PERFORMANCE MEASUREMENT AND ITS IMPACT ON SUSTAINABLE AND RESILIENT SUPPLY CHAIN MANAGEMENT PRACTICES IN THE THAI ELECTRONIC INDUSTRY

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Introduction

Supply chain management (SCM) is studied as a strategic method to improve organisational effectiveness and to achieve better success of organization, i.e. increased profitability, better customer service and enhanced competitiveness (Gunasekaran et al., 2001). In the modern supply chain context, it is necessary to implement management practices that not only promote company and overall supply chain performance, but that also focus on environmental, economic, and social concerns (Beske, 2012). Since the 1990s many companies have taken steps to implement the principles of sustainability into their short- and long-term decision-making (Ahi & Searcy, 2015). To support the sustainability of companies and to cope with unexpected events, supply chain resilience and supply chain risk management have also gained increasing attention from both a theoretical and practical perspective (Ponomarov & Holcomb, 2009). Sustainability and resilience approaches are referred to as SCM paradigms, which allow companies to become more competitive in a volatile high demand market (Govindan et al., 2014). Within current frameworks of sustainable supply chain management and supply chain resilience there are linkage definitions, but there is no specific definition as yet for a combination of the two concepts.

This paper presents a proposal for a research study investigating the interaction between these two concepts. These two concepts are also important for a company's supply chain strategies. According to the supply chain performance measurement literature, supply chain sustainability and supply chain resilience have a direct impact on short- and long-term supply chain performance. However, in the literature only few contributions have started to explore simultaneously the two concepts and their impact on SCM and performance measurement. This study will seek to provide direction to improve a company's performance and be more resilient and sustainable in the future. There are discussions about the difficulty to integrate performance measurement within SCM principles and perspectives and the necessity to examine both sustainability and resilience in SCM to improve supply chain performance is acknowledged. Thus, there is a need for research to develop a framework incorporating these notions that can be used for performance measurement in supply chains (Hassini et al., 2012). This study also intends to address research gap by proposing a framework and conceptual model to analyse the impact of sustainability and resilient supply chain practices on supply chain performance. The aim of this paper is to review the extant literature and propose a new framework for sustainable and resilient supply chain management which is to be empirically tested in a Thai context to assess performance measurement and short- and long-term business impacts.

A critical review of the relevant literature

A systematic literature review (SLR) approach was undertaken. An SLR allows an evidence-informed approach to identifying, selecting, and analyzing secondary data (Colicchia & Strozzi, 2012).

A systematic literature review

According to Mentzer & Kahn (1995) a literature review is a major contributor to the research process as it provides a historical perspective of the respective research area and an in-depth account of independent research endeavours. An SLR is a specific methodology that locates existing studies, selects and evaluates contributions, analyses and synthesizes data and reports the evidence

in such a way that allows reasonably clear conclusions to be reached about what is and is not known (Denyer & Tranfield, 2009). Following are the salient points for an SLR as applied to this study.

1) Question formulation

Firstly, the definition of the scope of this study is presented in compliance with the objectives and the underlying research hypotheses. Denyer & Tranfield (2009) provide the CIMO-logic (Context, Intervention, Mechanisms and Output) to define the scope of the literature review. The application of this logic to the context under study is represented as follows:

- *Context: sustainable supply chain management and supply chain resilience.* Sustainability and resilience are interesting paradigms within SCM. There are many published contributions on these two paradigms in the supply chain context. However, the investigation on the relationship between these themes is still in its infancy. Thus, this is an opportunity to examine the relation between supply chain sustainability and resilience.
- *Intervention: performance measurement and short- and long-term impact to company or supply chain.* The area of interest is performance measurement in sustainable and resilient SCM. Current measurement tools are specifically designed to assess individually, sustainability or resilience only. A measurement tool that is able to account for both sustainability and resilience will help companies to plan their strategy in the future. Short- and long-term impacts are the key issues for this study.
- *Mechanisms: electronic industry and Thailand.* The selected area for this study is the Thai electronic industry. The rationale for this choice is that this sector is characterized by interesting issues related to the main topic of this study. This sector needs to eliminate waste, reduce environmental impacts, improve worker welfare, and also improve long-term profit. Further, the Thai electronic supply chain is under pressure to become more sustainable and at the same time more resilient, and needs to focus on efficiency and sustainability of the supply chain. Finally, Thailand recently experienced a relevant supply chain disruption affecting this sector which can provide useful insights for this study.
- *Outcome: an appropriate strategy and competitive advantage.* Within the described context, companies should combine sustainability and resilience paradigms into their strategies, to gain and sustain competitive advantage.

Hence, according to the CIMO-logic above, this study investigates three main areas: (i) sustainable and resilient supply chain management, (ii) performance measurement and short- and long-term impact, and (iii) Thai electronic industry.

