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**The relationship between green supply chain management and performance:  
A meta-analysis of empirical evidences in Asian emerging economies**

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# **The relationship between green supply chain management and performance: A meta-analysis of empirical evidences in Asian emerging economies**

## **Abstract**

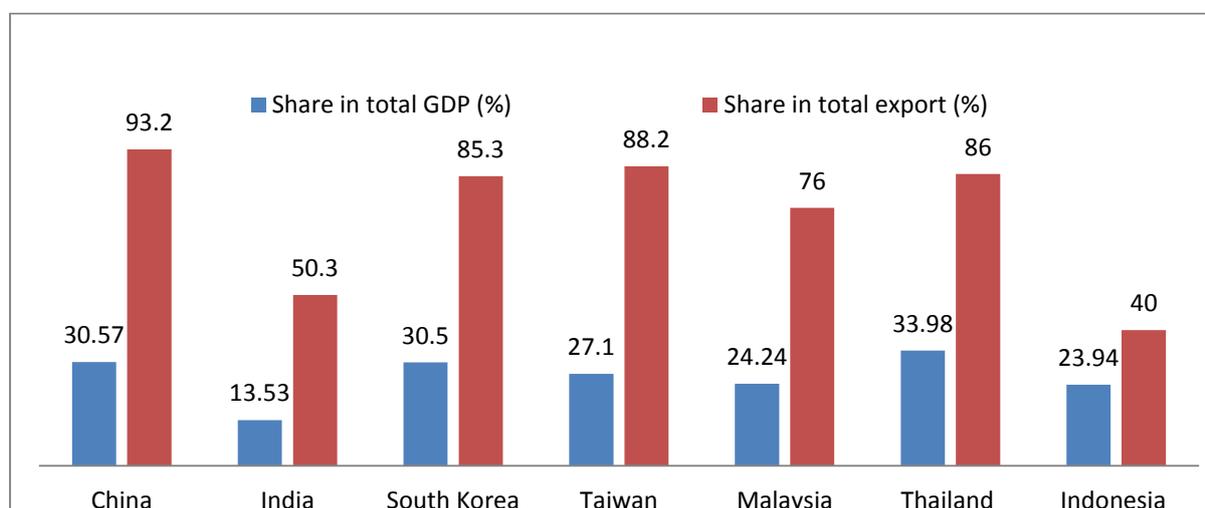
The purpose of this study is to understand the relationship between green supply chain management (GSCM) practices and firm performance in the manufacturing sector in Asian emerging economies (AEE) based on empirical evidence. Through a systematic literature review, we identified 50 articles that surveyed 11,127 manufacturing companies in the AEE and were published between 1996 and 2015. Subsequently, a conceptual framework was developed and analyzed through a meta-analysis of 130 effects from 25,680 effect sizes. The findings revealed that the GSCM practices lead to better performance in four aspects: economic, environmental, operational, and social performance. Moreover, the results indicate that industry type, firm size, ISO certification, and export orientation moderate several of the GSCM practice-performance relationships. Moreover, the findings of this research help managers and policy makers to have more confidence in the adoption of GSCM practices to improve firm performance. Such results also help researchers to better channel their efforts in studying the GSCM practices in Asian emerging economies. In addition, as meta-analysis has not been widely used in the supply chain management literature, our study is an important step in maturing the academic field by adopting this technique for confirming GSCM practice-performance relationships in the manufacturing sector of Asian emerging economies.

**Keywords:** Green supply chain management; Asian emerging economies; Manufacturing sector; Performance

## **1 Introduction**

In recent years, the rapid industrial modernization has led to negative environmental impacts including greenhouse gas emissions, toxic pollutions, and chemical spills (Peng and Lin, 2008). In response to the growing global environmental awareness, green supply chain management (GSCM) has emerged as a concept that considers sustainability elements and a combination of environmental thinking along the intra- and inter-firm management of the upstream and downstream supply chain (Walker and Jones, 2012; Zhu and Sarkis, 2004).

Moreover, manufacturers of the majority of products that are consumed in the developed countries relocated their manufacturing bases and production facilities in Asian Emerging Economies (AEE) (Lai and Wong, 2012; Tang and Zhou, 2012). This relocation to Asia was primarily rationalized by cheap labor and low material costs (Lai et al., 2013). Meanwhile, the increasing global awareness around environmental impact of production processes is placing an escalating pressure on manufacturers not only in the developed world but also in emerging economies in Asia. Based on the emerging economies index (MSCI Research, 2014), emerging markets represent 10% of world market capitalization. Particularly China, Taiwan, India, Malaysia, Indonesia, Thailand, and South Korea need to improve their supply chains in all aspects (Faber and Frenken, 2009; Lai and Wong, 2012; Woo et al., 2014). As shown in Figure 1, serving as the global production base, manufacturers in the AEE are increasingly expected to continue contributing to their countries' economic growth. As the manufacturing sector in the AEE is expected to continue its rapid growth until the next decade, managerial practices should balance the economic growth and the damage to the environment (Zhu et al., 2008b; Lee, 2008). Therefore, manufacturers in the AEE are subsequently beginning to realize the urgency to adopt green strategies and environmental practices with their customers and suppliers to reduce the environmental impacts of their products and services (Zhu and Sarkis 2004; Zhu and Geng 2013).



