 11$ , p-value is significant at 0.001 level.

Table 5. Construct Reliability and Discriminant Validity

Because all  $p_c$  are greater than 0.75 and all  $\alpha$  exceed the recommended value of 0.70, the reliability for all eight latent variables is confirmed. With the exception of Safety Consideration, the AVE values of the other seven constructs are greater than the cut-off values (i.e. 0.50). Furthermore, Table 5 shows that the square roots of AVE (bold numbers in diagonal) are greater than the correlations among the constructs (off-diagonal values). The results provide evidence to confirm good discriminant validity. We also assess the pairwise CFA model comparison tests. We first build a pairwise CFA model for every latent variables. Then the pairwise CFA models are compared with the single factor model (i.e. the measurement items from each pairwise model are forced to be measured in a single latent

variable). As shown in Table 5, the significant results of all 28 pairwise  $X^2$  difference tests demonstrate discriminant validity (Anderson and Gerbing, 1988, Zhu et al., 2008b).

### 3.6 Common Method Bias

Based on Podsakoff et al. (2003), the common method bias might be a potential problem of this study because we use the seven-point Likert scale and single informants from each organisation. There are two characteristics of common method bias: “1. Only a single factor emerges from the factor analysis and 2. One general factor accounts for the majority of the covariance among measures” (Podsakoff et al., 2003, p. 889). To check for this problem, we use two statistical tests. First, Harman’s single-factor-test reveals that the first factor of the total of eight extracted factors with Eigenvalue above one explains only 35.20% of the total variance. Since this is not the majority of the total explained variance of 61.05%, we can claim that the common method bias is not a concern in this research. To further conduct Harman’s single factor test, we apply an additional CFA. The model fit indices of the single factor model ( $X^2/df = 3.868$ , NNFI = 0.675, CFI = 0.696, and RMSEA = 0.099) are worse than the recommended values. Hence, the unacceptable model indices of the single factor model also indicate that the common method bias is not a threat to this research.

### 3.7 Third-order Model Validation

The structural equation modelling (SEM) results of the hierarchical model of SSCM are shown in Figure 2. The factor loading of the first-order, second-order and third-order factors are all positive and highly significant ( $p < 0.001$ ) with  $t$ -value above 7.070. The model fit indices for the hypothesised model also show a good overall fit and all meet the recommended values:  $X^2 = 589.153$  ( $df=423$ ,  $p < 0.01$ ); Normed  $X^2 = 1.393$ ; CFI = 0.959; NNFI = 0.955; IFI = 0.960 and RMSEA = 0.037. Therefore, the results provide empirical support for our conceptual structure of the SSCM (i.e. H1 – H3).

Indices	Shorthand	Hypothesised Model (n=293)	Competing Model 1 (n=293)	Competing Model 2 (n=293)
Chi-square Test (degree of freedom)	$X^2(d.f.)$	589.153(423)	611.821(426)	1519.769(457)
Root mean square error of approximation	RMSEA	0.037	0.039	0.089
Standardised root mean square residual	RMR	0.057	0.062	0.336
Non-normed fit index	NNFI	0.955	0.951	0.724
Incremental fit index	IFI	0.960	0.955	0.748
Comparative fit index	CFI	0.959	0.955	0.746
Normed Chi-square	$X^2/d.f.$	1.393	1.436	3.326
Parsimony normed fit index	PNFI	0.793	0.792	0.622

Table 6. Model Fit Indices for Third-order Model Validation

To further confirm the empirical results of the third-order structure, we adopt the model comparison method. Two models are assessed to compare with the hypothesised models – 1. SSCM modelled as a reflective second-order model, and 2. A formative model of dimensions of SSCM (Figure 3). First, although the model fit indices of competing model 1 (i.e. SSCM as a second-order factor) indicate a good fit, the hypothesised model (i.e. SSCM as a third-order factor) shows a better overall fit (Table 6). Second, competing model 2 (i.e. formative model) shows poor results of model fitness with normed  $X^2 = 3.326 > 3$ ; NNFI = 0.724 < 0.8; CFI = 0.746 < 0.8; and IFI = 0.748 < 0.8. In summary, the hypothesised model illustrates a better picture of the SSCM than the two competing models. Therefore, we can conclude that the hypothesised model (i.e. third-order model) is further supported (Oliveira and Roth, 2012).

