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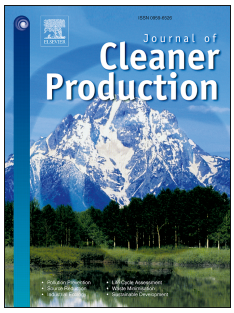

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From a systematic literature review to integrated definition for Sustainable Supply Chain Innovation (SSCI)

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Abstract：

The vast majority of supply-chain literature has focused on supply chain management, innovation and sustainability, separately. However, little supply-chain research focuses on innovation under the supply chain context, which is expected to deliver a sustainable outcome. Is it a great research opportunity to explore or a subject unworthy of studying? This paper offers a systematic literature review considering 107 related papers published from 1996 to 2014. In this review, both descriptive and thematic analyses demonstrate it to be a great research opportunity worthy of exploring. A conceptual framework containing the definition of sustainable supply chain innovation (SSCI) and its distinctive characteristics are proposed and identified. Furthermore, some opportunities for the research in future, such as antecedents to SSCI, are suggested and discussed in this paper. Both academics and practitioners in companies might find this review useful as it stimulates further research and guides sustainable supply chain innovation.

Keywords: Innovation; Supply chain management (SCM); Sustainable development; Sustainability; Supply chain innovation (SCI); Sustainable supply chain innovation (SSCI)

1. Introduction

Innovation was originally identified by Schumpeter (1934) as the ability to create economic value from new ideas; today, innovation is considered as a key determinant for organizational competitiveness and success (McAdam and Keogh, 2004). Innovation exhibits the direction and progress of the regional and world economic development (Yakovleva et al., 2015). For example, the first handheld mobile cellphone demonstrated by Motorola in 1973 was one of the great innovations in the world (Kempe, 2015). As the essayist Arthur C. Clarke predicted in his book *Profiles Of The Future*, "We will be able to call a person anywhere on Earth merely by dialing a number and no one need ever again be

lost." (Clarke, 1964).

Over approximately 40 years of development and popularization, the cellphone has grown from being a luxury item to becoming a daily necessity. According to the data from the International Telecommunications Union (ITU), there were more than seven billion mobile phone subscribers worldwide in 2014, and this number continues to grow (ITU, 2015). A recent survey by Nokia on the Chinese market shows that nearly every respondent has owned more than four cellphones, and other countries such as the U.S., Australia, Brazil and the U.K. have more than one cellphone in use for every citizen (Yufeng, 2012). A research in 2011 showed that Americans replaced their cellphones every 21.7 months (Entner, 2011). Another report in 2014 claimed that approximately 70 percent of users in China replaced their cellphones in 18 months (Qihoo360, 2014). Millions of outdated cellphones are abandoned, few are recycled (Yufeng, 2012). Some studies have argued that this great innovation has generated a severe impact to society and the environment (Inform, 2008). Discarded cellphones are labeled ‘electronic waste’ or ‘e-waste’ which may lead to serious health and pollution problems because they may contain contaminants such as lead and cadmium (Sthiannopkao and Ming, 2013). E-waste has become a major challenge to regional and global sustainable development (Selin and VanDeveer, 2006), while its recycling is a "rapidly expanding" issue. To recycle the unwanted cellphones, some innovative activities occurred in the supply chain which may include users, recyclers, logistics, manufacturers and the third-party service platforms. In 2015, Apple China started to join hands with its OEM manufacturer “Foxconn” and the third-party selling and service platform “JD.com” on its "reuse and recycling program". However, the cellphone recycling was not processed as smooth as expected. There are some issues still limiting its expending, like how to protect the users’ privacy, how to identify the recycled cellphone to prevent from selling as a new one, and how to price the used cellphone reasonably, etc (Yufeng, 2012).

Observing from case of cellphone, it should be noted that accomplishing a great and sustainable innovation is not only about the product or technology itself, but about its use and disposal in the life cycle. It should not compromise the ability of future generations to meet their own needs while using resources to meet the needs of the present (WCED, 1987), which requests to balance the economic, environmental and social performances (Elkington, 1998). The sustainable innovation should consider all requirements from various stakeholders in the supply chain such as customers, suppliers, regulators, media, non-governmental organization and even competitors. The sustainable innovation is not just created by an enterprise, but also based on the collaborative work and information transfer

upstream and downstream in the supply chain (Bouncken, 2011), as the transfer of information in the supply chain enriches and channels the activities of design, re-design, and innovation (Christopher, 2007). The sustainable innovation generation considered in a supply chain landscape involves changes in the product, process, or service for the commercial success of the invention (Roy et al., 2004).

The case of cellphone described above shows the intersection of innovation, supply chain management and sustainability. However, upon searching the literature related to sustainable innovation under the supply chain context in the last two decades, we found such research to be rare. Is this a major research opportunity yet unexplored or a subject unworthy of studying? It is an interesting question that a systematic literature review may be able to answer. In practice, the research focusing on the intersection of these three streams may reveal how the innovation in a supply chain can deliver a sustainable outcome. It may be possible to reduce or eliminate 'electronic waste' by recyclable design or design for the environment (Walls and Calcott, 2005).

This paper conducts a systematic literature review aimed at collecting and analyzing relevant papers in the area that overlaps innovation, supply chain management and sustainability. This review starts with innovation practices adopted in supply chain, meanwhile sustainable supply chain is considered as output of innovation practices.

2. Objectives and Research Methodology

2.1 Purpose of research

A literature review usually aims at two objectives: one is to sum up existing research by identifying the basic characteristics; another is to identify the conceptual content of the research field (Meredith, 1993). The purposes of this review are to:

i. Summarize the literature of innovation research in the supply chain in the last twenty years and analyze it from both descriptive and thematic perspectives;

ii. Explore the linkage among innovation, supply chain and sustainability;

iii. Propose a refined definition of supply chain innovation (SCI) and sustainable supply chain innovation (SSCI), and identify its characteristics;

iv. Highlight the gaps in the current research that need further study.

2.2 Research methodology

From the methodological point of view, a literature review can be understood as a content analysis, where quantitative and qualitative aspects are mixed to assess structural (descriptive) as well as content (thematic) criteria (Brewerton and Millward, 2001). This review follows the process model proposed by Mayring (2003) which contains four steps: material collection, descriptive analysis, category selection and material evaluation.

2.3 Delimitation and search for literature

The first step in Mayring's process model is to collect articles. The followings describe the process of literature collection:

i. The search was limited to research and review papers published in peer-reviewed journals in English during a twenty-year period between 1995 and 2014, which papers are considered to be formal and rigorous literature;

ii. Databases and online library services such as Elsevier, Web of Science, Emerald, Springer, Wiley and Scopus were selected for this research as they are the ones with the most comprehensive academic resources;

iii. The search started from the fields of title and keyword with the keywords 'innovation', 'supply chain' and 'sustain'. As a result, only eleven related papers were found. To expand the search scope, sustainability was considered as the output of innovation practices in supply chain context so that it was excluded from initial search. The syntax for search in Elsevier is showed below as an example: pub-date > 1994 and pub-date < 2015 and (TITLE(innovation) and TITLE(supply chain)) or (key(innovation) and key(supply chain)) ;

The first paper related to the review topic was published in 1996. All collected papers were first evaluated by a quick scan of the content. Accounting for the stated delimitations, a total of 107 papers about innovation in the supply chain were gathered for detailed review. The software program Endnote was applied to manage these papers. All reviewed papers are listed in *Appendix A: Reviewed papers*.

2.4 Rigor of the research process

The research process and related methodology have natural limitations because of the limitations of resources, time or the researchers' experience and knowledge. To reduce the risk of understanding the literature content based only on the multiple judgments of a single researcher, a principled and structured process was applied to ensure validity. Every paper was reviewed twice with an extensive and intensive review. The inclusion of any disputed

paper was determined by group discussion and escalated to a senior professor for further review if concern still remained. Targeted information was extracted, induced and coded subsequently.

To exam the research reliability, an intra-rater and inter-rater test was conducted on the four types of papers: review, case study, survey and theoretical papers. The consistencies within one rater and between two raters were 95% and 79%, respectively, and the related Fleiss kappa values were 0.91 and 0.71, respectively, which were both higher than 0.7, the lowest acceptance limit (Fleiss, 1981).

2.5 Subject of content analysis

The contents of the collected papers were assessed by methods of descriptive and thematic analyses. The subject of the descriptive analysis in previous literature reviews is used to provide an overview for literature selected, such as the trend of development, the major journals, the most popular methodology applied and the industry sector of focus (Hassini et al., 2012; Klewitz and Hansen, 2014; Linton et al., 2007; Seuring and Müller, 2008). In addition, in the thematic analysis, the analysis is conducted from the innovation phase's perspective and the functional perspective of the sustainable supply chain.

After analyzing the collected literature from the descriptive and thematic perspectives, a refined definition of sustainable supply chain innovation is developed and opportunities for future research are sequentially noted.

3. Descriptive Analysis

The second step in Mayring's process model is to conduct a descriptive analysis which provides a descriptive overview on the targeted literature. The following analysis was conducted by published year, published journal, research methodology and industry.

3.1 Distribution of reviewed papers across the time period

The basic body of the literature identified comprised 107 papers published from 1995 to 2014. Fig. 1 shows the distribution of all reviewed papers per year across the period studied. The first published paper found was from 1996. It is necessary to note that the development trend of literature can be divided into two stages at the end of the year 2006. According to the product life cycle theory developed by Raymond Vernon, a product's life cycle comprises five stages: introduction, growths, maturity, saturation and decline (Hill, 2007). The first stage before 2006 can be considered an introduction or incubation period of concept

development which is similar to the introduction stage in a product's life cycle because the volume is flat wavy at a low level. The average number of published papers is no more than 4 per year. Particularly, no papers were published in 1997. The number of published papers rapidly increased after 2006, that year can be regarded as entering the growth stage where the slope of development is much steeper than the previous stage. It can be seen in Fig. 1 that the number of published papers rapidly increased by year. Particularly, the number in 2014 is more than twice the average of the previous years, which are approximately 9 from 2007 to 2013.