**Figure 1. Contribution of manufacturing sector to total GDP and exports in the AEE (2012), Source: Bloomberg (2014)**

The topic of GSCM in manufacturing sectors in the AEE has received increasing attention from industry, academia, regulatory institutions, and customers (Golicic and Smith, 2013; Lai et al., 2013). In particular, there is a clear academic need for research to identify if the GSCM

practices lead to desirable firm performance and if so, the subsequent outcomes (Mitra and Datta, 2014; Lo, 2014; Subramanian, 2014). Moreover, the results of empirical studies on the impact of GSCM practices on firm performance are not conclusive. For instance, Zhu and Sarkis (2004) and Zhu et al. (2005) consistently argued that GSCM practices have not contributed to better economic performance in Chinese manufacturing firms. Admittedly, the concept of GSCM practices was in its early stages during those two studies. An early stage of adoption usually requires investment, which will increase companies' operational costs and have a negative impact on firms' economic benefit. In contrast, recent studies have examined the positive relationship between GSCM practices and economic performance (e.g. Kuei et al., 2013; Lai et al., 2012).

These mixed results and the need to gain further insights into the link between generalized GSCM practices and performance have motivated our study. Such empirical generalization is necessary because GSCM practices have been implemented differently. Hence, our study aims to provide empirical generalizations regarding the relationship between GSCM practices and firm performance.

We use meta-analysis (Hunter and Schmidt, 1990, 2004) to assist the development and refinement of GSCM practices and their impact on economic, environmental, social, and operational performance. Through a systematic literature review, we identified 50 articles that surveyed 11,127 manufacturing companies in the AEE and published between 1996 and 2015. Subsequently, a conceptual framework was developed by which we calculated 130 effects from 25,680 effect sizes that were calculated in the reviewed papers in the meta-analysis. Our study differs from the previous meta-analyses in the environmental field (Golicic and Smith, 2013) in three ways. Firstly, our study provides a more updated and comprehensive review of firm performance. Next, our paper specifically focuses on GSCM practices only in the manufacturing sector in the AEE, which avoids confounding and inaccurate results due different conceptualizations of the GSCM practices in different industries and regions. Finally, we used a combination of the systematic literature review and meta-analytic methods to overcome issues inherent in traditional narrative summaries of research by being systematic and explicit in the selected studies (Delbufalo, 2012).

## 2 Systematic literature review

We conducted a systematic literature review as suggested by Tranfield et al. (2003) and Denyer and Tranfield (2009) to identify and examine empirical studies that consider the effects of GSCM practices in manufacturing industry in the AEE. The timeframe included all papers published until the end of 2015. The extraction was closed by mid-March 2016 to include late volumes published in 2015. As can be seen in Table 1, we kept search terms sufficiently broad to avoid artificial limitations and undesirable results. We used the combinations of keywords related to country/region (China, Taiwan, India, Malaysia, Indonesia, Thailand and South Korea), GSCM practices (e.g. green purchasing, eco-design) and performance outcomes (e.g. performance, outcome and benefit) in five well-known databases: ABI/INFORM, Scopus, Emerald, Business Source Premier, and Science Direct. This search included articles with search terms appearing in title, abstract, and keywords of papers that were published in peer-reviewed journals. In addition, we included two articles that were not found in the database search (Peng and Lin, 2008 and Yang et al., 2010) but relevant to our work, in line with the meta-analysis study performed on environmental supply chains by Golicic and Smith (2013).

*Table 1. Keywords for the systematic literature review*

| AND                         |                |               |                  |
|-----------------------------|----------------|---------------|------------------|
| Region/Country              | GSCM practices |               | Outcomes/Results |
|                             | AND            |               |                  |
| China                       | green          | practice*     | performance      |
| India                       | sustainab*     | activities    | outcome          |
| Thailand                    | environment*   | operation*    | advantage        |
| Malaysia                    |                | logistic*     | benefit          |
| South Korea                 |                | production    |                  |
| Indonesia                   |                | manufacturing |                  |
| Taiwan                      |                | adoption      |                  |
| Vietnam                     |                |               |                  |
| Philippines                 |                |               |                  |
| Asia                        |                |               |                  |
| Emerging economies          |                |               |                  |
| *: any string of characters |                |               |                  |

These search strings initially resulted in 323 studies with duplication of 162 papers in five databases. Then, we further scrutinized the papers for inclusion in the meta-analysis exercise. To be included in the meta-analysis, articles had to meet three criteria:

- (i) Focuses on the AEE (105 papers remaining);
- (ii) Has data collected from manufacturing sector (68 papers remaining) and
- (iii) Reports the relationship between GSCM practices and performance with empirical effect sizes (50 papers remaining).

The Asian emerging economies were selected based on either nominal or inflation-adjusted GDP from BRIC countries (India and China), as well as MIKT (Indonesia and South Korea). Moreover, in line with the MSCI Emerging Markets Index (MSCI Research, 2014) and BBVA Research (Country Risk Quarterly Report, 2014), Vietnam, Philippines, Taiwan, Malaysia and Thailand were also considered as emerging economies. Therefore, we selected articles that collected data from emerging economies in Asia and particularly from China, India, South Korea, Indonesia, Vietnam, Philippines, Taiwan, Malaysia and Thailand. Among the remaining articles, we decided not to include studies on industries other than manufacturing such as retail, hospitality, or tourism. Manufacturing industry in this study refers to the companies which produce goods for use or sale using labor and machines, tools, chemical and biological processing or formulation (Zhu et al., 2011). Finally, articles needed to report the effect size of the relationship between GSCM practices and performance with Pearson's correlation coefficient or other test statistics such as Cohen's-d or F-statistics that can be converted to Pearson's correlation coefficients. Applying these criteria, we identified 50 qualifying empirical studies that represent a total sample of 11,127 companies. These articles are summarized in Table 2.