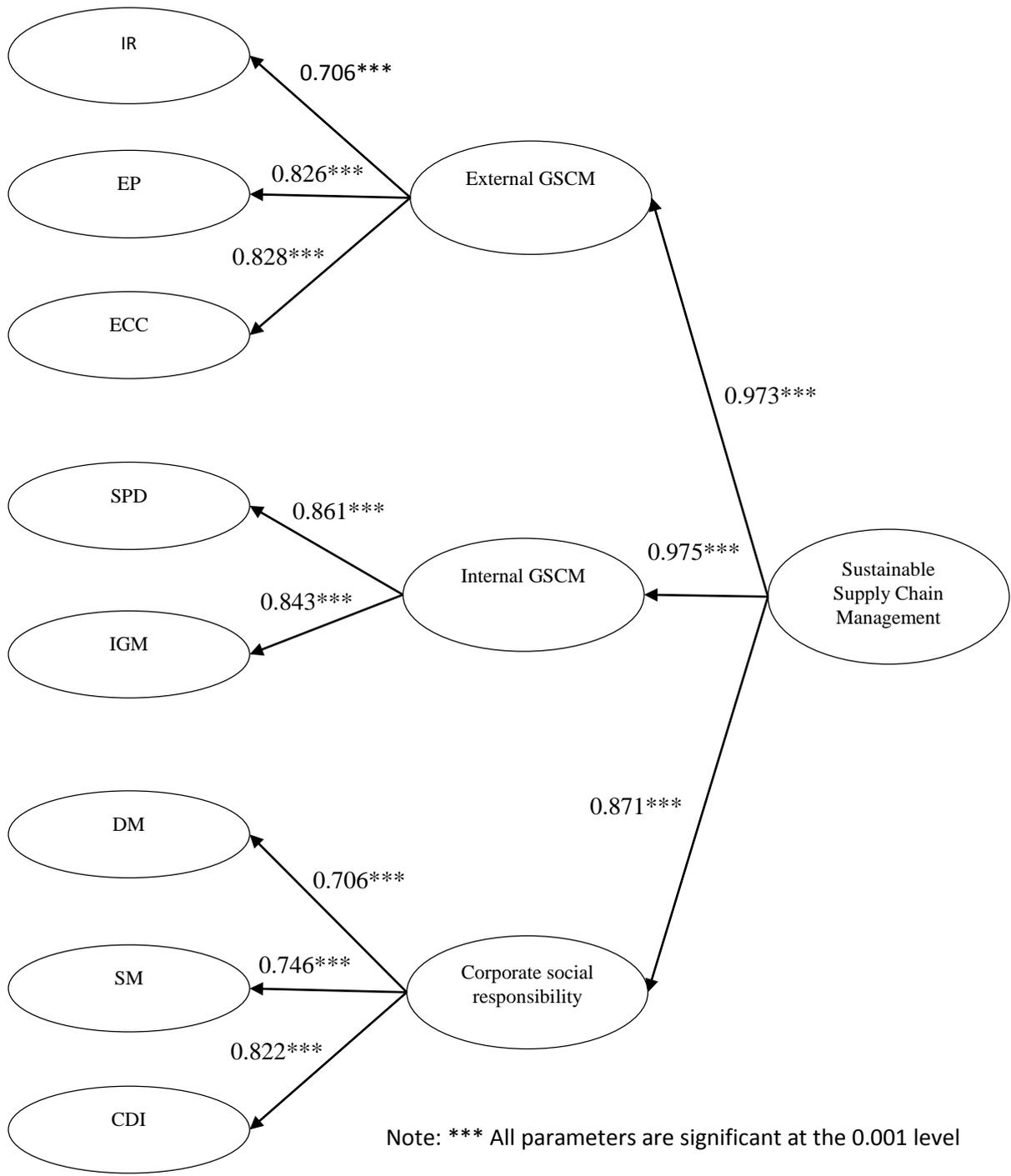
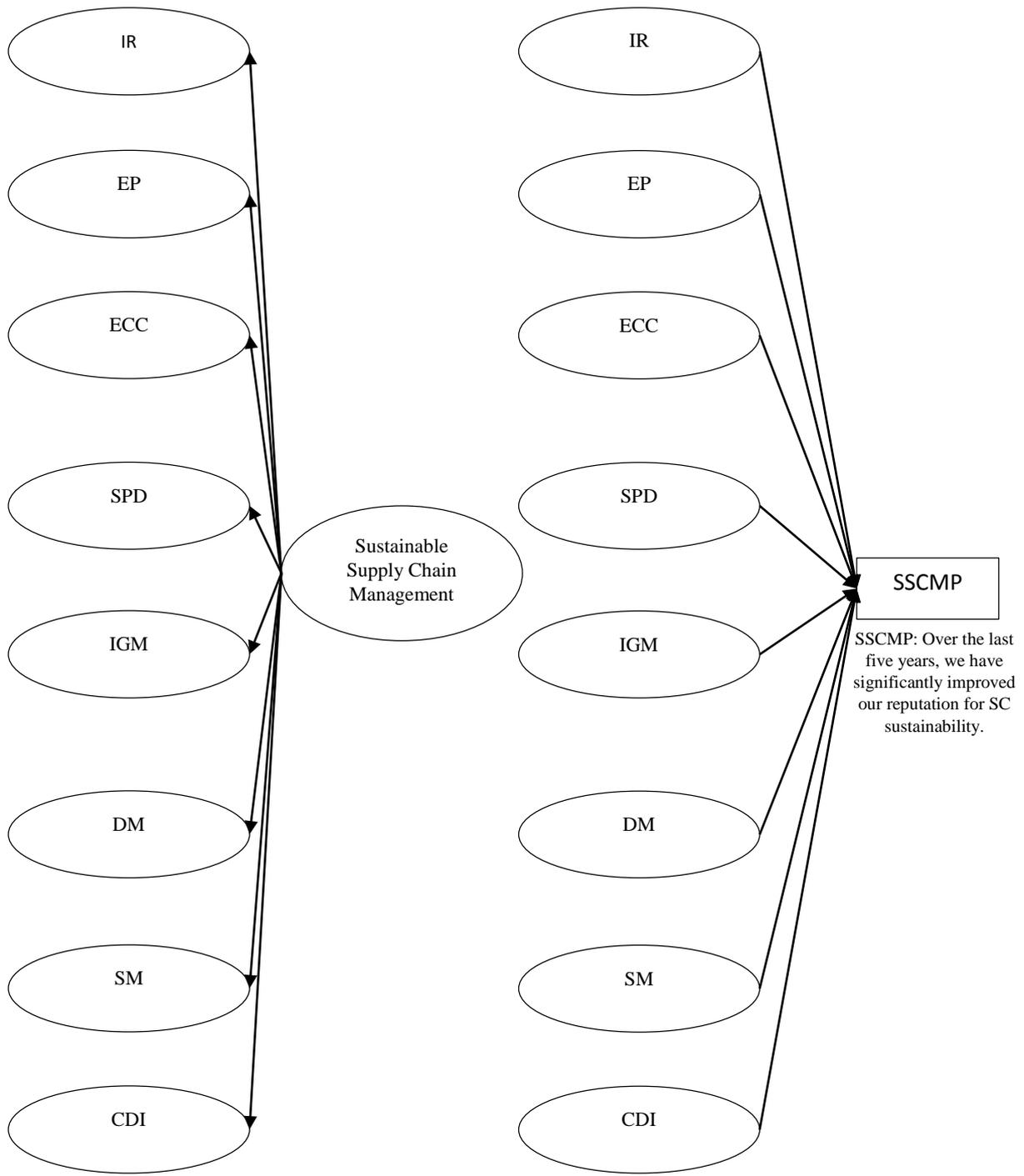