2) Locating studies

The next phase of the SLR process is to locate relevant studies. Two main search engines were used to find the existing contributions relevant to this study: Web of Science and ABI Inform ProQuest. The rationale for using them is as follows. These databases are a great resource for finding primary sources on a variety of topics. They include high quality journals (8,000 in Web of Science and more than 9,000 in ABI Inform ProQuest). Both databases provide users with full-length author, abstract, references, and bibliographic data. According to the CIMO logic, a total of 8 keywords were defined and combined into search strings as presented in Table 1. Search strings were refined and discussed with two academics. By combining keywords through simple operators and Boolean logic, complex searches can be constructed in order to avoid too generic and wide result.

Search	Actual Search Strings	ABI Inform ProQuest	Web of science	Total
1	Sustainab* AND "Supply Chain" AND (short OR long) AND Impact* AND Electr*	420	387	807
2	Resilien* AND "Supply Chain" AND (short OR long) AND Impact* AND Electr*	50	37	87
3	Sustainab* AND Resilien* AND "Supply Chain" AND (short OR long) AND Impact* AND Electr*	29	10	39
4	Sustain* AND Resilien* AND supply chain AND performance	154	15	169
5	Sustainab* AND "Supply Chain" AND Thailand	44	15	59
6	Resilien* AND "Supply Chain" AND Thailand	7	4	11
7	Sustainab* AND resilien* AND "Supply Chain" AND Thailand	6	1	7
8	Performance AND "Supply Chain" AND Thailand	51	46	97
	Total	761	515	1276

Table 1: Search strings and number of retrieved papers in ABI form ProQuest and Web of Science

3) Study selection and evaluation

The following criteria, adapted from Newbert (2007), were used to restrict the search and enhance the reliability of the literature review:

- Search for papers published in peer-reviewed journals;
- Search for papers written in English;
- Search for papers published in the time window from 2000 until 2015;
- Search for papers published in supply chain management journals and relevant journals dealing with sustainability and resilience, e.g. *International Journal of Logistics Management*, *International Journal of Physical Distribution & Logistics*, *International Journal of Operations & Production Management*.

All bibliographic data from the papers were imported into the Endnote software package. The data included title, author(s), journal, year of publication, and abstract. A total of 1,276 papers were selected. Duplicates were removed and the remaining papers were reviewed by reading the research topic and abstract. Relevant documents were selected if they were related to at least one of the following topics: sustainable supply chain management, supply chain resilience, performance measurement, electronic industry, Thailand. After the first review with these criteria the number of relevant papers was reduced to 704. Then, further relevance was ensured by reading all the remaining papers focusing on the introduction and conclusions. After this second review, the total number of selected papers was 323.

4) Analysis and synthesis

The 323 papers were read in their entirety and analysed focusing on year of publication, journal title, methodology, research area, research contribution, and further research directions. This process was used to analyse and review the papers according to the concepts of sustainable and resilient SCM, and then group them into descriptive classifications. Each paper had to answer questions (Denyer and Tranfield, 2009) such as:

- What is the general and big idea in the paper?
- How relevant is the paper with the research topic?

- What are the key research findings?
- What are the recommendations for further research?

5) Reporting and using the results

The data from each paper were analysed and classified into different groups including: year, publisher, research methodology, dimensions of sustainable supply chains, supply chain resilience, and business field. The results from the SLR were presented in two ways: key trends and key issues.

Descriptive results: sustainable and resilient supply chain

Key trends

The analysis in this section categorized each paper in different groups as follows.

1) Classification of papers according to year of publication

For SLR process, the criteria for period of time are the papers published from 2000 onwards. First paper in this list was published in 2000. After that, there is a significant increasing for published papers in this field. As shown in Figure 1, most papers were published from 2010-15 (247 papers or 76 percent). The most papers published in one year were in 2013 (71 papers or 22 percent).

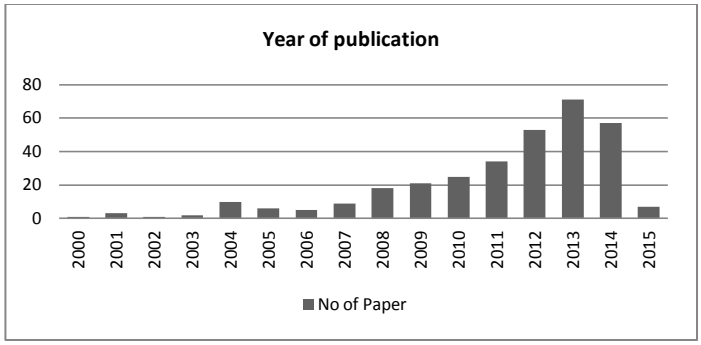

Figure 1: Publications by year of the papers investigated

2) Classification of papers according to publisher

The second category was selected papers in different journals or publishers. As sustainability and resilience are interesting and growing topics at this time, many journals have been publishing papers on these topics for the last fifteen years. Most papers were published in *Journal of Cleaner Production* (36) followed by *Supply Chain Management: An International Journal* (34) and then the other journals selected, *International Journal of Physical Distribution & Logistics Management*, *International Journal of Production Economics* and *International Journal of Operations & Production Management* respectively. Sustainability and resilience are interesting topics in different journals and are not specific to sustainability journals or a specific domain such as logistics and SCM.