**Table 2. Reviewed Papers**

|    | <b>Paper</b>                             | <b>Methodology</b>               | <b>Analysis method</b>                                  | <b>Sample size<sup>1</sup></b> | <b>Theoretical approach</b>                  | <b>Region</b>                 |
|----|--|----------------------------------|---|--------------------------------|--|-------------------------------|
| 1  | Lee and Miller (1996)                    | Survey                           | Pearson correlation analysis                            | 151                            | Contingency theory                           | South Korea                   |
| 2  | Zhu and Sarkis (2004)                    | Survey                           | Regression analysis                                     | 186                            | Not specified (NS)                           | China                         |
| 3  | Rao and Holt (2005)                      | Mail survey                      | Covariance based Structural Equation Modelling (CB-SEM) | 52                             | NS   | 15 South East Asian countries |
| 4  | Ann, Zailani and Wahid (2006)            | Mail Survey                      | Factor analysis   | 159                            | NS   | Malaysia                      |
| 5  | Zhu, Sarkis and Lai (2007)               | Survey with convenience sampling | Pearson correlation analysis                            | 89                             | NS   | China                         |
| 6  | Peng and Lin (2008)                      | Mail Survey                      | CB-SEM  | 101                            | Institutional theory                         | Taiwan                        |
| 7  | Yang et al. (2010)                       | Mail Survey                      | Multivariate linear regression model                    | 107                            | NS   | China and Taiwan              |
| 8  | Chiou, et al. (2011)                     | E-mail Survey                    | CB-SEM  | 124                            | NS   | Taiwan                        |
| 9  | Kim, Youn and Roh (2011)                 | Mail Survey                      | CB-SEM  | 125                            | NS   | South Korea                   |
| 10 | Wong et al.(2011)                        | Mail Survey                      | CB-SEM  | 151                            | Contingency theory                           | Thailand                      |
| 11 | Chan et al (2012)                        | Mail Survey                      | Path analysis   | 194                            | Resource Based View                          | Taiwan                        |
| 12 | Huang, Wu and Rahman (2012)              | Mail Survey                      | CB-SEM  | 349                            | NS   | Taiwan                        |
| 13 | Kim and Rhee (2012)                      | E-mail Survey                    | CB-SEM  | 249                            | NS   | South Korea                   |
| 14 | Lai and Wong (2012)                      | Mail Survey                      | CB-SEM  | 134                            | NS   | China                         |
| 15 | Lee, Kim and Choi (2012)                 | Survey with consulting firm      | CB-SEM  | 233                            | NS   | South Korea                   |
| 16 | Wong et al.(2012)                        | Mail Survey                      | CB-SEM  | 122                            | NS   | Taiwan                        |
| 17 | Zailani et al.(2012)                     | E-mail Survey                    | CB-SEM  | 132                            | Institutional theory                         | Malaysia                      |
| 18 | Kuei et al. (2013)                       | Mail Survey                      | CB-SEM  | 113                            | NS   | China                         |
| 19 | Lai et al. (2013)                        | Mail Survey                      | Seemingly unrelated regression                          | 128                            | Production frontier theory                   | China                         |
| 20 | Laosirihongthong, Adebajo and Tan (2013) | Mail Survey                      | Multivariate linear regression model                    | 190                            | Institutional theory                         | Thailand                      |
| 21 | Lee et al. (2013)                        | Mail Survey                      | CB-SEM  | 128                            | Institutional theory and Resource Based View | South Korea                   |
| 22 | Lin et al. (2013)                        | Mail Survey                      | Regression analysis                                     | 208                            | NS   | Vietnam                       |
| 23 | Nagarajan et al. (2013)                  | Survey                           | CB-SEM  | 75                             | Resource Based View                          | India                         |
| 24 | Ye et al. (2013)                         | Mail Survey                      | CB-SEM  | 209                            | Intuition theory                             | China                         |
| 25 | Youn et al. (2013)                       | Mail Survey                      | CB-SEM  | 141                            | NS   | South Korea                   |
| 26 | Lee et al. (2013B)                       | Mail Survey                      | CB-SEM  | 119                            | NS   | Malaysia                      |