Figure 2. Third-order Model



Competing Model 1  
 SSCM as second-order reflective construct

Competing Model 2  
 Formative model of dimensions of SSCM

Figure 3. Competing Models

#### 4. Discussion and Managerial Implications

The conventional view of SSCM emphasises the implementation of efficient management practices to deal with environmental problems (Carter and Easton, 2011, Seuring and Muller, 2008). More recent literature in the field highlights the necessity of the social component in the SSCM framework, based on the insights from sustainable TBL (Tseng et al., 2015). Do socially responsible management practices also reflect a dimension of SSCM? In order to address this question, we need first to identify a valid measurement structure for SSCM. Utilising a large-scale survey of Chinese manufacturing managers, this paper goes beyond the traditional, environmentally-focused, view of SSCM, to refine and empirically validate a multidimensional measure schema for SSCM that considers both environmental and social issues.

According to the definitions of SSCM provided by Seuring and Muller (2008) and Carter and Easton (2011), we identify 31 practices (i.e. Items/indicators) to compose the hierarchical structure of SSCM. Utilising a classical scale development process, the selected items are generated into eight first-order factors, namely SPD, EP, ECC, IGM, IR, DM, SM and CDI. Drawing from the CSR and GSCM research, of the eight factors found in this study, we propose that three (i.e. EP, ECC, IR) reflect the external GSCM, two measures (i.e. IGM, SPD) reflect the internal GSCM and three evaluate the CSR (i.e. DM, SM, CDI).

Through confirming the validity and reliability of the constructs, this study has established a set of credible measurement scales for implementing SSCM practices. Specifically, adopting the split sample testing method, the measurement models show adequate overall fit for both the calibration sample and the validation sample. Moreover, in the measurement model, the eight first-order factors established in this study are significantly and positively correlated with each other (i.e.  $p < 0.001$ ). The result provides initial support for the integrated nature of SSCM, which suggests that managers should consider the dual aspects of sustainable development (i.e. environment and social). According to Shah (2002), highly inter-correlated management practices could assist practitioners to recognise the close relationships among the SSCM practices and at the same time to discern their differences. To confirm the third-order structure of SSCM, we adopt the model comparison method (Oliveira and Roth, 2012). Using the SEM method, we find that both the reflective models (i.e. third-order and second-order models) have an acceptable model fit, while the formative model has a poor fit. Compared with the second-order model, the proposed third-order model shows a better fit and all estimated parameters are highly significant. The possible implications of these results are twofold. First, the multi-layer model of SSCM provides a more complementary and synergistic approach for managers to achieve sustainability in their supply chain. The presence of the third-order structure provides a more easily interpretable model to understand the mechanism of SSCM. The SSCM implementation should be multifaceted, not limited to a single aspect or a single factor. Second, both social and environmental aspects should be considered in the implementation of the SSCM practices, which is consistent with the prevailing view in SSCM research (Carter and Easton, 2011; Seuring and Muller, 2008; Tseng, 2013; Tseng et al., 2015).

The scale development and the empirical findings presented in this paper offer a comprehensive picture of SSCM implementation. They offer helpful guidance for practitioners to scrutinise both environmental and social issues in the framework of SSCM. There are several managerial implications from our empirical analysis. First, the definition and valid measurement of the individual first-order factors can help managers to address the questions “*What is SSCM?*” and “*How should SSCM be implemented?*” in their business decision making. Specifically, the questionnaire items used in this research offer a set of quantifying and benchmarking tools for achieving SSCM. That is, the questionnaire items and individual factors could help managers to undertake the suggested activities or actions and direct their attention to particular areas. Second, the analysis of the higher-order model

enables managers to understand the SSCM implementation in a structured way. As the debate regarding SSCM has continued, various so-called “sustainable management practices” have emerged in the literature over the last decade. The third-order model proposed in this research reveals the similarities and differences between these practices. By abstracting the three dimensions of SSCM, namely external GSCM, internal GSCM and CSR in SSCM, we offer practitioners insights on identifying the critical areas in order to improve their business decisions to achieve the goal of sustainable development.

## 5. Conclusion

In summary, this study focuses exclusively on conceptualising the factors of SSCM and developing a holistic model to implement the SSCM. Using the SEM method and data of Chinese manufacturers, we empirically verify the structural hypotheses (i.e. H1 – H3) raised in the proposed model. Based on the significant results, we find that all of the hypotheses are supported. This paper provides empirical evidence of the multidimensionality in SSCM, which should consider both social and environmental issues. The 31 indicators validated in this study can serve to guide managers to regularly implement a particular set of initiatives to manage sustainability in the supply chain.