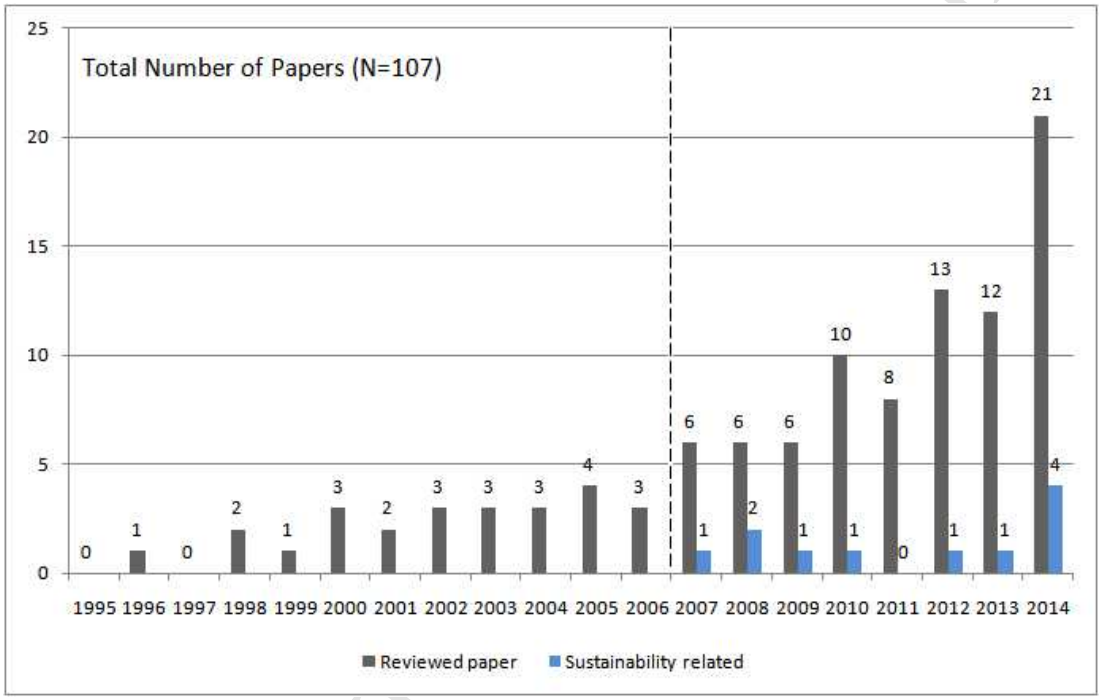

Fig. 1. Distribution of publications per year across the period studied

It is also worth noting that the articles related to sustainable supply chain innovation first occurred in 2007; it appears to currently be at the introduction stage. Assuming its development trend is similar to supply chain innovation, we might be able to predict that the rapid growth stage of the research in sustainable supply chain innovation is approaching soon. The discussion above supports the increasing acceptance of and interest in this topic in this research area.

3.2 Distribution of reviewed paper by journals

The reviewed papers are distributed widely across total 68 different journals. Fig. 2 shows that twenty journals have published more than one paper in the collected sample, which account for 63.5% of the total. By far, the highest ranking journal is the Journal of Operations Management with eight articles, followed by the Journal of Cleaner Production

with seven articles. Furthermore, greater than one fourth of the total papers (29 in 107 papers) are concentrated in four journals, which play dominant roles in this research field. With regard to articles related to sustainable innovation in the supply chain, the Journal of Cleaner Production ranks first.

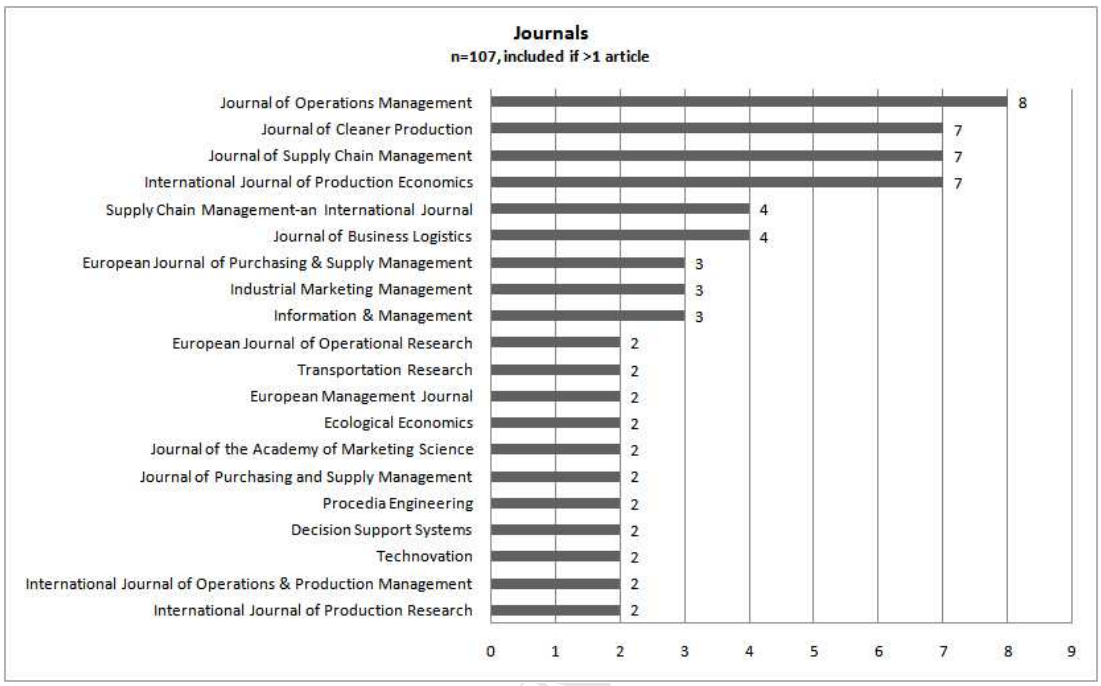

Fig. 2. Distribution of reviewed papers by journal

3.3 Research methodologies applied

The methodologies applied in research are usually differentiated into five categories:(1) theoretical and conceptual paper; (2) case study; (3) survey; (4) modeling paper; and (5) literature review (Seuring and Müller, 2008).

Fig. 3 shows the assignment of papers to each research methodology. Survey and case study are the top two most common empirical research methods, comprising three-fourths of the total papers. Furthermore, the case study method is also separated into a single case and multiple cases which cover one-third and two-thirds of case studies, respectively. Theoretical and model development papers rank third and fourth, respectively. It is worth noting that only one literature review was found in this field of study, which summarized the special topic forum on “innovation in business networks from a supply chain perspective: current status and opportunities for future” and introduced four related papers (Arlbjorn and Paulraj, 2013). The lack of systematic review demonstrates the necessity of this study. When focusing only on papers related to sustainable supply chain innovation, case study is the dominant research method (6 of 11 articles). A novel methodology called “Q

methodology" is observed and grouped as 'other' (Nicholas et al., 2014).

According to the ranking in Fig 3, it can be concluded that the research methodologies favor practical over theoretical approaches. To render the classification transparent to the reader, the research methodology of each paper is listed in *Appendix B:* Methodologies applied.

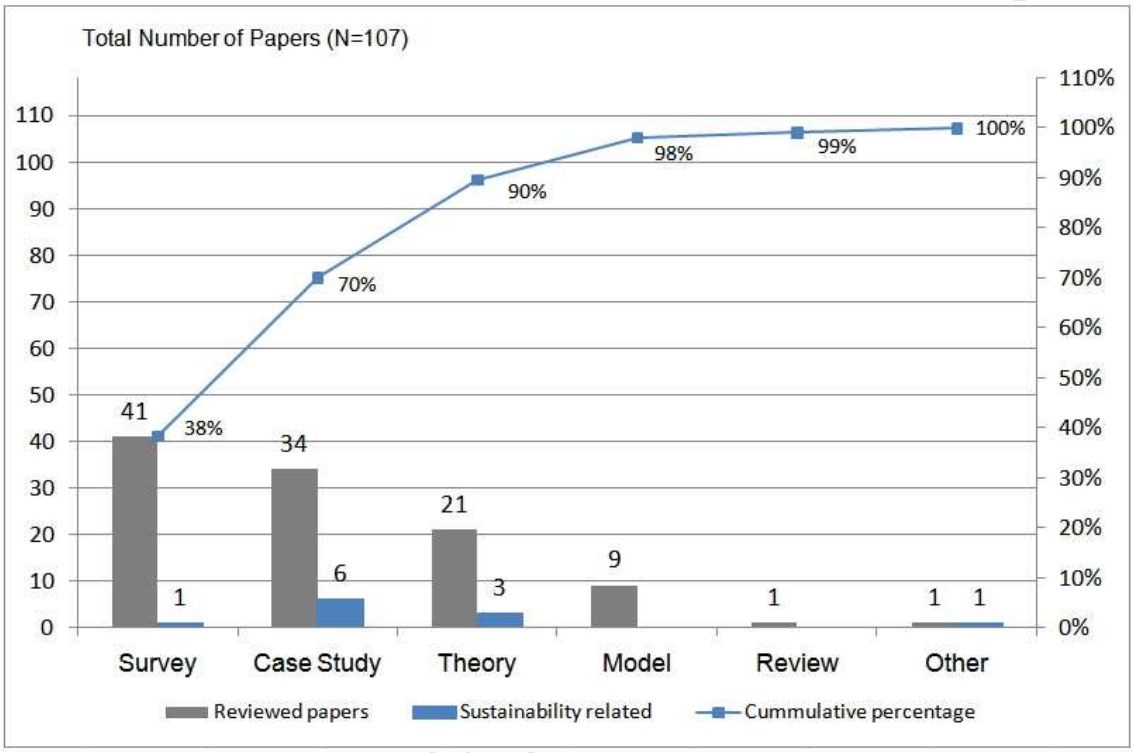

Fig. 3. Research methodologies applied

3.4 Classification by industry sectors

The difference between industry sectors is worth investigating because many studies consider industry to be a moderating factor in their frameworks (Flint et al., 2008; Mylan et al., 2014; Wu and Chang, 2012; Wu and Chuang, 2010). However, the industry classification standard is the key for coding. There are two types of popular standards for consideration: GICS and ISIC. GICS (Global Industry Classification Standard) is an industry taxonomy developed by MSCI and S&P (Standard & Poor's) and commonly used by the global financial community. Its structure consists of 10 sectors, 24 industry groups, 67 industries and 156 sub-industries (MSCI, 2014). ISIC (International Standard Industrial Classification) is a United Nations system for classifying economic data. It is widely used both nationally and internationally for classifying data according to classifications of economic activity (ISIC, 2008). After the pilot coding, ISIC was selected as the basic classification standard for coding. In addition, two more categories were added as

supplements, labeled as “V” for “multiple-industries” and “X” for “Unclear or non-mentioned.” Thus, the empirical studies using questionnaires to collect survey data from multiple industries were classified with “V,” and the theoretical or modeling studies that did not mention any industries of focus were classified with “X.” “S” refers to the service sector covering the five sectors (N/S/R/O/P) related to service activities in ISIC. Fig. 4a shows the distribution of the industries of focus.