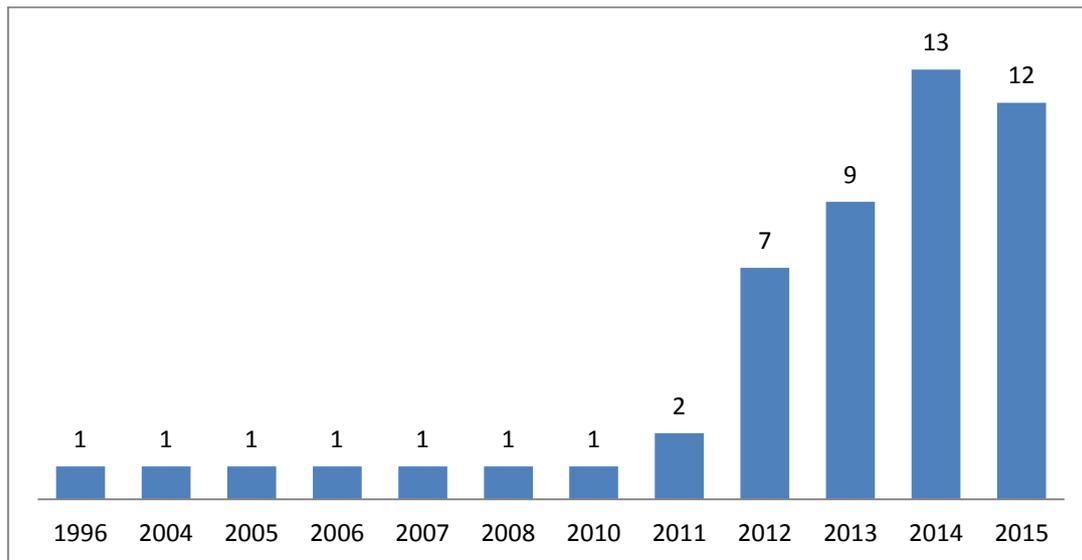
|    | <b>Paper</b>                       | <b>Methodology</b>     | <b>Analysis method</b>  | <b>Sample size<sup>1</sup></b> | <b>Theoretical approach</b>                | <b>Region</b> |
|----|------------------------------------|------------------------|---|--------------------------------|--|---------------|
| 27 | Abdullah and Yaakub, (2014)        | E-mail Survey          | Partial Least Squares Structural Equation Modelling (PLS-SEM) | 201                            | NS   | Malaysia      |
| 28 | Cheng, Yang and Sheu (2014)        | Mail Survey            | CB-SEM  | 121                            | Resource Based View                        | Taiwan        |
| 29 | Huang and Yang (2014)              | Mail Survey            | Regression analysis   | 1200                           | Institutional theory                       | Taiwan        |
| 30 | Hung, Chen and Chung (2014)        | Mail Survey            | PLS-SEM   | 160                            | Social capital theory                      | Taiwan        |
| 31 | Huo et al. (2014)                  | Mail Survey            | CB-SEM  | 617                            | Stage theory                               | China         |
| 32 | Sancha et al. (2014)               | Mail Survey            | CB-SEM  | 170                            | Transaction cost economies theory          | China         |
| 33 | Woo et al. (2014)                  | Survey                 | Multivariate linear regression model                          | 1656                           | Stakeholder theory                         | South Korea   |
| 34 | Wu et al. (2014)                   | Survey                 | Regression analysis   | 172                            | NS   | Taiwan        |
| 35 | Wong et al. (2014)                 | Mail survey            | CB-SEM  | 122                            | NS   | Taiwan        |
| 36 | Yu et al. (2014)                   | Mail Survey            | CB-SEM  | 126                            | NS   | China         |
| 37 | Lai et al.(2014a)                  | Mail and E-mail Survey | CB-SEM  | 134                            | Contingency theory                         | China         |
| 38 | Lai et al.(2014b)                  | Mail Survey            | CB-SEM  | 210                            | Resource dependents theory                 | China         |
| 39 | Chan et al. (2015)                 | Survey                 | CB-SEM  | 250                            | Contingency theory                         | China         |
| 40 | Choi and Hwang (2015)              | Web-based Survey       | Hierarchical regression                                       | 230                            | Resource Based View                        | South Korea   |
| 41 | Dubey, Gunasekaran and Alic (2015) | Electronic survey      | Hierarchical regression                                       | 361                            | Institutional theory                       | India         |
| 42 | Feng et al. (2015)                 | Two waves of survey    | Hierarchical moderated regression                             | 214                            | Contingency theory                         | China         |
| 43 | Gopal and Thakkar (2015)           | Mail Survey            | CB-SEM  | 98                             | NS   | India         |
| 44 | Lai, Wong and Lam (2015)           | Mail Survey            | CB-SEM  | 210                            | Resources dependence theory                | China         |
| 45 | Lee (2015)                         | Mail Survey            | CB-SEM  | 207                            | Social capital theory                      | South Korea   |
| 46 | Lee et al. (2015)                  | Mail Survey            | PLS-SEM   | 119                            | NS   | Malaysia      |
| 47 | Li et al. (2015)                   | Survey                 | CB-SEM  | 256                            | Stakeholder theory and Resource-based view | China         |
| 48 | Chen, Wu and Wu (2015)             | Mail Survey            | Regression analysis   | 205                            | Resource-based view                        | Taiwan        |
| 49 | Huang et al. (2015)                | Mail Survey            | Hierarchical regression                                       | 284                            | Contingency theory                         | Taiwan        |
| 50 | Zailani (2015)                     | Mail Survey            | PLS-SEM   | 153                            | Institutional theory                       | Malaysia      |

<sup>1</sup>: Number of companies in the paper

CB-SEM = Covariance Based Structural Equation Modelling; PLS-SEM = Partial Least Squares Structural Equation Modelling; NS = Not Specified