The empirical analysis of the third-order model is among the first efforts to examine the multidimensionality in SSCM. Therefore, this paper also suffers several limitations, and further research is necessary. First, because the current business environment is characterised as highly uncertain, the use of cross-sectional data in this research might provide only a snapshot of the best practices in SSCM. In order to document the causal processes of how SSCM practices evolve over time, we suggest that future research should adopt longitudinal study. Second, we only establish and approve the measurement of SSCM. Whether this higher-order structure of SSCM has a complementary effect on organisational sustainable performance (i.e. TBL) remains an open question for future research. Third, future studies should also address the potential issues raised by the data collected from a single informant and a single nation, in this case China. Although China is currently known as the world’s factory, the generalisability of the SSCM structure is still in doubt. A recommendation for future research is to extend the current model to different country contexts. For instance, it would be a good idea to compare the SSCM model in an emerging country and a developed country. Fourth, the SSCM practices verified in this study are only starting points. Our third-order structure with three main second-order dimensions has outlined the key areas (i.e. external GSCM, internal GSCM and CSR) that need further research. Future study could adopt alternative research methods, such as cross-firm case study, to explore more management practices or to refine the management practices under the three main dimensions of SSCM we have approved in this study.

## Appendix

The respondents were asked to indicate the extent to which they agree or disagree with each statement as applicable to their firm: 1 = strongly disagree – 7 = strongly agree. Items that noted with “\*” were deleted in data analysis.

Variables and Items	Citations
<b>Sustainable Product Design</b>	
SPD2: We are continually improving the design of our production process to reduce consumption of material and energy.	Veleva and Ellenbecker (2001); Zhu et al. (2005); Zhu et al. (2008b); Zhu et al. (2015)
SPD3: We are continually improving the design of our products to use more recycled materials.	
SPD4: We are continually improving the design of our products to avoid or reduce the use of hazardous products.	
SPD1*: We do not consider the biodegradability of the materials used in our products. (reverse coded)	
<b>Environmental Procurement</b>	
EP1: Our major suppliers have ISO 14000 certification.	Zhu et al. (2004); Zhu et al. (2005); Zhu et al. (2008b) IBM (2016)
EP2: We have close cooperation with our suppliers regarding the environmental objectives.	
EP3: We strive to prevent first-tier suppliers from transferring responsibility for environmentally sensitive operations to unqualified companies.	
EP5: We evaluate the environmentally-friendly practice of second-tier suppliers.	
EP4*: We regularly conduct environmental audit for suppliers' internal management.	
<b>Environmental Customer Collaboration</b>	
ECC1: We have close cooperation with customers to achieve cleaner production.	Zhu et al. (2008b); Green et al. (2012)
ECC2: We have close cooperation with customers to develop environmentally-friendly packaging.	
ECC3: We have close cooperation with customers to maximise the use of logistics resources.	
ECC4*: We have close cooperation with customers to reduce energy use during product transportation.	
<b>Internal Green Management</b>	
IGM1: The management team (e.g. senior managers and middle-level managers) of our company are committed to applying green supply chain management practices.	Veleva and Ellenbecker (2001); Zhu et al. (2005); Zhu et al. (2008b); Green et al. (2012)
IGM4: Our company has cross-functional cooperation to achieve environmental improvement.	
IGM5: Environmental compliance and auditing programs are regularly conducted in our company.	
IGM6: The green manufacturing training for our employees has increased over the last three years.	
IGM2*: Our company has a comprehensive environmental management system.	
IGM3*: The workplaces are designed to minimise continuously, or eliminate, physical, chemical, biological, and ergonomic hazards.	
<b>Investment Recovery</b>	
IR1: We aim to sell the excess inventories/materials.	Zhu et al. (2005); Zhu et al. (2008b); Green et al. (2012)
IR2: We aim to sell the scrap and used materials.	
IR3: We aim to sell the excess capital equipment.	
IR4: We aim to sell the refurbished products.	
<b>Diversity Management</b>	
DM1: Minority/Women-owned business enterprise suppliers have equal opportunity to become our partners.	Carters and Jennings (2004)
DM2: All workers have equal opportunity for promotion (i.e. no difference regarding gender, nationality).	
DM3: Minority/women workers have equal opportunity of employment with us.	
DM4: There is no difference in salary between women/minority and men/majority workers.	
<b>Community Development and Involvement</b>	
CDI1: We strive to improve employment opportunities for the local community.	Veleva and Ellenbecker (2001); Carter and Jennings (2004); Zhu et al. (2016)
CDI2: We strive to create wealth and income for the local community.	
CDI3: We continuously promote community education and cultural development.	
CDI4: Our employees often volunteer for local charities.	
CDI5: We are involved in local community development plans.	
<b>Safety Management</b>	
SM2: Ensuring warehousing safety is essential to us.	Carters and Jennings (2004); Zhu et al. (2016)
SM3: We consistently promote the importance of safe production in the value chain.	
SM4: Safety is a priority of our working plan.	
SM5: We guarantee the health and safety of our staff at work.	
SM1*: We always provide safety training to our employees.	