3) Classification of papers according to business field

The selected papers are published in various fields in academia and the business field was used to segregate type of journals. The management field encompasses logistics and supply chain management journals and had the most papers for this criterion (28 percent or 91 papers) followed business, operations research and management science, and environmental sciences with 24 percent, 21 percent and 20 percent respectively.

4) Classification of papers according to research methodology

This criterion separated the selected papers into five groups according to the research methodology applied. It included theory, cases, surveys, models and reviews and considered both methodology and methods used within each paper. Models or simulations were the most methods applied

however case studies and reviews were popular methods also. In contrast, theory building was the least popular method for this research topic.

5) Classification of papers according to key themes

This criterion is the aspect or dimension that paper explained. Sustainability has the well-known dimensions of environment, economic, and social named as the triple-bottom-line (TBL) and supply chain resilience has supply chain risk management or supply chain disruption. Papers were categorised into single or multi- dimensions, TBL, or related to resilience dimensions of supply chain risk, supply chain disruption, or robustness. Figure 1 shows the main dimension(s) for each paper.

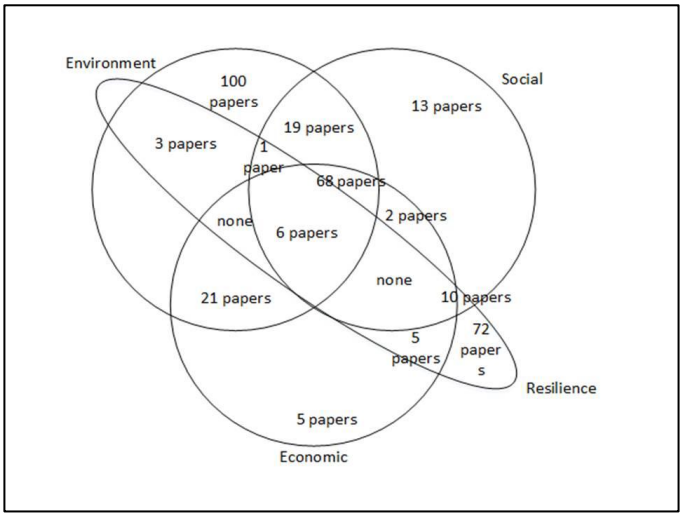

Figure 1: Paper category by aspect and dimension

The environment dimension is the highest single dimension rank for this criterion (100 papers) followed by resilience (72 papers) and the TBL (68 papers). There are 6 papers that mentioned both sustainability or TBL and resilience. However, there are fewer papers with three single aspects such as environmental-social-resilience (1 paper) or environmental-economic-resilience and economic-social-resilience (no papers).

<u>Key issues in sustainable and resilient supply chain management</u>

Some papers have provided gaps in sustainable supply chains, supply chain resilience and supply chain performance measurement terms. Govindan et al. (2014) discussed lean, resilient and green SCM practices, including waste elimination, supply chain risk management, mad cleaner production, impact on SC sustainability. That work is related to studies of Azevedo et al. (2012) and Azevedo et al. (2013), who found that green and lean practices are two important pillars of sustainable development of business. Moreover, green practices and resilient supply chain are the way to increase the sustainability of companies and their supply chains. Some researchers suggest future research on performance measurement, for example Colicchia et al. (2013) revealed that companies needs to develop an effective performance measurement system to assess their future environmental impact. Taticchi et al. (2013) argued there is no popular academic framework for supply chain performance measurement and only few integrate the triple bottom line approach. On the other hand, Carvalho et al. (2012) stated that further studies are needed to identify the main effects between supply chain resilience design strategies and performance and the various moderating and mitigating factors. Ponomarov & Holcomb (2009) suggested that such measurement will helps companies and their supply chain to decide the scope of which parts and factors of supply chain resilience should be improved. However, multiple measurements should be assessed at each sub-factor level with the addition of objective measurements where appropriate (Pettit et al., 2013).

And finally, in the Thai electronic industry there is a lack of study concerning the influence of green supply chain strategies on business performance (Kamolkittiwong & Phruksaphanrat, 2015).