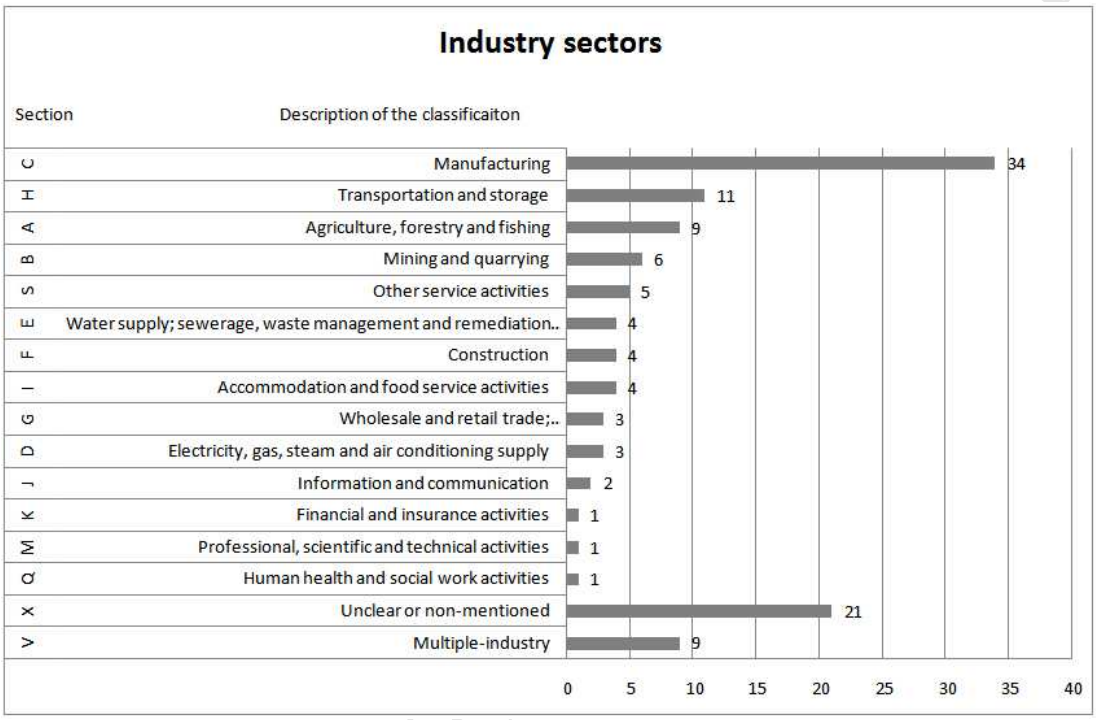

Fig. 4a. Industry sectors in the studies

It can be noted that the manufacturing sector is the most popular sector in research, accounting for approximately 30% of the total papers. The supply chain innovation focused on ‘Manufacturing’ can be explained by two reasons. Firstly, it is because of the classification standard. ‘Manufacturing’ in the classification standard is a major sector comprising 24 divisions, 71 groups, and 189 classes (ISIC, 2008), covering nearly one-fourth of the total industries. Secondly, ‘Manufacturing’ is a key function creating value in the supply chain, and data are easily collected for research. Another sector ‘Transportation and storage’ follows ‘Manufacturing’ as another key function in the supply chain because it makes materials flow. If only the papers related to sustainable supply chain innovation are considered, it is interesting to note that the major sector is not ‘Manufacturing’ but rather ‘Mining’ and ‘Agriculture’. See Fig. 4b for further details. The reason could be that these two sectors might have a higher probability of releasing pollution to the environment; thus, they have garnered more attention in sustainability research. This view is supported by

a life cycle assessment case study of oil and gas and agricultural biotechnology (Matos and Hall, 2007).

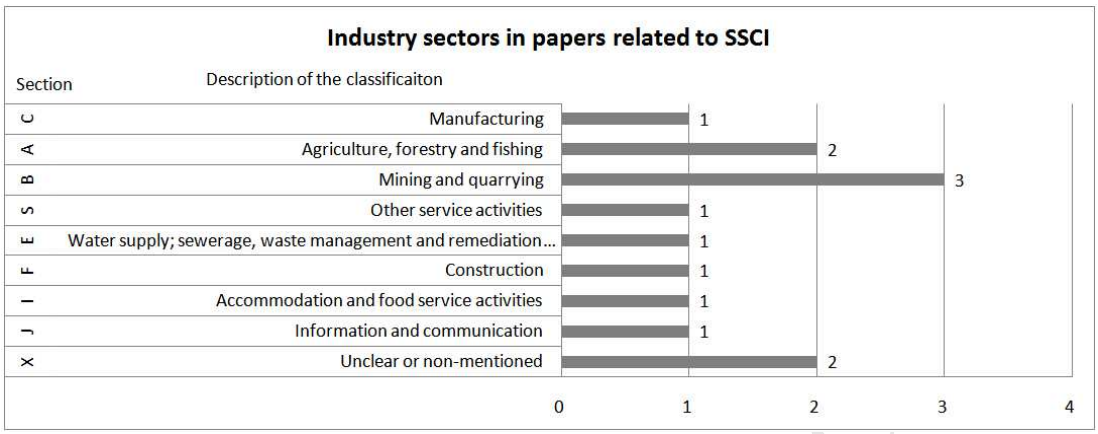

Fig. 4b. Industry sectors in studies related to SSCI

3.5 Classification by countries of focus

In this review, we attempt to reveal the difference among countries related to supply chain innovation and the level of sustainability development with different economic levels. Two principles for identifying the "country" characteristics in papers were used: either the information gained directly from papers or the nationality of the first author. The direct information was the first priority if conflicts existed. The evaluation of economic level was based on the gross domestic product (GDP) of each country published by IMF.