## Reference

- Amann, M., Roehrich, J. K., Essig, M. and Harland, C. 2014. Driving sustainable supply chain management in the public sector The importance of public procurement in the European Union. *Supply Chain Management-an International Journal* 19 (3), 351-366.
- Anderson, J. C. and Gerbing, D. W. 1988. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological bulletin* 103 (3), 411.
- Apple (2015). Environmental Responsibility Report. <http://www.apple.com/uk/environment/our-progress/> (accessed 20 March 2016).
- Armenakis, A. A., Bernerth, J. B., Pitts, J. P. and Walker, H. J. 2007. Organizational change recipients' beliefs scale development of an assessment instrument. *The Journal of applied behavioral science* 43 (4), 481-505.
- Bai, C. G. and Sarkis, J. 2010. Green supplier development: analytical evaluation using rough set theory. *Journal of Cleaner Production* 18 (12), 1200-1210.
- Bentler, P. M. and Weeks, D. G. 1980. Linear Structural Equations with Latent-Variables. *Psychometrika* 45 (3), 289-308.
- Berman, S. L., Wicks, A. C., Kotha, S. and Jones, T. M. 1999. Does stakeholder orientation matter? The relationship between stakeholder management models and firm financial performance. *Academy of Management journal* 42 (5), 488-506.
- Bowen, F. E., Cousins, P. D., Laming, R. C. and Faruk, A. c. 2001. Horse for courses: explaining the gap between the theory and practice of green supply. *Greener Management International* 9 (Autumn), 41-60.
- Brady, M. K. and Cronin, J. J. 2001. Some new thoughts on conceptualizing perceived service quality: A hierarchical approach. *Journal of Marketing* 65 (3), 34-49.
- Byrne, B. M. (2013). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*, Routledge.
- Canada, N. R. C. (2003). *Design for environment guide*. (accessed January 2016).
- Cao, M. and Zhang, Q. 2011. Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management* 29 (3), 163-180.
- Carroll, A. B. 1979. A Three-Dimensional Conceptual Model of Corporate Social Performance. *Academy of Management Review* 4 (4), 497-505.
- Carroll, A. B. 1991. The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders. *Business Horizons* 34 (4), 39-48.
- Carter, C. R., Auskalnis, R. and Ketchum, C. 1999. Purchasing from Minority BusinessEnterprises: A Cross-Industry Comparison of Best Practices. *Journal of Supply Chain Management* 35 (1), 28-32.
- Carter, C. R. and Easton, P. L. 2011. Sustainable supply chain management: evolution and future directions. *International Journal of Physical Distribution & Logistics Management* 41 (1), 46-62.

- Carter, C. R. and Jennings, M. M. 2004. The role of purchasing in the socially responsible management of the supply chain: a structural equation analysis. *Journal of Business Logistics* 38 (5), 360-387.
- Carter, C. R. and Rogers, D. S. 2008. A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management* 38 (5-6), 360-387.
- Carus, F. 2011. Apple named 'least green' tech company. <http://www.theguardian.com/environment/2011/apr/21/apple-least-green-tech-company> (accessed 21 February 2016).
- CCPA. 2000. *Corporate Community Involvement: Establishing a Business Case*. Melbourne: Centre for Corporate Public Affairs.
- Chen, I. J. and Paulraj, A. 2004. Towards a theory of supply chain management: the constructs and measurements. *Journal of Operations Management* 22 (2), 119-150.
- Chi, T. 2011. Building a sustainable supply chain: an analysis of corporate social responsibility (CSR) practices in the Chinese textile and apparel industry. *Journal of the Textile Institute* 102 (10), 837-848.
- Christmann, P. and Taylor, G. 2001. Globalization and the environment: Determinants of firm self-regulation in China. *Journal of international business studies*, 439-458.
- Ciliberti, F., Pontrandolfo, P. and Scozzi, B. 2008. Logistics social responsibility: Standard adoption and practices in Italian companies. *International Journal of Production Economics* 113 (1), 88-106.
- Clark, W. C. 2007. Sustainability Science: a room of its own. *Proceedings of the National Academy of Science*.
- Clark, W. C. and Dickson, N. M. 2003. Sustainability science: the emerging research program. *Proceedings of the National Academy of Science, USA*.
- Cohen, J. 1960. A coefficient of agreement for nominal scales. *Educational and psychological measurement* 20, 37-46.
- Corbett, C. J. and Klassen, R. D. 2006. Extending the horizons: environmental excellence as key to improving operations. *Manufacturing & Service Operations Management* 8 (1), 5-22.
- Cruz, J. M. and Wakolbinger, T. 2008. Multiperiod effects of corporate social responsibility on supply chain networks, transaction costs, emissions, and risk. *International Journal of Production Economics* 116 (1), 61-74.
- Dabholkar, P. A., Thorpe, D. I. and Rentz, J. O. 1996. A measure of service quality for retail stores scale development and validation. *Journal of Academy of Marketing Science* 24 (1), 3-16.
- De Giovanni, P. 2012. Do internal and external environmental management contribute to the triple bottom line? *International Journal of Operations & Production Management* 32 (3-4), 265-290.
- Dollinger, M. J., Enz, C. A. and Daily, C. M. 1991. *Purchasing from minority small businesses*.
- Donaldson, T. and Dunfee, T. W. 1999. *Ties that bind: A social contracts approach to business ethics*. Harvard Business Press