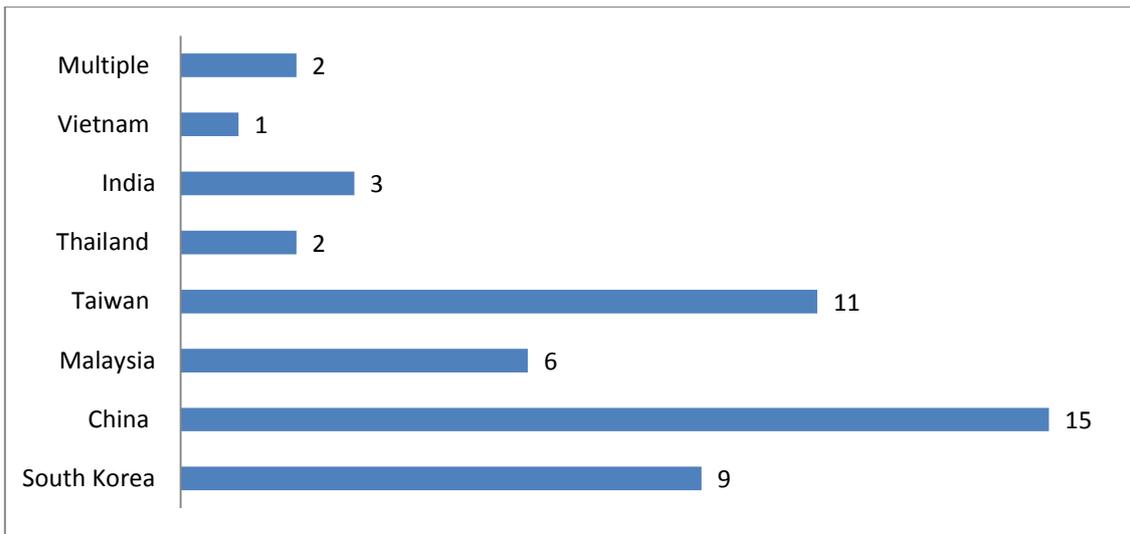
## 2.1 Descriptive statistics results

Figure 2 shows the distribution of papers from 1996 to 2015. The first paper published on the topic was by Lee and Miller (1996). The substantial growth trend from 2012 onwards is also visible in Figure 2. Moreover, 13 papers published in 2014 and 12 papers published in 2015 indicate the increasing focus on the relationship between GSCM practices and firm performance.



*Figure 2. Distribution of reviewed papers across the period 1996 – 2015*

Figure 3 shows the country profile studied in the papers included in the review. The majority of publications about the AEE have focused on and collected data from China (15 papers), Taiwan (11 papers), and South Korea (9 papers). The term multiple refers to studies that have collected their data from more than one economy (e.g. Rao and Holt, 2005 and Yang et al., 2010)



***Figure 3. Geographic distribution of the papers reviewed***

Table 3 presents the distribution of the CABS Journal Quality Guide<sup>1</sup> for each of the accessed journals. The Chartered Association of Business Schools (CABS) Journal Quality Guide is based upon peer review, editorial and expert judgements on the quality of journals in which business and management academics publish their research. The CABS Journal Quality Guide provides a wide journal coverage and it has high levels of internal and external reliability in the business and management field (Morris et al., 2009). It has also been used by researchers to identify papers in the systematic literature search for quality purposes (Harvey, Kelly, Morris, & Rowlinson, 2010; Ashby et al., 2012; Alhejji et al., 2015). As per our study, most of the papers we reviewed are published in high-ranked CABS journals which emphasize the quality of this systematic review. The leading role is now held by the International Journal of Production Economics with seven papers, followed by Journal of Cleaner Production with five papers. Although the latter is not currently on the CABS list, it explicitly focuses on the sustainability field (Ashby et al., 2012). Additionally, journals on strategy and operations were the home for a majority of the reviewed GSCM studies.

<sup>1</sup> Chartered Association of Business Schools' (CABS) Academic Journal Guide 2015: <http://charteredabs.org/academic-journal-guide-2015/>

*Table 3. Number of papers by journal*

| <b>Journal name</b>   | <b>Number of Articles</b> | <b>CABS ranking 2015</b> | <b>Percentage</b> |
|---|---------------------------|--------------------------|-------------------|
| International Journal of Production Economics                           | 10                        | 3                        | 20                |
| Journal of Cleaner Production   | 7                         | n.a.                     | 14                |
| Production Planning and Control   | 4                         | 3                        | 8                 |
| Industrial Management and Data Systems                                  | 2                         | 1                        | 4                 |
| International Journal of Operations and Production Management           | 2                         | 4                        | 4                 |
| Journal of Operations Management  | 2                         | 4                        | 4                 |
| International Journal of Physical Distribution and Logistics Management | 2                         | 2                        | 4                 |
| International Journal of Production Research                            | 2                         | 3                        | 4                 |
| Supply Chain Management: An International Journal                       | 2                         | 3                        | 4                 |
| Business Strategy and the Environment                                   | 1                         | 2                        | 2                 |
| Industrial Marketing Management   | 1                         | 3                        | 2                 |
| International Journal of Business and Society                           | 1                         | n.a.                     | 2                 |
| International Journal of Services and Operations Management             | 1                         | 1                        | 2                 |
| Journal of Business Ethics  | 1                         | 3                        | 2                 |
| Journal of Environmental Planning and Management                        | 1                         | n.a.                     | 2                 |
| Management Decision   | 1                         | 2                        | 2                 |
| Management Research Review  | 1                         | 1                        | 2                 |
| Management of Environmental Quality                                     | 1                         | n.a.                     | 2                 |
| Organization Studies  | 1                         | 4                        | 2                 |
| Omega   | 1                         | 3                        | 2                 |
| Production and Operations Management                                    | 1                         | 4                        | 2                 |
| Sustainability  | 1                         | n.a.                     | 2                 |
| Technology Analysis and Strategic Management                            | 1                         | 2                        | 2                 |
| Asia Pacific Journal of Marketing and Logistics                         | 1                         | n.a.                     | 2                 |
| Operations Management Research  | 1                         | 1                        | 2                 |