A new framework for sustainable and resilient supply chain management

As above discussed even if a relationship between sustainable supply chain management and supply chain resilience is acknowledged in the extant literature, this relationship has not been investigated in details so far. According to the SSCM framework from Carter & Rogers (2008) and the SCRES framework from Pettit et al. (2010), there are some factors that link sustainability and resilience. However, the relationship between sustainability and resilience is in a developing stage. Hence this study focuses on this topic to combine and develop a new framework of sustainable and resilient supply chain management. For this study we present the Sustainable Resilient Supply Chain Management (SResSCM) framework that can be defined as the management of materials, information and capitals flows along the supply chains with three dimensions as environment, economic, and social perspectives for the situation between before-during-after disruption period by integrate vulnerabilities and capabilities factors to maintain continuity of operations at the desired level of connectedness and control over structure and function.

Pettit et al. (2010) developed fourteen measureable capabilities with sub-factors and identified seven distinct supply chain vulnerabilities. Then, Pettit et al. (2013) found that connectivity and external pressure are two vulnerabilities sources that have the highest impact on companies. Moreover, low collaboration provides more concerns to companies (Pettit et al., 2013). This study merges connectivity, external pressure, recovery, and collaboration into a triple-bottom-line (TBL) framework and provides a useful SResSCM framework for improving performance as shown in Figure 2. However, this framework still needs to be evaluated with empirical study.

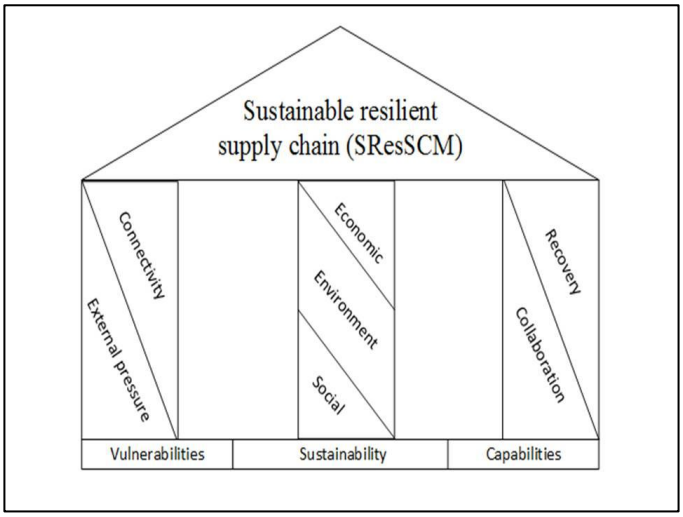

Figure 2: Framework of sustainable and resilient supply chain management

The contribution of this study is to develop a new framework of sustainable and resilient supply chain management needed to investigate and assess the relationship between supply chain sustainability and resilience. The result of its application in the electronics sectors in Thailand might be: (i) there is a positive impact of supply chain sustainability on supply chain resilience; (ii) there is a positive impact of supply chain resilience on supply chain sustainability, taking into account one of its dimensions or all the dimensions of sustainability, i.e. environmental, social and economic; (iii) there is a mutual and positive relationship between supply chain sustainability and supply chain resilience; and (iv) there is no relationship between supply chain sustainability and supply chain resilience.

Future research

This study is currently in-progress. However, five companies in Thai's electronic industry were chosen for case study and empirical is planned to collect more data from this industry to test related research propositions. According to SResSCM framework, the purpose of this paper was to review extant literature and present a proposed research agenda as follows:

- To review or current understanding of performance measurement and sustainable and resilient SCM.
- To develop a new framework for sustainable and resilient SCM.
- To build a new measurement tool to measure short- and long-term impact on performance of sustainable and resilient SCM.
- To assess the short- and long-term impacts of sustainable and resilient SCM practices in the Thai electronic industry.

To achieve these research objectives, Thailand represents an interesting context to be analysed for the purpose of this study since it has attracted various world-renowned foreign and joint venture companies from around the world. There are almost 2,000 electrical appliance factories across the country (Kamolkittiwong & Phruksaphanrat, 2015). In 2011, the electrical and electronic industry contributed approximately US$55 billion or 24 percent of Thailand's annual export revenues. Dominant export destinations were ASEAN, the EU, China, the US, Hong Kong, and Japan (BOI, 2013).

Conclusions

According to current business trends many companies are looking to make their supply chains strong and also pay attention to their environmental, social and economic impacts. Sustainable SCM is popular for making companies become more eco-friendly and enhance customer satisfaction at the same time. Further, supply chain resilience is a strategy that can be adapted within a supply chain to survive when companies are facing turbulent change. Thus, sustainability and resilience are an interesting paradigm to implement within the supply chain.

This paper has provided a new framework for sustainable and resilient SCM and performance measurement to assess short- and long-term impacts in supply chains. The Thai electronic industry has been chosen for this study to assess these relationships and impacts of sustainability and resilience in an empirical study. Subsequently, the model should provide an appropriate strategy for companies to use in different situations with suitable levels of sustainability and resilience.

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