- Eltayeb, T. K., Zailani, S. and Ramayah, T. 2011. Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: Investigating the outcomes. *Resources Conservation and Recycling* 55 (5), 495-506.
- Emmelhainz, M. and Adams, R. 1999. The apparel industry response to “sweatshop” concerns: A review and analysis of codes of conduct. *Journal of Supply Chain Management* 35 (3), 51-57.
- Esfahbodi, A., Zhang, Y., Watson, G. 2016. Sustainable supply chain management in emerging economies: Trade-offs between environmental and cost performance. *International Journal of Production Economics* ‘In Press’ Available on line 26 February 2016 [Available from: doi:10.1016/j.ijpe.2016.02.013]
- Frohlich, M. 2002. Techniques for improving response rate in OM survey research. *Journal of Operations Management* 20 (1), 53-62.
- Geffen, C. A. and Rothenberg, S. 2000. Suppliers and environmental innovation - The automotive paint process. *International Journal of Operations & Production Management* 20 (2), 166-186.
- GEMI, G. E. M. I. (2001). *New Paths to Business Value*. Washington, DC.
- Gladwin, T. N., Kennelly, J. J. and Krause, T. S. 1995. Shifting Paradigms for Sustainable Development - Implications for Management Theory and Research. *Academy of Management Review* 20 (4), 874-907.
- Goncalves, H. M. M. 2013. Multi-group invariance in a third-order factorial model: Attribute satisfaction measurement. *Journal of Business Research* 66 (9), 1292-1297.
- Govindan, K., Jafarian, A., Khodaverdi, R. and Devika, K. 2014. Two-echelon multiple-vehicle location–routing problem with time windows for optimization of sustainable supply chain network of perishable food. *International Journal of Production Economics* 152, 9-28.
- Gray, R., Owen, D. and Adams, C. 1996. *Accounting and accountability: Changes and challenges in corporate social and environmental reporting*. London: Prentice Hall.
- Green, K. W., Zelbst, P. J., Meacham, J. and Bhaduria, V. S. 2012. Green supply chain management practices: impact on performance. *Supply Chain Management-an International Journal* 17 (3), 290-305.
- Gunther, E. and Scheibe, L. 2006. The hurdle analysis. A self-evaluation tool for municipalities to identify, analyze and overcome hurdles to green procurement. *Corporate Social Responsibility and Environmental Management* 13 (2), 61-77.
- Hair, J. F., Anderson, R. and Blcak, W. (2006). *Multivariate data analysis*. Upper Saddle River, NJ, Pearson Prentice Hall.
- Hall, J. K., Daneke, G. A. and Lenox, M. J. 2010. Sustainable development and entrepreneurship: Past contributions and future directions. *Journal of Business Venturing* 25 (5), 439-448.
- Hardesty, D. M. and Bearden, W. O. 2004. The use of expert judges in scale development - Implications for improving face validity of measures of unobservable constructs. *Journal of Business Research* 57 (2), 98-107.

- Harms, D., Heansen, E. and Schaltegger, S. 2013. Strategies in aligning supply chains for sustainability, an empirical investigation of large German companies. *Corporate Social Responsibility and Environmental Management* 20 (4), 205-218.
- Hausman, W. H., Montgomery, D. B. and Roth, A. V. 2002. Why should marketing and manufacturing work together? Some exploratory empirical results. *Journal of Operations Management* 20 (3), 241-257.
- Heeler, R. M. and Ray, M. L. 1972. Measure validation in marketing. *Journal of Marketing Research*, 361-370.
- Hervani, A. A., Helms, M. M. and Sarkis, J. 2005. Performance measurement for green supply chain management. *Benchmarking: An international journal* 12 (4), 330-353.
- Hillman, A. J. and Keim, G. D. 2001. Shareholder value, stakeholder management, and social issues: what's the bottom line? *Strategic Management Journal* 22 (2), 125-139.
- Hinkin, T. R. 1995. A Review of Scale Development Practices in the Study of Organizations. *Journal of Management* 21 (5), 967-988.
- IBM. (2016). Environmental reporting, disclosure and verification. <http://www.ibm.com/ibm/environment/annual/> (accessed 25th May 2015).
- Inoue, Y. and Lee, S. 2011. Effects of different dimensions of corporate social responsibility on corporate financial performance in tourism-related industries. *Tourism Management* 32 (4), 790-804.
- Jennings, P. D. and Zandbergen, P. A. 1995. Ecologically Sustainable Organizations - an Institutional Approach. *Academy of Management Review* 20 (4), 1015-1052.
- Johnson, R. A. and Greening, D. W. 1999. The effects of corporate governance and institutional ownership types on corporate social performance. *Academy of Management Journal* 42 (5), 564-576.
- Jordan, A. 2008. The governance of sustainable development: taking stock and looking forwards. *Environment and Planning C-Government and Policy* 26 (1), 17-33.
- Jorgensen, A., Le Bocq, A., Nazarkina, L. and Hauschild, M. 2008. Methodologies for social life cycle assessment. *International Journal of Life Cycle Assessment* 13 (2), 96-103.
- Kacperczyk, A. 2009. With Greater Power Comes Greater Responsibility? Takeover Protection and Corporate Attention to Stakeholders. *Strategic Management Journal* 30 (3), 261-285.
- Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B., Dickson, N. M., Faucheux, S., Gallopin, G. C., Grubler, A., Huntley, B., Jager, J., Jodha, N. S., Kasperson, R. E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., O'Riordan, T. and Svedin, U. 2001. Environment and development - Sustainability science. *Science* 292 (5517), 641-642.
- King, A. A. and Lenox, M. J. 2001. Lean and green? An empirical examination of the relationship between lean production and environmental performance. *Production and Operations Management* 10 (3), 244-256.
- Kleindorfer, P. R., Singhal, K. and Van Wassenhove, L. N. 2005. Sustainable operations management. *Production and Operations Management* 14 (4), 482-492.
- Knight, P. and Jenkins, J. O. 2009. Adopting and applying eco-design techniques: a practitioners perspective. *Journal of Cleaner Production* 17 (5), 549-558.