Table 4 summarizes theoretical perspectives of the reviewed literature. Although majority of the papers did not explicitly adopt any theory, institutional theory (14%), contingency theory (12%), and resource based view (12%) were the most common theories in the reviewed papers. Most studies used intuitional theory as the theoretical underpinning for investigating the adoption of GSCM. Intuitional theory was used to identify external drivers including suppliers, customers, competitors, and regulations. On the other hand, contingency theory is another frequently referenced theoretical lens for explaining GSCM practice - performance

relationship. In the contingency theory, companies are defined as an open system where their performances are affected by the environment (Lai et al., 2014a).

*Table 4. Number of papers by theoretical lens*

| <b>Theory</b>              | <b>Numbers</b> | <b>Percentage</b> |
|----------------------------|----------------|-------------------|
| Institutional Theory       | 7              | 14                |
| Contingency Theory         | 6              | 12                |
| Resource Based View        | 6              | 12                |
| Social Capital Theory      | 2              | 4                 |
| Resource Dependency Theory | 2              | 4                 |
| Stakeholder Theory         | 2              | 4                 |
| Production Frontier Theory | 1              | 2                 |
| Stage Theory               | 1              | 2                 |
| Transaction Cost Economics | 1              | 2                 |
| Not Specified              | 21             | 42                |

Moreover, as can be seen from Table 5, the majority of reviewed papers applied Covariance Based Structural Equation Modelling (CB-SEM) method to analyze their empirical data (56%), followed by regression analysis (14%).

*Table 5. Number of papers by methodology*

| <b>Method</b>   | <b>Numbers</b> | <b>Percentage</b> |
|---|----------------|-------------------|
| Covariance Based Structural Equation Modelling (CB-SEM)       | 28             | 56                |
| Regression analysis   | 7              | 14                |
| Hierarchical regression                                       | 5              | 10                |
| Partial Least Squares Structural Equation Modelling (PLS-SEM) | 4              | 8                 |
| Multivariate linear regression model                          | 2              | 4                 |
| Pearson correlation analysis                                  | 2              | 4                 |
| Path analysis   | 1              | 2                 |
| Factor analysis   | 1              | 2                 |

## **2.2 Data coding**

To ensure the commensurability and heterogeneity of the studies in the meta-analysis, coding data along the dimension of variables posed an additional unique challenge. A common difficulty in terms of coding is to ensure that different measures for the same constructs are consistent among primary studies. For instance, there is an issue regarding construct boundaries. In this regard, our systematic literature review revealed that the term “performance” has been used broadly with a variety of measurements. We resolved this issue

by determining whether the indicators were consistent among the definitions of economic performance. We confirmed that 75% of the items are closely matching the definition for that construct via discussion by the three authors (Hunter and Schmidt, 2004). Firstly, three authors reached an agreement on the conceptual definitions for each dimension of GSCM practices and type of firm performances. With the agreed definitions, the papers were coded independently to reduce bias, and any disagreements were resolved through discussion. In short, we categorized the construct into the relevant dimension of GSCM practices or type of performance when more than 75% of the items in each construct closely matched our definition (Hunter and Schmidt, 2004).

After reviewing the sample of empirical studies collected for the meta-analysis, four dimensions were developed to compare and contrast the specific effects of GSCM practices on firm performance. Therefore, following the insight from our systematic review of the literature on performance measurement, we coded the firm performance along four dimensions: economic, environmental, operational, and social performance as defined below:

- i. Economic performance, referring to profitability in general, is a significant reason for companies to implement GSCM practices. Therefore, we coded studies that measured economic performance using objective or perceived growth in sales, profit, and market share (Chan et al., 2012; Lee et al., 2013; Kuei et al., 2013; Abdullah and Yaakub, 2014) within GSCM practice - economic performance relationship.
- ii. The environmental performance is usually concerned with saving energy and reducing waste, pollution, and emissions. Moreover, linking the supply chain performance with manufacturing sectors, the environmental performance included reducing air emissions, waste water, and solid wastes, as well as decreasing consumption of hazardous materials (Zhu, et al., 2005). Measures of environmental performance included indicators of saving energy and reducing waste, pollution, and emissions (Rao, 2002; Zhu et al., 2005; Chiou et al., 2011; Lee et al., 2012).
- iii. Operational performance is related to the efficiency of the firm's operations such as decreased scrap rates and delivery times, decreased inventory levels, and improved capacity utilization (Zhu, et al., 2012). In the meta-analysis, operational performance included various indicators related to the efficiency of the firm's operations such as scrap rate, delivery time, inventory levels, and capacity utilization (Wong et al., 2009; Lai et al., 2012; Dou et al., 2013).