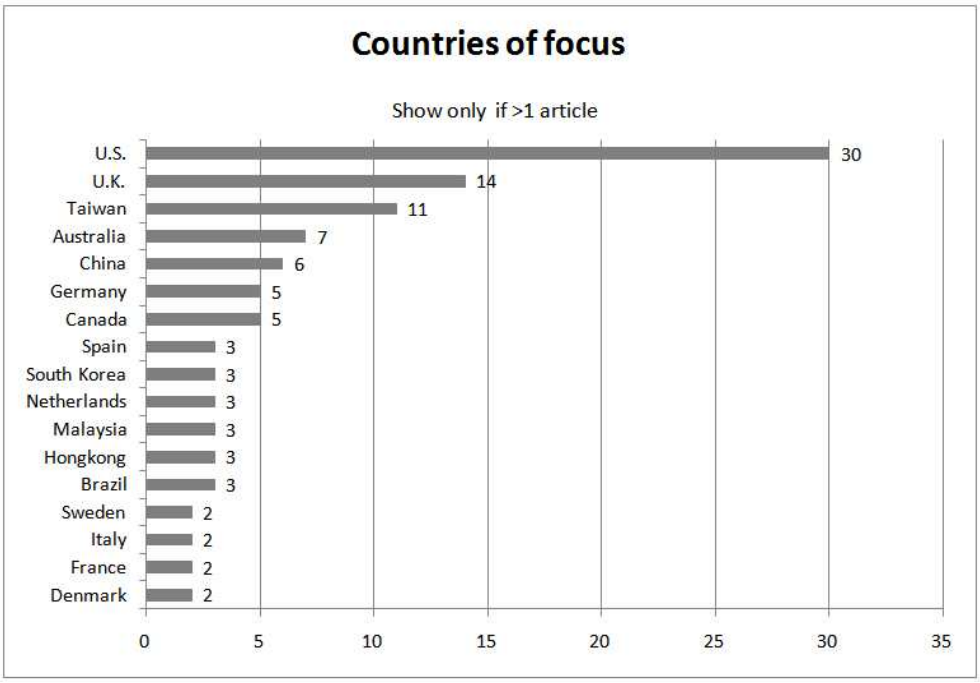

Fig. 5a. Countries of Focus in the studies

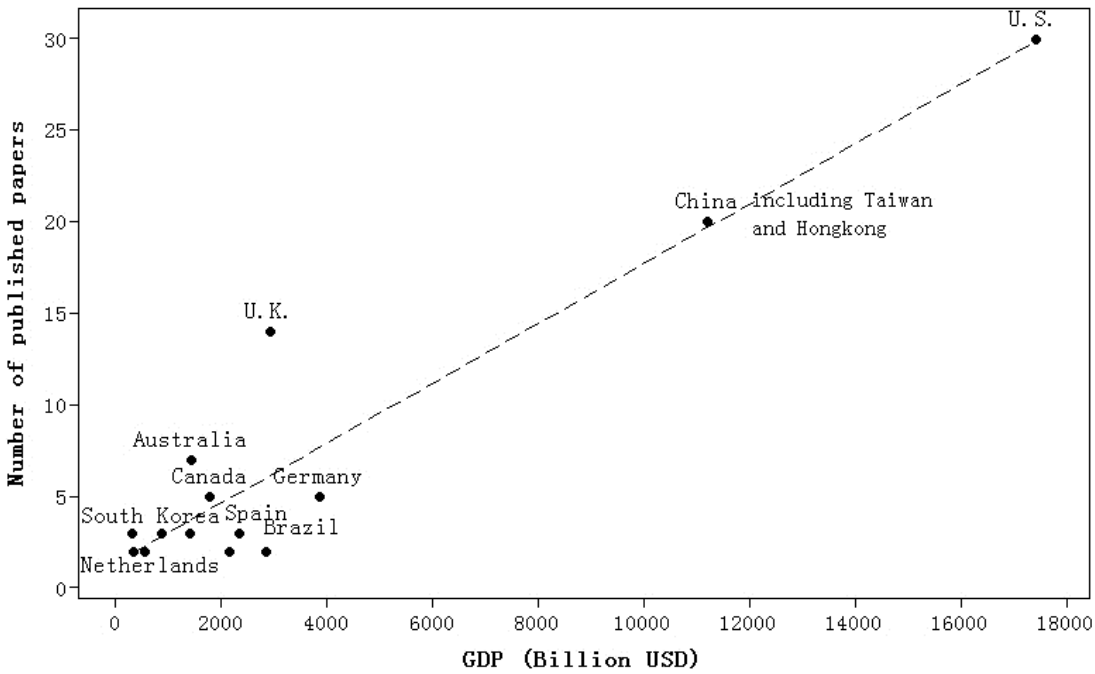

Fig. 5b. GDP vs. Number of published papers

Fig. 5a shows the distribution of countries mentioned in more than one reviewed paper. Ninety-six percent of studies focused on a single country because inter-country research should be difficult to be implemented. Countries with advanced economies such as the U.S. and the U.K. have paid more attention to this topic and account for approximately 40% of the papers. It is also worth noting that developing economies such as China including Taiwan are both on the top five of the list; in particular, all papers from these two regions were published since 2010, evidencing the increasing focus on this topic in developing countries. *Appendix C shows the reviewed papers for each country* in detail. Fig. 5b shows the relationship between the GDP of each country and the number of published papers in this research field. The regression dot line on the scatter plot shows the strong relationship between these two variables; the countries with a higher GDP focus more attention on innovation in supply chains as identified by the number of published papers. This conclusion strongly supports the finding in Fig. 5a. However, it should be noted that GDP is not the sufficient factor affecting the number of published papers; for example, Indian GDP ranks ninth in the world in 2014, but no papers were found related to this research topic.

4. Thematic Analysis

According to Mayring's process model, the third step is to identify the categories for literature coding. The thematic analysis below intends to explore the gap of research on

sustainable supply chain innovation from two perspectives: the innovation process and different functions in a sustainable supply chain. The innovation process in supply chains can be separated into three phases: pre-innovation, innovation and post-innovation. According to Hassini's classification, there are six major relevant functions in sustainable supply chains including sourcing, transformation, delivery, value proposition, customers and product use, and recycling (Hassini et al., 2012). The categories such as the key themes, innovation type, innovation novelty, dimension of sustainability, innovation phases, functions in supply chain and theories applied were selected for coding.

4.1 Terminology development

Evaluating the material coded is the last step in Mayring's process model. To demonstrate the terminology development in the reviewed papers and investigate the research opportunities, a set of key definitions related to innovation, supply chain management and sustainability are summarized in Table 1.

From Table 1, the integration and development of concepts can be easily observed. In supply chain innovation, the supply chain enables innovative channel integration, which is defined as "fifth generation innovation" (Rothwell, 1992); it is a multifactor process requiring a high level of integration at both the intra and inter-organizational levels (Liao and Kuo, 2014). The consideration about sustainability improves the expectation of supply chain innovation by effecting an outcome with more than one dimension. However, in the 107 published papers reviewed, there is no clear and complete concept considering all three streams of innovation, supply chain management and sustainability together. A refined and integrated definition for sustainable supply chain innovation is worth developing to close such gap.

Table 1: Terminology Development

INN.	SCM	SUS.	Introduction	References
X			The original concept of innovation was the ability to create economic value from new ideas. With the development of this concept, researchers defined it with different focuses. From the process perspective, it was defined as the process of the creation, development, and implementation of new ideas. From the marketing perspective, it was defined as an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to the development, production, and marketing tasks striving for the commercial success of the invention. From the capability perspective, it was defined as "the capabilities which are accustomed to developing effective and efficient systems to foresee opportunities, share and re-examine information using these systems, and overcome organizational inertia." From the cultural and environmental perspective, it was defined as "the notion of openness to new ideas as an aspect of a firm's culture as measure of the organization's orientation toward innovation." The central element in these diverse definitions of innovation is a new idea being put into practice.	(Bouncken, 2011; Damanpour, 1991; Detre et al., 2011; Garcia and Calantone, 2002; Gualandris and Kalchschmidt, 2014; Hult and Hurley, 1998; Ruff, 2006; Schumpeter, 1934; Tushman and Nadler, 1986)
	X		'Supply chain' refers to "a set of organizations directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer," and supply chain management (SCM) was defined by the Global Supply Chain Forum (GSCF) as "…the integration of key business processes from end users through original suppliers that provide products, services, and information that thus add values for customers and other stakeholders."	(Lambert et al., 1998; Mentzer et al., 2001).
		X	Sustainability is generally defined as using resources to meet the needs of the present without compromising the ability of future generations to meet their own needs. In business, it was defined as the ability to conduct business with a long-term goal of maintaining the well-being of the economy, environment and society, which was called the "triple bottom line" by Elkington to emphasize the integration of economic, social, and environmental aspects.	(Elkington, 1998; Hassini et al., 2012; WCED, 1987)

X	X		The integration of innovation and supply chain refers to tools that can improve the organizational processes needed for effective SCM through seamless interactions with suppliers, manufacturers, distributors and customers. Hence, supply chain innovations result in reductions in cost and lead time, the creation of new operational strategies, the provision of consistent quality, and the development of flexibility for handling rapid changes in the business environment. Supply chain innovation management builds on the idea that collaborative work and information transferred up- and down-stream of the supply chain improve innovation in the supply chain, which enriches the channels and activities of design, re-design, and innovation. This integration was also extended to the supply chain network and defined as “an incremental or radical change in process, structure, and/or technology that takes place in the supply chain network to create value for all stakeholders.” Another concept close to supply chain innovation has been labeled as logistics innovation, indicating any logistics-related service being seen as new and helpful to a particular focal audience. This audience could be internal to improve operational efficiency or external to better serve customers. Logistics innovations can range from very basic to very complex.	(Arlbjorn and Paulraj, 2013; Christopher, 2007; Flint et al., 2005; Grawe, 2009; Lee et al., 2011; Lin, 2008)
	X	X	The integration of supply chain management and sustainability was advocated as a new archetype for companies to meet stakeholder requirements and improve profitability and competitiveness while improving ecological efficiency and social responsibility in their supply chains. Sustainable supply chain management was defined 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.”	(Ahi and Searcy, 2013; Gualandris and Kalchschmidt, 2014; Seuring and Müller, 2008; Zhu et al., 1980)
X		X	In the context of renewable markets, innovation must not only create economic profits but also meet the environmental and social performance metrics increasingly associated with corporate social responsibility (CSR). A myriad of terms related to sustainable innovation have been proposed, such as sustainable development innovation, sustainable innovation, CSR-driven innovation, sustainability-related innovation, sustainability-driven innovation and sustainability-oriented innovation.	(Amaeshi et al., 2008; Andersson et al., 2005; Bröring et al., 2006; Hall, 2002; Hockerts, 2003, 2009; Klewitz and Hansen, 2014; Little, 2005; Wagner, 2008)

4.2 Key themes in reviewed papers

The use of coding enables our literature review to identify key themes by the different phases of innovation in the supply chain including pre-innovation, innovation and post-innovation. In pre-innovation, the themes relate to antecedents to innovation including motivators and barriers. Motivators contain some supporting activities such as information sharing, communication and learning (Berghman et al., 2012; Narasimhan, 2013; Wong et al., 2013); requirements from diverse stakeholders such as customers, suppliers and regulators, and secondary stakeholders such as media, non-governmental organization and competitors (Gualandris and Kalchschmidt, 2014; Lau et al., 2014; Mylan et al., 2014; Zhang et al., 2014); and key resources to enable innovation such as technology, relationship and trust (Michalski et al., 2014; Munksgaard et al., 2014; Wagner and Bode, 2014). In addition to resource scarcity, some sources of resistance such as high cost, inertial thinking, complexity and uncertainty highly hinder innovation (Kim and Lim, 2015; Lee et al., 2014; Leung et al., 2014; Nicholas et al., 2014). In innovation, the key themes relate to implementing the innovation. The innovation process can be divided into three, four, or five stages by different researchers. The three-stage process comprises conceptualization and definition, pilot implementation, and full implementation (Holmstrom, 1998). The four-stage process is first formed from a value creation with resource-based view and comprises value co-creation, resources integration and the reconfiguration of value constellation (Lin et al., 2010). The five-stage process comprises initiating or discovering an invention, launching an innovation initiative, embedding the initiative in the organization, focusing the innovation effort, and successfully commercializing the innovation (Narasimhan, 2013). In post-innovation, the key themes relate to innovation adoption and diffusion. Table 2 presents the count of papers identified according to the key themes in different innovation phases. There are some significant differences existing among these three phases. Fewer papers and lower publishing frequency distinguish the innovation phase from the pre- and post-innovation phases. The innovation process may be another opportunity for further research.