- Ko, Y. J. and Pastore, D. L. 2005. A hierarchical model of service quality in the recreational industry. *Sport Marketing Quarterly* 14 (2).
- Kokalitcheva, K. (2016). 93% of Apple's Worldwide Facilities Run on Renewable Energy. <http://fortune.com/2016/03/21/apple-renewable-energy-93-percent/> (accessed 22 March 2016).
- Kolk, A. and Tudder, R. V. 2002. The effectiveness of self-regulation: Corporate codes of conduct and child labour. *European Management Journal* 20 (3), 260-271.
- Lai, K. H., Wu, S. J., and Wong, C. W. 2013. Did reverse logistics practices hit the triple bottom line of Chinese manufacturers?. *International Journal of Production Economics* 146 (1), 106-117.
- Li, S., Rao, S. S., Ragu-Nathan, T. S. and Ragu-Nathan, B. 2005. Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management* 23 (6), 618-641.
- Li, S. H., Ragu-Nathan, B., Ragu-Nathan, T. S. and Rao, S. S. 2006. The impact of supply chain management practices on competitive advantage and organizational performance. *Omega-International Journal of Management Science* 34 (2), 107-124.
- Lin, M.-H., Hu, J., Tseng, M.-L., Chiu, A. S. and Lin, C. 2016. Sustainable development in technological and vocational higher education: Balanced scorecard measures with uncertainty. *Journal of Cleaner Production*.
- Lumms, R. R. and Vokurka, R. J. 1999. Defining supply chain management: a historical perspective and practical guidelines. *Industrial Management & Data Systems* 99 (1-2), 11-17.
- MacCallum, R. C., Browne, M. W. and Sugawara, H. M. 1996. Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods* 1 (2), 130-149.
- Menor, L. J. and Roth, A. V. 2007. New service development competence in retail banking: Construct development and measurement validation. *Journal of Operations Management* 25 (4), 825-846.
- Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W. and Smith, C. D. 2001. DEFINING SUPPLY CHAIN MANAGEMENT. *Journal of Business Logistics* 22 (2), 1-25.
- Min, H. and Galle, W. P. 1997. Green purchasing strategies: trends and implications. *The Journal of Supply Chain Management* 33 (3), 10-17.
- Moore, G. C. and Benbasat, I. 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research* 2 (2), 192-222.
- Moir, L. 2001. What do we mean by corporate social responsibility?. *Corporate Governance: The International Journal of Business Society* 1 (2), 16-22
- Nagel, M. H. (2000). Environmental supply-chain management versus green purchasing in the scope of a business and leadership perspective. *Proceedings of the 2000 IEEE International Symposium*.
- Nunnally, J. C. (1978). *Psychometric theory*, McGraw-hill. Inc.
- Oliveira, P. and Roth, A. V. 2012. Service orientation: the derivation of underlying constructs and measures. *International Journal of Operations & Production Management* 32 (1-2), 156-190.
- Pagell, M. and Wu, Z. H. 2009. Building a More Complete Theory of Sustainable Supply Chain Management Using Case Studies of 10 Exemplars. *Journal of Supply Chain Management* 45 (2), 37-56.

- Perez-Sanchez, D., Barton, J. and Bower, D. 2003. Implementing environmental management in SMEs. *Corporate Social Responsibility and Environmental Management* 10 (2), 67-77.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y. and Podsakoff, N. P. 2003. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology* 88 (5), 879-903.
- Ranjan, K. R. and Read, S. 2014. Value co-creation: concept and measurement. *Journal of the Academy of Marketing Science*, 1-26.
- Rao, P. 2002. Greening the supply chain: a new initiative in South East Asia. *International Journal of Operations & Production Management* 22 (5-6), 632-655.
- Saunders, L. W., Kleiner, B. M., McCoy, A. P., Lingard, H., Mills, T., Blismas, N. and Wakefield, R. 2015. The effect of early supplier engagement on social sustainability outcomes in project-based supply chains. *Journal of Purchasing and Supply Management* 21 (4), 285-295
- Schaltegger, S. and Burritt, R. 2014. Measuring and managing sustainability performance of supply chains Review and sustainability supply chain management framework. *Supply Chain Management- an International Journal* 19 (3), 232-241.
- Schumacker, R. E. and Lomax, R. G. (1996). *A Beginner's Guide to Structural Equation Modeling*. New Jersey, Lawrence Erlbaum Associates.
- Segars, A. H. and Grover, V. 1998. Strategic information systems planning success: an investigation of the construct and its measurement. *MIS Quarterly* 22 (2), 139-163.
- Seuring, S. and Muller, M. 2008. From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production* 16 (15), 1699-1710.
- Shah, R. and Ward, P. 2007. Defining and developing measures of lean production. *Journal of Operations Management* 25 (4), 785-805.
- Sharfman, M., Ellington, R. and Meo, M. 1997. The future of green issues in business: Life-cycle oriented environmental management. *Business Horizons* 40 (3), 13-22.
- Steurer, R., Langer, M. E., Konrad, A. and Martinuzzi, A. 2005. Corporations, stakeholders and sustainable development I: A theoretical exploration of business-society relations. *Journal of Business Ethics* 61 (3), 263-281.
- Stratman, J. K. and Roth, A. V. 2002. Enterprise resource planning (ERP) competence constructs: Two-stage multi-item scale development and validation. *Decision Sciences* 33 (4), 601-628.
- Swafford, P. M., Ghosh, S. and Murthy, N. 2006. The antecedents of supply chain agility of a firm: Scale development and model testing. *Journal of Operations Management* 24 (2), 170-188.
- Swart, R. and Raes, F. 2007. Making integration of adaptation and mitigation work: mainstreaming into sustainable development policies? *Climate Policy* 7 (4), 288-303.
- Tekin, E. K., Ertürk, A. and Tozan, H. 2015. *Corporate Social Responsibility in Supply Chains*.
- Tibben-Lembke, R. S. 2004. Strategic use of the secondary market for retail consumer goods. *California Management Review* 46 (2), 90-104.