- iv. The social performance in this study was considered a concept to quantify outcomes of the GSCM practices about increasing product and company image, protecting employee health and safety, ensuring customer loyalty and satisfaction (Zailani et al., 2012; Ashby et al., 2012).

Subsequently, the “firm performance” in this study is defined as the summation of economic performance, environmental performance, operational performance and social performance.

### **2.2.1 Independent variables**

In the literature review, papers discussed GSCM practices based on different types of activities along the supply chain. For instance, Ann et al., (2006) and Yang et al., (2010) only mentioned intra-organizational environmental practices; while Huang and Yang (2014) and Huang et al., (2015) focused on reverse logistics. However, 25 (out of 50) of the reviewed papers that examined the adoption of GSCM practices used the measurement index developed by Zhu et al. (2005) as a guideline. Accordingly, we used the classification by Zhu et al. (2005) as guideline, which is the most cited paper on the adoption of GSCM practices in our systematic literature review. From this perspective, Zhu et al. (2005) investigated Chinese textile, automobile, power generation, chemical, electrical, and electronics industries and identified five types of GSCM practices. These include: internal environmental management, green purchasing, cooperation with customers, investment recovery, and eco-design. In order to reflect the focal companies’ direct involvement by investigating different resources as well as to have a better understanding of the voluntary adoption of GSCM practices, we classify GSCM practices into five categories:

- i. *Intra-organizational environment management* (IEM) refers to the intra-organizational practices such as top management support, environmental compliance programs, and inter-departmental cooperation for environmental improvements (Zhu et al. ,2005; Ann, Zailani and Wahid, 2006; Yang et al.,2010; Kim, Youn and Roh, 2011; Huang et al .,2012; Kuei et al., 2013; Cheng et al., 2014; Feng et al., 2015) ;
- ii. *Product eco-design* (ECO) is a structural process consisting of ecological attributes in products and processes as well as the demands from stakeholders in the company for product design and development (Zhu et al. ,2005; Peng and Lin, 2008; Zailani et al.,2012; Lin et al., 2013; Wong et al., 2014; Chan et al., 2015);
- iii. *Green supplier integration* (SI) involves collaboration for environmental purposes between a focal company and its suppliers on managing cross-firm business processes,

including information sharing and strategic partnerships (Rao and Holt, 2005; Zhu et al., 2005; Chiou, et al., 2011; Laosirihongthong et al., 2013; Huang et al., 2014; Dubey et al., 2015);

- iv. *Green customer cooperation* (CC) involves strategic information sharing and collaboration between a focal company and their customers and it aims to improve visibility and enable joint planning for environment (Zhu et al., 2005; Wong et al., 2011; Yu et al., 2014; Lai et al., 2015);
- v. *Reverse logistics* (RL) is a task associated with the three “Re’s” of circular economy: recycling, reusing and reducing the amount of raw materials in production phase or post consumption (Zhu et al., 2005; Chan et al., 2012; Lai et al., 2013; Abdullah and Yaakub, 2014; Huang et al., 2015).

### **2.2.2 Moderating variables**

Moderating variables in meta-analysis, unlike standard moderators, are often taken from control variables in empirical studies (Golicic and Smith, 2013). Therefore, moderating variables in a correlational analysis refer to a third variable that affects the zero-order correlation between the independent and dependent variables (Hunter and Schmidt, 2004). In the reviewed literature, researchers have highlighted several factors such as firm size and industry type that may influence the adoption of GSCM practices and firm performance (Zhu et al., 2008; Liu et al., 2012; Chan et al., 2012; Zhu et al., 2013; Abdulrahman et al., 2014). Therefore, moderating variables in this study were coded based on the difference of relevant samples on the relationship of adoption of GSCM practices and economic, environmental, operational, and social performance including: (i) firm size; (ii) industry type; (iii) ISO certification; and (iv). export orientation.

Firm size has been reported by several scholars as a significant factor that influences the adoption of GSCM practices ( Grant et al., 2002; Klassen, 2000; Zhu et al., 2008; Mohanty and Prakash 2013). However, the arguments regarding the relationship between size and GSCM practices in the AEE are not conclusive. For instance, Lai and Wong (2012) indicated that the firm size does not affect the adoption of GSCM practices. In contrast, Wu (2013) found that firm size is positively related to green purchasing and eco-design among the Taiwanese apparel manufacturing companies. Therefore, we conclude that there is a need to include the firm size as a moderator when analyzing the adoption of GSCM practices. To

code for firm size, we grouped papers into categories based on whether the data was collected from SMEs or in mixed companies.

Based on the literature review, we found that most researchers have drawn samples from different industries and companies with different business orientation. Most of the reviewed papers collected their data from multiple sectors (e.g. Nagarajan et al., 2013; Huo, Zhao, and Zhou, 2014; Kim and Rhee, 2012). However, some studies drew their sample from one particular industry, mainly the automotive (e.g. Yu et al., 2014) and the electronics industry (e.g. Huang and Yang, 2014). Delbufalo (2012) argued that multiple industries yield more variation in the data than a single industry. Therefore, we seek to examine whether the industry type moderates the relationship between GSCM practices and firm performance. To code for the industry types, we grouped articles into two categories depending on whether the data was collected from single or multiple industries. The papers focusing on a single industry group worked with data from automotive or electronics industries. We grouped the articles that collected data from more than one industry into the various industries category.