Table 2: Key themes with innovation phases

Phase	Category	Count of paper	Year of the 1st paper published	Maximum number of paper published per year
Pre-innovation	Antecedent to innovation	51	1996	10
Innovation	Innovation process	12	2000	3
Post-innovation	Innovation adoption and diffusion	43	1998	8

According to the six major relevant functions in sustainable supply chains classified by Hassini et al. (2012), the innovation adoption activities were grouped into six functions. Fig. 6 shows the count of papers in different sustainable supply chain functions. The transformation function also named as “manufacturing” had the highest number of papers. This critical function in a sustainable supply chain has received much research attention, and this conclusion is similar to the finding in 3.4. One key adoption of innovation is to integrate advanced IT technologies or systems into the transformation function. For example, e-SCM implementation enabled the success in SCM practice (Wu and Chuang, 2010), and technology innovations surrounding supply chain communication systems enhance channel relationships and affect market performance (Kim et al., 2006). Another key innovation practice in supply chains is green innovation, such as the diffusion of lead-free soldering in ICT manufacturers (Tong et al., 2012).

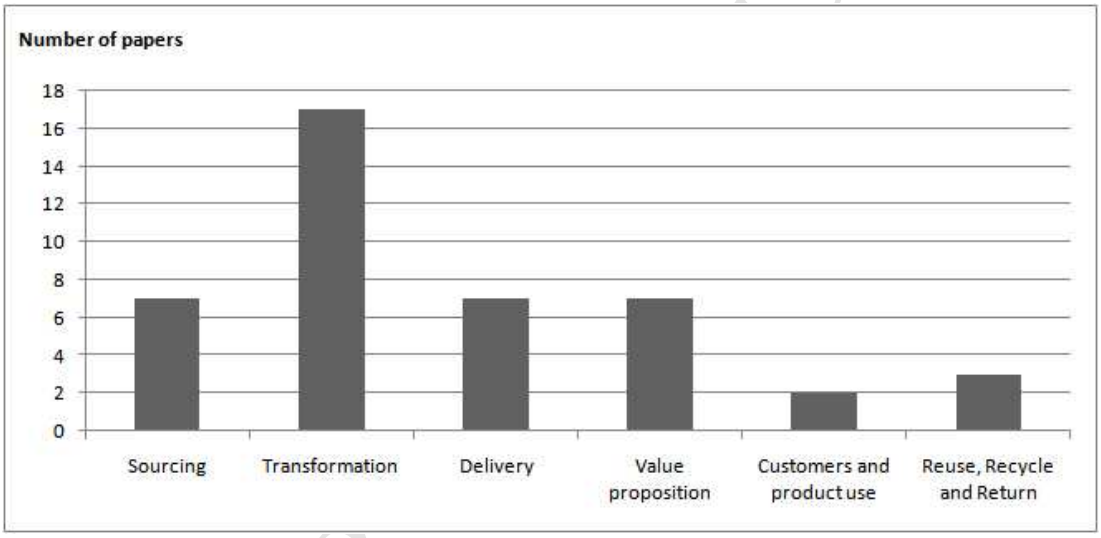

Fig. 6. Count of papers in function of the sustainable supply chain

4.3 **Classification by innovation type**

There are many analytical perspectives for classifying the Innovation types. Schumpeter first argued that innovation undergoes new combinations made by an entrepreneur, resulting in a new product, a new process, the opening of new markets, a new way of organizing the business, and a new source of supply in his book “The Theory of Economic Development” (Schumpeter, 1934). The Organization for Economic Co-operation and Development (OECD) classified the innovation as the implementation of a new or significantly improved product (e.g., change in product properties), process (e.g., changed delivery methods), marketing method (e.g., new product packaging) or organizational method (e.g., changes in workplace organization) in business practices,

workplace organization, or external relations (OECD, 2000). Based on the organizational ambidexterity developed, scholars have focused on explorative and exploitative innovations (Blome et al., 2013). According to drivers of innovation, innovation has been distinguished into 'technology push' innovation driven by technological discovery and 'market pull' innovation developed in response to market demand (Bruce and Moger, 1999). According to different levels of novelty, researchers have noted the difference between 'radical innovation' such as major processes or product advances, and 'incremental innovation' characterized by the improvement of existing systems (Bessant, 1992). From the innovation approach perspective, innovation can be grouped into technological innovation and administrative innovation for supply chain management (Kim et al., 2006). From the relationship perspective, innovation can also be distinguished into independent innovation and collaborative innovation (Ribeiro, 2009; Zhang et al., 2014). From the result orientation perspective, innovations can be grouped into cost reduction, technological advantage, green or ecological, sustainability-oriented innovations.

In this review, innovation classification follows what Schumpeter proposed originally. Furthermore, technological innovation is considered an additional type. Technology was defined as the "design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (Rogers, 1962). As such, nearly any contemporary idea, practice or product that an organization wishes to adopt and employ for the purpose of obtaining gains in performance can be considered as a technological innovation (Hazen et al., 2012). Although technological innovation overlaps with some product and process innovations, many papers applied the term "technological innovation" directly in research.

Table 3a: Innovation types with innovation phases

Innovation types	**No.**	**Innovation Phases**		
		Pre-Inn.	**Inn.**	**Post-inn.**
Product Innovation	32	**14**	**5**	**13**
Process Innovation	40	21	5	14
Technological Innovation	30	12	2	16
Organizational Innovation	15	9	3	3
Marketing Innovation	3	2	1	-
Resource Allocation Innovation	4	1	1	2

Table 3a shows the innovation types in three phases. It should be noted that most supply chain innovations are related to process, product, technological and organizational innovation. The reason may be because the collaborative activities in the supply chain

enhance or create new functions of the products and improve the process efficiency and effectiveness. The organizational changes are usually because of the adoption of technological changes or marketing changes. In comparison with other two phases, the innovation phase is still lack of focus in research. It may be interesting to note that the number of organizational innovations in post-innovation phase is much less than the one in pre-innovation phase. The reason could be that adopting organizational innovation by other participants is more difficult than other innovation types in the supply chain.

To explore the relationship between innovation types and functions in a sustainable supply chain, Table 3b shows innovation types with functions in sustainable supply chain; the figure in brackets denotes the number of papers, and the figure outside the brackets represents the item number of typical examples.

Table 3b: Innovation types with functions in sustainable supply chain

Functions in SSC / **Innovation Type**	**Sourcing**	**Transform -ation**	**Delivery**	**Value Proposition**	**Product use**	**Reuse, Recycle, Return**
Product Innovation	(3) 1	(6) 2		(5) 3	(2) 4	(1) 5
Process Innovation	(2) 6	(6) 7	(3) 8, 16	(3) 7	(3) 9,10	(3) 9, 10
Technological Innovation	(2) 11	(8) 12	(3) 13	(3) 14		(1) 15
Organizational Innovation			(2) 16	(2) 17, 18		
Marketing Innovation				(1) 19	(1) 19	
Resource allocation Innovation	(1) 15	(1) 6				

Typical Example in references:

1. Kim and Lim (2015)	6. Wuttke et al. (2013)	11. Davila et al. (2003);	16. Holmstrom (1998)
2. Wong et al. (2013)	7. Wu (2013)	12. Grover (2013)	17. Gilbert and Cvsa (2003)
3. Nicholas et al. (2014)	8. Lau et al. (2014)	13. Neubert et al. (2011)	18. Zhu et al. (2012)
4. Goldsmith (2001)	9. Buffington (2012)	14. Wu and Chang (2012)	19. Silvestre (2014)
5. Verghese and Lewis (2007)	10. Richey et al. (2005)	15. Jensen and Govindan (2014)	

It is easy to find that product innovation occurring in almost all functions of sustainable supply chains except delivery because it is a key function for the focal company to integrate all resources from internal and external supply chains (Wong et al., 2013). For example, the focal company may invite suppliers for joint innovation or even outsource the R&D in an innovation-driven supply chain (Kim and Lim, 2015). When innovation is successfully developed by the focal company, it should be widely advertised to gain end-user acceptance and adoption; however, acceptance is a long process (e.g., the generalization of genetically modified food) (Nicholas et al., 2014). From the innovator's point of view, the innovations might command a price premium in the marketplace; however, from the adopters' point of view, they face a large investment and a great risk of giving up the original product (Goldsmith, 2001). To reduce the potential

environmental impact of a product, environmental innovation can be used in product design; for example, the reduction of industrial packaging reduces the supply chain cost and the environmental impacts, making the product more sustainable (Verghese and Lewis, 2007).

Process innovations occur in all functions of the sustainable supply chain, e.g., the innovation of supply chain finance between suppliers and buyer, the employment of green supply chain integration with intra- and inter-organizational environmental practices, the lateral transshipment during product delivery in the supply chain, and development of effective reverse logistics processes to enable aluminum can recycling (Buffington, 2012; Lau et al., 2014; Richey et al., 2005; Wu, 2013; Wuttke et al., 2013). Technological innovation occurs on almost all functions in a supply chain except the customer use. Customer requirement drives technological innovation; however, the innovations require the innovator to master the most advanced technology, which might be hard for general end-users (Gualandris and Kalchschmidt, 2014). In technological innovation, the most common innovation relates to the application of information technology, such as the application of e-procurement, e-SCM and RFID, and to the technology of pollution reduction, such as controlling GHGs and renewable bioenergy applications (Davila et al., 2003; Grover, 2013; Jensen and Govindan, 2014; Neubert et al., 2011; Wu and Chang, 2012).

Comparing the innovations in products, processes and technologies, the innovations in organization, marketing and resource allocation appear to be only related to certain function in a sustainable supply chain. To gain the first mover advantage, the focal company must lead the strategically organizational innovation with partners in the supply chain, and outsourcing and implementing vendor managed inventory are both common adoptions in practice (Gilbert and Cvsa, 2003; Holmstrom, 1998; Zhu et al., 2012). Because innovation is central to sustainable supply chain management (Silvestre, 2014), a new and green market niche might develop or innovations could be applied to emerging economies even with uncertainties (Saint Jean, 2008; Silvestre, 2014). Resource allocation innovation only occurs in the sourcing and transformation functions which demand resource inputs, such as capital, material, energy (Holmstrom, 1998; Wuttke et al., 2013).