- Tse, Y. K., Zhang, M., Pervaiz, A. and Jillian, C. M. 2016. Embracing supply chain agility: an investigation in the electronics industry. *Supply Chain Management: An International Journal* 21 (1).
- Tseng, M. L. 2013. Modeling sustainable production indicators with linguistic preferences. *Journal of Cleaner Production* 40, 46-56.
- Tseng, M. L., Lim, M. and Wong, W. P. 2015. Sustainable supply chain management A closed-loop network hierarchical approach. *Industrial Management & Data Systems* 115 (3), 436-461.
- Tseng, M.-L., Chiang, J. H. and Lan, L. W. 2009. Selection of optimal supplier in supply chain management strategy with analytic network process and choquet integral. *Computers & Industrial Engineering* 57 (1), 330-340.
- Tseng, M.-L. and Chiu, A. S. 2013. Evaluating firm's green supply chain management in linguistic preferences. *Journal of cleaner production* 40, 22-31.
- Tseng, M.-L., Lin, Y., Chiu, A. and Liao, J. 2008. Using FANP approach on selection of competitive priorities based on cleaner production implementation: a case study in PCB manufacturer, Taiwan. *Clean technologies and environmental policy* 10 (1), 17-29.
- Tseng, M.-L. and Lin, Y. H. 2009. Application of Fuzzy DEMATEL to develop a cause and effect model of municipal solid waste management in Metro Manila. *Environmental monitoring and assessment* 158 (1-4), 519-533.
- Vachon, S. and Klassen, R. D. 2008. Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International Journal of Production Economics* 111 (2), 299-315.
- Veleva, V. and Ellenbecker, M. 2001. Indicators of sustainable production: framework and methodology. *Journal of cleaner production* 9 (6), 519-549.
- Walton, S. V., Handfield, R. B. and Melnyk, S. T. 1998. The green supply chain: integrating suppliers into environmental management process. *Journal of Supply Chain Management* 34 (2), 2-11.
- WCED, W. C. o. E. a. D. (1987). *Our common future*. Oxford, Oxford University Press.
- Wittstruck, D. and Teuteberg, F. 2012. Understanding the Success Factors of Sustainable Supply Chain Management: Empirical Evidence from the Electrics and Electronics Industry. *Corporate Social Responsibility and Environmental Management* 19 (3), 141-158.
- Worthington, R. L. and Whittaker, T. A. 2006. Scale development research - A content analysis and recommendations for best practices. *Counseling Psychologist* 34 (6), 806-838.
- Wu, C.-L., Fang, D.-P., Liao, P.-C., Xue, J.-W., Li, Y. and Wang, T. 2015. Perception of corporate social responsibility: the case of Chinese international contractors. *Journal of Cleaner Production* 107, 185-194.
- Wu, H. J. and Dunn, S. C. 1995. Environmentally responsible logistics systems. *International Journal of Physical Distribution & Logistics Management* 25 (2), 20-38.
- Yardley, J. (2005). China's next big boom could be the foul air. *New York Times*: 3.
- Zhang, K., Wen, Z. and Xhang, X. 2002. China's water environment at the beginning of the 21 st century: challenges and countermeasures. *Water Science & Technology* 46 (11), 245-251.

- Zhang, K.-m. and Wen, Z.-g. 2008. Review and challenges of policies of environmental protection and sustainable development in China. *Journal of environmental management* 88 (4), 1249-1261.
- Zhao, X., Huo, B., Flynn, B. B. and Yeung, J. H. Y. 2008. The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain. *Journal of Operations Management* 26 (3), 368-388.
- Zhu, Q., Liu, J. and Lai, K.-h. 2016. Corporate social responsibility practices and performance improvement among Chinese national state-owned enterprises. *International Journal of Production Economics* 171, 417-426.
- Zhu, Q. and Sarkis, J. 2007. The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research* 45 (18-19), 4333-4355.
- Zhu, Q., Sarkis, J. and Geng, Y. 2005. Green supply chain management in China: pressures, practices and performance. *International Journal of Operations & Production Management* 25 (5), 449-468.
- Zhu, Q. H., Qu, Y., Geng, Y. and Fujita, T. 2015. A Comparison of Regulatory Awareness and Green Supply Chain Management Practices Among Chinese and Japanese Manufacturers. *Business Strategy and the Environment*.
- Zhu, Q. H. and Sarkis, J. 2004. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management* 22 (3), 265-289.
- Zhu, Q. H., Sarkis, J., Cordeiro, J. J. and Lai, K. H. 2008a. Firm-level correlates of emergent green supply chain management practices in the Chinese context. *Omega-International Journal of Management Science* 36 (4), 577-591.
- Zhu, Q. H., Sarkis, J. and Lai, K. H. 2007. Initiatives and outcomes of green supply chain management implementation by Chinese manufacturers. *Journal of Environmental Management* 85 (1), 179-189.
- Zhu, Q. H., Sarkis, J. and Lai, K. H. 2008b. Confirmation of a measurement model for green supply chain management practices implementation. *International Journal of Production Economics* 111 (2), 261-273.
- Zhu, Q. H., Sarkis, J. and Lai, K. H. 2008c. Green supply chain management implications for "closing the loop". *Transportation Research Part E-Logistics and Transportation Review* 44 (1), 1-18.
- Zhu, Q. H., Sarkis, J. and Lai, K. H. 2013. Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *Journal of Purchasing and Supply Management* 19 (2), 106-117.
- Zsidisin, G. A. and Hendrick, T. E. 1998. Purchasing's involvement in environmental issues: a multi-country perspective. *Industrial Management & Data Systems* 98 (7-8), 313-320.
- Zsidisin, G. A. and Siferd, S. P. 2001. Environmental purchasing: a framework for theory development. *European Journal of Purchasing & Supply Management* 7 (1), 61-73.