4.4 Classification by innovation novelty

In supply chain, the interactions of partners such as the buyer-seller interaction generate both incremental and radical innovations (Roy et al., 2004). To distinguish

between two innovations, innovations were conceptualized as a sequence of S curves, with each S curve representing a distinct type of base technology with its own stream of incremental innovations (Roy et al., 2004). Incremental innovations are considered to move along the same S curve; in contrast, radical innovations are considered as moving from one S curve to another (Asthana, 1995). To investigate the novelty of innovation in supply chains, the innovations in reviewed papers are categorized as radical and incremental.

Table 4: Innovation novelty with innovation phase

Degree of Novelty	Total Number	Innovation Phases		
		Pre-Inn.	Inn.	Post-inn.
Incremental	23	10	4	9
Radical	40	11	6	23

Table 4 shows that radical innovations occur much more often than incremental innovations in the supply chain, particularly in post-innovation phase. Innovations in the supply chain involve changes in product, process, or service that either reduce cost or improve efficiency; the notion of efficiency includes increasing end-of-chain customer satisfaction. A particular S curve involves close teamwork with the concerned suppliers based on interactions and a set of moderating factors. Such close teamwork which involves relationships in which both the strength of the relationship and a high degree of shared knowledge allow very specific technical development work to be undertaken. Jumping across S curves, which involves new knowledge domains, and increases the possibility of radical innovation being generated. More rapid movements across S curves are designated as "increased generation of radical innovations." (Roy et al., 2004). Hence, the innovations in the supply chain comprising many inter-organizational activities are more radical than incremental. The success of radical innovations is more obvious and attractive than incremental to other participants in the supply chain. It encourages them to adopt the best practices.

4.5 Classification by dimension of sustainability

The performance of supply chain innovation can be measured through three aspects of sustainability (Sus) including economic (Eco), environmental (Env) and social (Soc) aspects (Labuschagne et al., 2005; Parris and Kates, 2003). To investigate the balance of innovation performance among these three aspects, Table 5a shows the result of differentiation.

Nearly all supply chain innovations account for economic performance at the

beginning but not environmental and social performance. Since 2000, environmental and social issues have been considered in supply chain innovations, which can be explained by the increasing demands from a variety of stakeholders, particularly customers and regulators (Gualandris and Kalchschmidt, 2014). A small percentage of innovation has started to consider sustainability since 2007. This observation is similar to the conclusion drawn in prior research (Seuring and Müller, 2008). The social dimension gains the lowest focus in these three dimensions, which may be because the papers arguing for the social dimension commonly have already considered all three dimensions for sustainability. From the innovation phase perspective, it should be noted that there is no paper studying the innovation process aiming at environmental or social innovation. The possible reason might be the difficulty of distinguishing the difference among these three dimensions.

Table 5a: Dimensions of sustainability with innovation phases

Dimensions	Number of papers	Percentage	Year of the 1st paper published	Innovation Phases		
				Pre-Inn.	Inn.	Post-inn.
Eco	72	67%	1996	38	9	24
Eco + Env	16	15%	2000	5	-	11
Eco + Soc	3	3%	2000	2	-	1
Sus	10	9%	2007	3	2	5

Table 5b shows three dimensions of sustainability with functions in sustainable supply chain. It should be noted that there are three characteristics in their relationship. Firstly, no paper specially argues the economic performance at the function of “product use” in the supply chain. An innovation creating economic benefit for customers is the essential and common sense for academics and practitioners, which is the possible reason why it is not worthy of further study. Secondly, at the function of “delivery”, all researches focus on economic performance. Most of innovations at this “delivery” function are technological and process innovations, such as the application of RFID, e-SCM and SAP (Holmstrom, 1998; Leung et al., 2014; Neubert et al., 2011; Tajima, 2007; Wu and Chuang, 2009). The application of IT systems and new technologies strongly improve the efficiency of supply chain which results in cost reduction and economic performance improvement. Thirdly, Social dimension still gains less focus than other dimensions. Only one paper specially focuses economic and social dimension at the function of “customers and product use” in supply chain. This paper argued the use of genetically modified seed in farming industry that increased the welfare of entire society. However, the increased concentration among suppliers raised a concern about “fairness to farmers” in this revolution, which is an economic and social issue (Goldsmith, 2001).

Table 5b: Dimensions of sustainability with functions in sustainable supply chain

Functions in SSC / Innovation Type	Sourcing	Transform-ation	Delivery	Value Proposition	Product use	Reuse, Recycle, Return
Eco	3	8	9	5	-	1
Eco + Env	1	6	-	2	2	3
Eco + Soc	-	-	-	-	1	-
Sus	2	1	-	3	1	1

4.6 Various theories applied

A total of 63 various theories or models have been applied in the reviewed papers, and they are shown in Appendix D: Various Theories applied. Table 6 only lists the top ten theories applied. To analyze how these theories have been applied to the sustainable supply chain innovation, the reviewed papers are differentiated into four groups according to sustainability and its three dimensions which are labeled as Sus, Eco, Env and Soc, respectively. The number of the papers for each group is shown in each column. The economic dimension is assumed as the basic dimension being covered by all papers. Hence, the environmental group includes both economic and environmental dimensions, as does the social group.

Table 6: Top ten theories applied in the papers

Theories	Dimensions of sustainability				Innovation Phases		
	Eco	Eco+Env	Eco+Soc	Sus	Pre-Inn.	Inn.	Post-inn.
Resource-Based Theory	23*	4		3	13**	2	2
Transaction Cost Theory	12	1	1		9	1	2
Innovation Diffusion Theory	7	1					6
Organization Theory	7	2		1	3	1	3
Social Theory	7	1			7		
Relationship Theory	6				5	1	
Network Theory	5				1	2	
Stakeholder Theory	5	4	1	4	3	1	1
Strategic Approach	5				3		1
Systems Theory	5	3		1	5		

* Number of papers applying the theory to different dimensions of sustainability.

** Number of papers applying the theory to different phases of innovation in supply chains.

It is obvious to note from table 6 that resource-based theory is the major theoretical perspective for sustainability and its economic and environmental dimensions. More than 20 percent of papers apply resource-based related theory to analyze the supply chain

innovation. The resources include not only the capital, which is defined as the accumulation and deployment of resources with the implicit expectation of positive returns (Brewer, 1984) but also human beings and knowledge. Hence, the resource-based theories comprise the resource-based view (RBV) theory, knowledge-based view theory, resource dependency theory, resource exchange concept, resource advantage theory resource and capability theory and natural-resource-based view (NRBV). From the resource-based view (RBV), the basis for the competitive advantage of a firm lies primarily in the application of a bundle of valuable tangible or intangible resources at the firm's disposal (Barney, 1991). For example, flexibility of the information technology infrastructure is regarded as a set of resources to facilitate the innovation performance (Cheng et al., 2014). The resource-based theories explain the firm's ability to deliver a sustainable competitive advantage through innovation with resources managed in such a way that they cannot be replicated by others, which serves as an ideal barrier to entry, thus securing the firm's competitive advantage and market positioning (Tan and Ndubisi, 2014). The transaction cost theory was used by more than 10 percent of papers, and it was developed by Coase who firstly suggested that the determination of whether a transaction would be implemented across a market between two separate firms or within the same firm was determined by a set of costs (Coase, 1937). The transaction cost theory provides some insight into new governance structures such as vertical integration, licensing, contracts and bundling that such firms employ (Goldsmith, 2001). From the transaction cost view, the structure of a firm's supply chain (or governance structure) is determined by the costs associated with the uncertainty, frequency and degree of asset specificity pertaining to each transaction (Burns, 1978). Restructuring the supply chain through channel innovation reduces the transaction cost (Croom, 2001).

It is necessary to note that few theories are applied to the social dimension as this paper has found little research on this dimension. From the sustainability perspective, the stakeholder theory plays a key role. Stakeholder theory is very popularly applied in supply chain and sustainability research. A stakeholder is defined as any group or individual who can affect or is affected by the achievement of an organization's purpose and includes multiple individuals or groups such as financial claimants, non-governmental agencies, employees, customers, communities, universities, media, and governmental officials, among others (Stubbs and Cocklin, 2008). Stakeholders can be classified into primary and secondary stakeholders (Clarkson, 1995). The requirements of primary stakeholders are usually regarded as the customer pressure to motivate firms to begin and sustain the sustainable supply chain management development process (Gualandris and

Kalchschmidt, 2014).

As shown in table 6, this study also analyzes the theories applied in the reviewed papers from the innovation process perspective. The reviewed papers are differentiated into the categories of pre-innovation, innovation and post-innovation. As we have mentioned in 4.2, the chief themes in the pre-innovation phase relate to the antecedents to innovation. Except innovation diffusion theory (IDT), almost all of the theories on the list are suitable for pre-innovation research if the resource, transaction cost, organizational structure, social capital, relationship among partners in the supply chain, structure and tie of the supply chain network, stakeholder requirements, strategy and system complexity are considered as key antecedents to innovations in supply chain (Autry and Griffis, 2008; Blome et al., 2013; Cheng et al., 2014; Choi and Krause, 2006; Craighead et al., 2009; Gualandris and Kalchschmidt, 2014; Panayides and Lun, 2009; Wagner and Bode, 2014). Resource-based theory is again the key concept; according to this theory, resources such as technology and trust can influence the innovation (Fawcett et al., 2012; Munksgaard et al., 2014).

In the phase of innovation, six theories with low frequency were applied to the innovation process research. Innovation is regarded as internal and external organizational learning interaction and information-sharing process which target the reduction of transaction costs and meet stakeholder requirements (Berghman et al., 2012; Chapman and Corso, 2005; Silvestre, 2014). In the post-innovation phase, diffusion is the key task; thus, innovation diffusion theory (IDT) has a high frequency of application. Diffusion is the “process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 1962). Diffusion research has been conducted from a variety of different disciplines, and its origins can be traced back to Tarde in 1903 (Harrison and Waite, 2006). Rogers’ diffusion model is widely accepted; he suggested that the organization could be classified into five categories(innovators, early adopters, early majority, late majority, and laggards) with two stages of diffusion: adoption and implementation (Rogers, 1962). With the effort of prior researchers, the extended stage-based diffusion models varying from two to six stages have been well summarized in Wu’s studies (Wu and Chang, 2012; Wu and Chuang, 2009). During innovation adoption and diffusion, the cultural theory systematically addressed the difficulty because of the complexity of different individual perspectives (Matos and Hall, 2007).

5. Conceptual Framework for Sustainable Supply Chain Innovation (SSCI)

5.1 Sustainable supply chain innovation (SSCI) framework

The linkage between the innovative firm and its supply chain is even more important when one considers that a sustainable supply chain is one of the few remaining ways for a company to achieve a sustainable competitive advantage (Damanpour, 1991); hence, sustainable innovations need to extend beyond one individual firm to a connected supply chain of firms.

According to the literature reviewed above, the concepts of innovation in supply chains have been developed by researchers to a certain extent. However, the developments contain partial or fractional views when evaluated from the supply chain and sustainable perspectives. For example, most studies have mainly focused on the focal companies and interaction with suppliers (Vale, 2004; Wong et al., 2013; Wuttke et al., 2013). Similarly, some studies have mainly argued the environmental dimension of sustainability known as green innovation or eco-innovation (Chiou et al., 2011; Seman et al., 2012; Wu, 2013; Zhu et al., 2012). It is necessary to note the lack of one clear and complete concept considering the three aspects of innovation, supply chain management and sustainability together which can enable a more accurate understanding of sustainable supply chain innovation. Based on the prior studies, this paper aims to integrate these three research streams and establish complete and accurate definitions for supply chain innovation (SCI) and sustainable supply chain innovation (SSCI).

The innovation occurring in the supply chain is expected to deliver some desirable changes and includes all parties, such as multiple tiers of suppliers, R&D, producers, logistic providers, retailers, and consumers. According to the sustainable supply chain framework proposed by Hassini et al. (2012), different actors in the supply chain fulfilling different responsible functions may have different views on an innovation depending on how it is perceived to affect their business or themselves. In Fig. 7, we illustrate a framework for the conception of sustainable supply chain innovation. Supply chain innovation (SCI) can be envisaged as a large umbrella which encompasses all of the innovative activities occurring in every function in the supply chain.

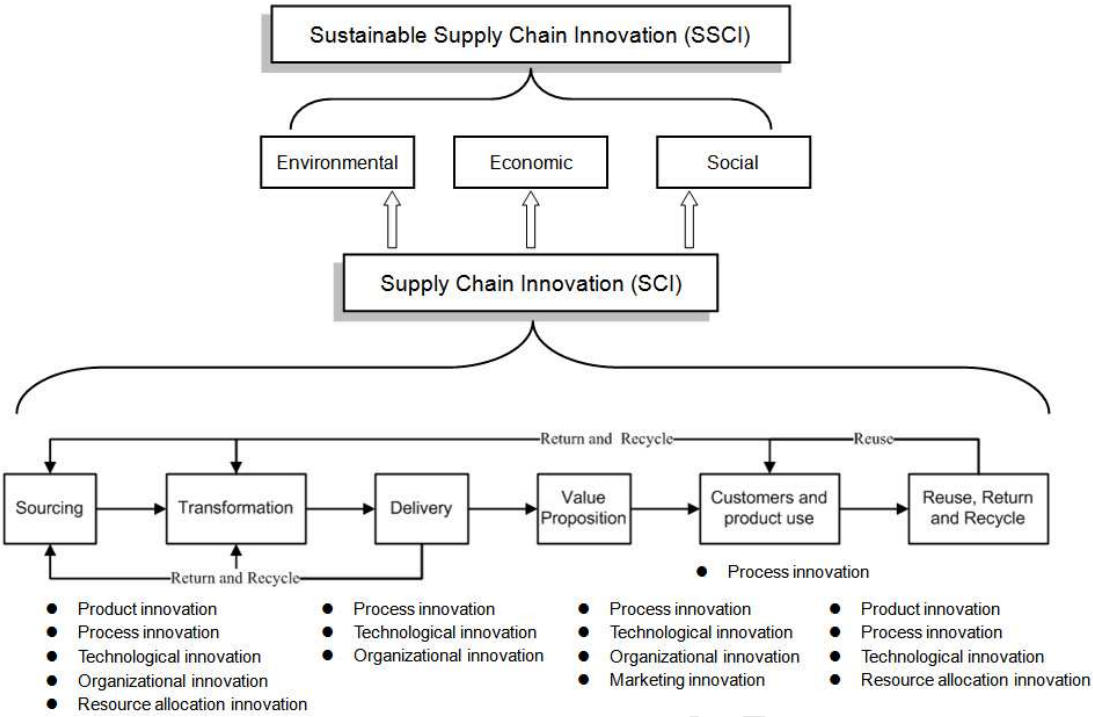

Fig. 7. Sustainable Supply Chain Innovation (SSCI) framework

In such a conceptual framework, supply chain innovation (SCI) comprises a set of innovative activities. In the sourcing and transformation functions, it covers product, process, technological, organizational and resource allocation innovations among multiple tiers of suppliers and producers including R&D; this innovation may be led by either the supplier or the buyer. The innovation in delivery function, named as logistics innovation by Flint et al. (2005), essentially works as a process, technological or organizational innovation among producers, logistic providers, product sales, customers and/or recyclers. The value proposition function in the supply chain is to quantify the benefits and justify the value added to customers (Hassini et al., 2012), hence, the innovations in value proposition function are sometimes regarded as business model change, service innovation or value innovation (Berghman et al., 2012; Gadde, 2013; Paton and McLaughlin, 2008), and it essentially works as a process, technological, organizational or marketing innovation between product sales and the customers. In the product use function, the customers in the service supply chain may be regarded as component suppliers, labor, design engineers, production managers, products, quality assurance, inventory or even competitors, and it can essentially be regarded as process innovation (Sampson and Spring, 2012). The product reuse, return and recycle functions usually perform as eco-innovation among recyclers, product disposers and/or remanufacturers, and it essential works as a product, process, technological or resource allocation

innovation (Jabbour et al., 2014; Mylan et al., 2014; Seman et al., 2012). The supply chain innovations could start from accumulating incremental changes to final radical changes or immediately launching a radical change directly. To achieve sustainable innovation, maximizing the supply chain profitability, minimizing the environmental impact and maximizing the social well-being should be considered and balanced at the same time (Elkington, 1998; Hassini et al., 2012). So that it is ready to propose a unified definition for SCI and SSCI considering the innovation with different types acceptable to all related parties and covering all related functions in whole supply chain, hence, *supply chain innovation (SCI) can be defined as an integrated change from incremental to radical changes in product, process, marketing, technology, resource and/or organization, which are associated with all related parties, covering all related functions in supply chain and creating value for all stakeholders. If the supply chain innovation results in balanced performance of economic, social and environmental dimensions, in other words, all three dimensions have positive innovation performance. It is called a sustainable supply chain innovation (SSCI).*

5.2 Characteristics of SSCI

The proposed definition of sustainable supply chain innovation (SSCI) which was developed and drawn from prior literature highlights several important characteristics:

(i) Systematic: Sustainable supply chain innovation is a collection of interacting activities that are operated by different participants to achieve a common goal, and it is the typical systematic behavior described in system literature (Elmaghraby, 1966).

(ii) Complex: Complexity is the typical symptom of a system. In supply chain innovation, the complexity can be detected from the product, process, technology, network, and so on. Greater complexity will lead to a lower level of supply chain performance (Closs et al., 2008).

(iii) Internal and external: Sustainable supply chain innovation requires both internal and external activities and capabilities, such as internal learning, absorptive capability, internal integration; external information sharing and coordination (Berghman et al., 2012).

(iv) Dynamic: Facing rapidly changing environments and the changing needs of customers and integrating existing conceptual and empirical knowledge require dynamic capabilities among all parties in a supply chain (Cheng et al., 2014).

Dynamic capabilities belong to an extension of the resource-based view where supply chain members own different tangible and intangible resources and capabilities (Wu, 2010). The processes of change continually produce new externalities that must be addressed (Emerson and Emerson, 1962).

(v) Collaborative: To achieve significant change and conquer the barriers in innovation process such as high-cost pressure, a shortened project cycle and increasing competition, both upstream and downstream parties in supply chain must form a collaborative relationship with each other. Collaboration in the supply chain demands aligned objectives, open communication, sharing of resources, risks and rewards. Collaborative relationships enhance innovation and sustainability performance (Silvestre, 2014).

(vi) Complementary: Each participant in the supply chain has its own advantage and disadvantage. The collaboration enables supply chain participants to create complementary effect in innovation, which is defined as doing more than one activity and increasing the return from doing the other activity (Blome et al., 2013). Complementary can also be named as the “one plus one is greater than two” effect.

(vii) Sustainable: The innovation is associated with all parties in the supply chain; thus, its aim is not only to create value for the focal company but also to consider the needs of all stakeholders. Hence, this type of innovation will search for balance among economic, social and environmental performance, which was called as sustainable performance. A new archetype is for supply chain participants to meet stakeholder requirements and improve profitability and competiveness while improving ecological efficiency and social responsibility (Gualandris and Kalchschmidt, 2014).

(viii) From incremental to radical: supply chain innovation usually accumulates from small changes or further intra-organizational optimization to significant changes in inter-organizational optimization (Tseng et al., 2013).

5.3 Discussion and suggestions for further research

This literature review has described and analyzed the prior research on supply chain innovation related to sustainability. The research trend shows that SSCI has gained increasingly attention. The next central aim of a systematic literature review is to identify the opportunities for future research. Here are some research opportunities captured and

discussed.

Firstly, an integrated and completed definition for SCI and SSCI has been proposed. This generalized definition contains different types of innovation covering all related functions in the supply chain. In further research, an empirical study such as a case study is necessary to demonstrate the effectiveness of the definitions.

Secondly, as seen in this review, some researchers have argued which antecedents may motive or hinder the innovation. However, most of the studies were under the context of an individual or binary relationship. The antecedents of sustainable innovation under the supply chain context and the mechanism of SSCI are worth investigating, and a survey approach using questionnaires is strongly recommended.

Thirdly, almost all of the studies, the case studies in particular, were conducted by a cross-sectional approach. Cross-sectional studies benefit the comparison analysis, but they lack a longitudinal evolutionary analysis which is important for the incremental innovation research. Particularly, if the innovation is expected to achieve sustainable performance, the environmental impact may not be measured over a short term, and a longitudinal study may be more suitable for revealing the evolution of the sustainable innovation (Lee et al., 2014; Richey et al., 2005; Wagner and Bode, 2014).

Fourthly, as we have mentioned in the previous literature review, few studies have discussed the process of SSCI. How is sustainable innovation generated in the supply chain context? What are the differences in process in different industries or in different business types such as B2B and B2C? These questions are very interesting for further research.

Fifthly, although a measurement of the sustainability of corporations or supply chains has been proposed in some literature, most measurements focus on environmental dimension such as the reduction of GHG emissions, disposition of waste, reduction in compliance costs, and so forth (Amini and Bienstock, 2014; Hassini et al., 2012; Lang et al., 2007). Isaksson et al. (2010) proposed a process model with some performance indicators to measure the innovation potential; however, the model only focuses on process innovation. It is worth noting that creating an effective system for evaluating the sustainable supply chain innovation is necessary.

Finally, benefit sharing and risk taking are both two key issues which motivate or hinder supply chain innovations; some researchers have proposed that the strategic commitment to price can stimulate downstream innovation in a supply chain (Gilbert and

Cvsa, 2003). However, the method of sharing the benefits and risks of innovation with all participants in supply chain is still unclear.

This systematic literature review delivers meaningful implications for both academics and practitioners. This study reveals the trend of SSCI, and the definition proposed provides a unified way for communication in the research and practice on sustainable supply chain innovation. Furthermore, for academic research, the characteristics of SSCI are described well in this study to help researchers identify what is true SSCI, and six opportunities are identified to provide directions for further academic research. For practitioners, this study clearly emphasizes the importance of sustainability in supply chain innovation. A long-term strategic view is strongly recommended by this study. All parties in the supply chain are encouraged to seek for the supply chain innovations that consider all three dimensions of sustainability rather than profitability, and sustainable innovation will create and maintain the long-term competition advantage for supply chain.

6. Conclusions

In this paper, we have conducted a systematic review of sustainable supply chain innovation. It is necessary to note that the present literature review has existing limitations. Firstly, with our focus on academic journal papers in English, we are aware of excluding papers in other languages as well as other types of publications, such as conference papers which might lead to some loss of knowledge. Secondly, due to the keyword-based searching method applied to the publications, it is possible that some papers related to the research focus but with different keywords were excluded. Finally, the findings in the literature review strongly depend on the reviewers' experience and educational background.

Despite the limitations, this study following Mayring's content analysis model still provides some significant findings to academic research and managerial practice by analyzing interdisciplinary literature from diverse fields as broad as innovation, supply chain management and sustainability.

In the descriptive analysis, the rapidly increasing tendency and the stage breakpoint during the year 2006 were clearly described and summarized. Three key published journals taking a dominant position were identified. Survey and case study were found to be the main research methodologies applied. Manufacturing was found to be the main industry sector in supply chain innovations.

To explore the linkage among innovation, supply chain management and sustainability, the thematic analysis was conducted by innovation process and sustainable supply chain perspectives. As the result of analysis, the antecedents to innovation and the transformation function were identified as the most important and popular themes in the reviewed literature. Advanced countries have been proven to pay more attention to this topic, and the attention rate is positively related to the economic level. Process, product and technological innovations are regarded as the major innovation types, and different functions in supply chain lead to different types of innovation. In the supply chain, innovation is more radical, and its economic consideration has a much higher priority than the environmental and social dimensions. The application frequency of theories applied in supply chain innovation are summarized and analyzed, and the resource-based theory is ranked as the most popular one.

This study also delivers some significant contributions. The definitions of supply chain innovation (SCI) and sustainable supply chain innovation (SSCI) are proposed by an integrated and completed framework with identified characteristics. Several suggestions are advanced to guide further research. It should be mentioned that a case study on the SSCI process and the study on antecedents to SSCI are in progress, which will continue to contribute to the research on SSCI.

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Appendix A: Reviewed papers (1-107)

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Appendix B: Methodologies applied

Methodologies	Reference number of papers
Survey	5, 6, 7, 8, 13, 14, 16, 18, 22, 23, 24, 29, 30, 33, 35, 42, 50, 54, 55, 57, 58, 59, 61, 62, 69, 71, 72, 76, 78, 80, 83, 89, 90, 94, 96, 98, 99, 100, 101, 102, 107
Case Study	1, 9, 11, 17, 20, 21, 32, 34, 37, 38, 39, 40, 44, 45, 46, 47, 48, 52, 56, 60, 63, 64, 65, 67, 81, 84, 86, 87, 92, 93, 95, 103, 104, 105
Theory	3, 4, 10, 12, 15, 19, 25, 26, 28, 36, 41, 43, 66, 70, 73, 75, 82, 85, 88, 91, 97
Model	27, 31, 49, 51, 53, 74, 77, 79, 106
Review	2
Other	68

Appendix C: Countries of Focus

Countries of focus	Reference number of papers
Australia	12, 7, 23, 53, 69, 93, 87
Boland	42
Brazil	19, 45, 60
Canada	38, 52, 84, 88, 60
China	29, 48, 90, 97, 106, 107
Demark	2, 47
Estonia	41
France	67, 79
Germany	6, 8, 96, 103, 104
Greece	42
Hongkong	56, 70, 71
Italy	33, 86
Malaysia	55, 82, 89
Mexico	81
Netherlands	5, 95, 42
New Zealand	26
Nordic Sweden	39
Porland	61
Portugal	92
Singapore	87
South Korea	49, 54, 105
Spain	1, 42, 61
Sweden	11, 44
Taiwan	13, 40, 57, 58, 59, 83, 91, 99, 100, 101, 102
Thailand	98
U.K.	9, 14, 17, 34, 35, 37, 46, 63, 65, 68, 72, 73, 75, 78
U.S.	3, 4, 10, 15, 16, 18, 20, 21, 22, 24, 25, 27, 28, 30, 31, 32, 36, 43, 50, 51, 62, 64, 66, 74, 76, 77, 80, 85, 94, 60

Appendix D: Various Theories applied

Theories or Models	Reference number of papers
Absorptive Capacity	31, 66, 84, 99
Ambidexterity Theory	66, 98
Attitude Theory	101
Balance Score Card (BSC)	100
Behavioural Theory	75, 100, 101, 102
Benchmarking	7, 46
Business Ethics	44
Chase's Customer Contact Model	80
Competing Value Framework (CVF)	66
Competitive Theory	46, 101
Complementarity Theory	6
Complexity Theory	60
Concept of Channel Power	34
Concept of Core Competencies	34
Contingency Theory	40, 84, 99
Contractual Coordination Mechanisms	86
Decision Theory	97
Demand Distortion	39
Design Structure Matrix (DSM)	37
Eco Efficiency Concept	44
Ecological Modernization Theory (EMT)	107
Evolution Theory	63, 65, 84
Exploitation-Exploration Theory	31, 88
Fitness Landscapes Theory	60
Fuzzy Theory	70, 97
Game Theory	23, 30, 97
Industrial Marketing And Purchasing (IMP) Theory	77
Innovation Diffusion Theory	35, 61, 100, 101, 102, 104, 107
Innovation Dynamics	60
Institutional Theory	13, 48
Interaction Theory	77
Inventory Echelon	57
Lead Market Theory	90
Life Cycle Management	45, 60, 93, 103
Linguistic Decision Making Model (LDMM)	97
Mindfulness Theory	56
Neoclassic Economics	28
Network Theory	3, 3, 12, 31 , 77
NK Model	15
Optimal Control Theory	49

Organization Theory	5, 20, 34, 60, 72, 86, 88
Profiting from Innovation (PFI)	20
Property Right Theory	26
Quality Management	44
Quantum Energy Level Theory	48
Relationship Theory	4, 6, 22, 70, 77, 96
Resource-Based Theory	3, 3, 5, 13, 16, 16, 22, 23, 26, 31, 31, 31, 43, 50, 58, 59, 61, 69, 69, 84, 89, 91, 99
Risk Management	60
Schumpeterian Innovation Framework	31
Service Theory	80
Six Sigma	105
Social Theory	3, 43, 58, 65, 69, 72, 97
Stakeholder Theory	33, 44, 52, 60, 84
Strategic Approach	16, 67, 67, 86, 92
Structural Density Theory	3
Systems Theory	15, 34, 44, 65, 92
TCOS Uncertainties	84
Technology Acceptance Model (TAM)	100, 101, 102
Theory of First-Mover Advantages	88
Theory of S-Curves	31
Theory of Swift And Even Flow	62
Transaction Cost Theory	4, 6, 12, 17, 26, 28, 34, 38, 43, 61, 86, 96
Triple Bottom Line	52, 91
TRIZ	19
Unified Theory of Acceptance And Use of Technology (UTAUT)	36
Virtual Enterprise (VE)	100, 102

From a systematic literature review to integrated definition for Sustainable Supply Chain Innovation (SSCI)

- First systematic literature review of sustainable innovation in supply chain
- Refine definition for supply chain innovation (SCI)
- Develop definition for sustainable supply chain innovation (SSCI)
- Identify characteristics of sustainable supply chain innovation (SSCI)
- Propose a set of opportunities for future research