Moreover, some studies emphasized the highly correlated relationship between the GSCM practices and firm performance for companies that are ISO 14001 certified (e.g. Rao and Holt, 2005; Ann, Zailani, and Wahid, 2006; Kuei et al., 2013; Laosirihongthong et al., 2013). For instance, Lee et al. (2013) found significant relationship between greening the supplier and environmental performance among the ISO 14001 certified manufacturing firms in Malaysia. However, the high cost of obtaining ISO certification might result in the redirection of resources away from investing in more environmentally friendly processes (Ann et al., 2006). Therefore, to code this, we also evaluated the samples from companies that are ISO certified and companies for which the ISO certification is not explicitly stated.

Additionally, some scholars hypothesized the impact of international customers on the adoption of GSCM practices. Examples of such investigations drew samples from exporting companies and showed highly correlated relationships as reported by Zhu and Sarkis, (2004) and Lai et al. (2014). As such, we analyze the difference between samples of companies that are export-oriented and companies for which a specific orientation is not mentioned. Thus, we grouped papers into one of two categories depending on whether the data was collected from an export orientated industry or not specified.

### 2.3 Research framework

Our systematic literature review revealed that most of the reviewed papers have mentioned the relationship between GSCM practices and firm performance in four dimensions: economic, environmental, operational, and social performance. Zhu et al. (2007) argued that firms implement GSCM practices to achieve better supply chain performance. Although the primary goal for the AEE is still economic development (Lee et al., 2013), the increasing global focus on the environmental issues has forced the manufacturing sector in this region to improve its environmental performance (Lee et al., 2013; Mohanty and Prakash 2013). Subsequently, governments in the AEE have established stricter regulations to improve environmental performance of the manufacturing industry (Zhu et al., 2013; Wu, 2013; Mathiyazhagan et al., 2014). In addition, scholars on GSCM in the AEE have mainly focused on economic, operational and environmental performance. However, social issues such as product safety and labor conditions have attracted the attention of researchers in recent years (Zailani et al., 2012). Consequently, social performance has also become a key element to enhance sustainability of supply chains (Gimenez and Tachizawa, 2012). Therefore, the first hypothesis is proposed:

***H1. The GSCM practices are positively correlated with the firm performance.***

For manufacturing firms in the AEE, gaining economic performance is the key to adopt GSCM practices (Lee et al., 2012; Zhu and Sarkis, 2004). Regarding the economic performance, some early studies argued GSCM practices have no positive impact on economic performance (Zhu and Sarkis, 2004; Zhu et al., 2005). The early stage of adoption usually requires investment, which will increase companies' operational costs and negatively impact firms' economic performance. In contrast, more recent studies such as Hung et al. (2014) and Kim et al. (2011) or Liang et al. (2006) from the previous decade have highlighted the significant positive relationship between GSCM practices and firm performance.

The literature shows increasing evidence of the positive relationship between GSCM and environmental performance with manufacturing sectors in the AEE (e.g. Zhu and Sarkis, 2004; Lai and Wong 2012; Lai et al., 2012; Dou et al., 2013; Zhu et al., 2013). In this perspective, Zhu et al. (2013) showed that substantial environmental performance could be achieved by eliminating waste. Moreover, Chiou et al. (2011) examined three GSCM practices including product innovation, process innovation and managerial innovation and demonstrated their positive association with environmental performance. However, Mitra and

Datta (2014) and Abdullah and Yaakub (2014) investigated reverse logistics practices and found that manufacturers have not assumed a proactive role to consider these practices in the design phase and both studies found a negative impact of logistics operations on environmental performance.

Most of the studies in the AEE have found a positive relationship between GSCM practices and operational performance (e.g. Chiou et al.,2011; Dou et al., 2013; Zhu, Sarkis and Lai 2011; and Zailani et al., 2012; Lee et al., 2012; Lee et al.,2013). The adoption of GSCM practices can increase efficiency of processes and recycling of wastes, avoidance of penalties from government's environment department, disposal costs and higher future costs of compliance (Lee et al., 2012). Consequently, Lee et al. (2013) found that GSCM practices can increase operational efficiency which allows organizations to save on items such as scrap rate, delivery time, and inventory levels and hence enhance operational performance.

In terms of social performance, Zailani et al. (2012) analyzed data from 400 manufacturing firms in Malaysia and found that the adoption of green purchasing and green packaging have a positive effect on social performance. This finding was in line with that reported by Preuss (2000) who showed that the implementation of social and/or environmental standards could be transferred to suppliers by the purchasing function. This can generate a chain effect leading to quick and deep changes in overall social outcomes (Zailani et al., 2012). Social issues such as labor conditions are playing more significant role in manufacturing supply chains (Gimenez and Tachizawa, 2012). For example, fourteen employees of Foxconn, a major manufacturer in China supplying companies such as Apple, Dell, HP, Motorola, Nintendo, Nokia, and Sony attempted suicide between January and November 2010 due to poor working conditions (Chan, 2013). Production goals, business growth and profits should not come at the expense of well-being of workers. In turn, to achieve truly green supply chains, Pagell and Shevchenko (2013) suggested looking at the supply chain from the perspective of other stakeholders, such as NGOs and communities. Therefore, social performance could be considered as an important factor to make supply chains sustainable.

Given the above arguments, the following hypotheses are proposed considering the five GSCM practices defined in section 2.2 (i.e. IEM, SI, ECO, CC, and RL):

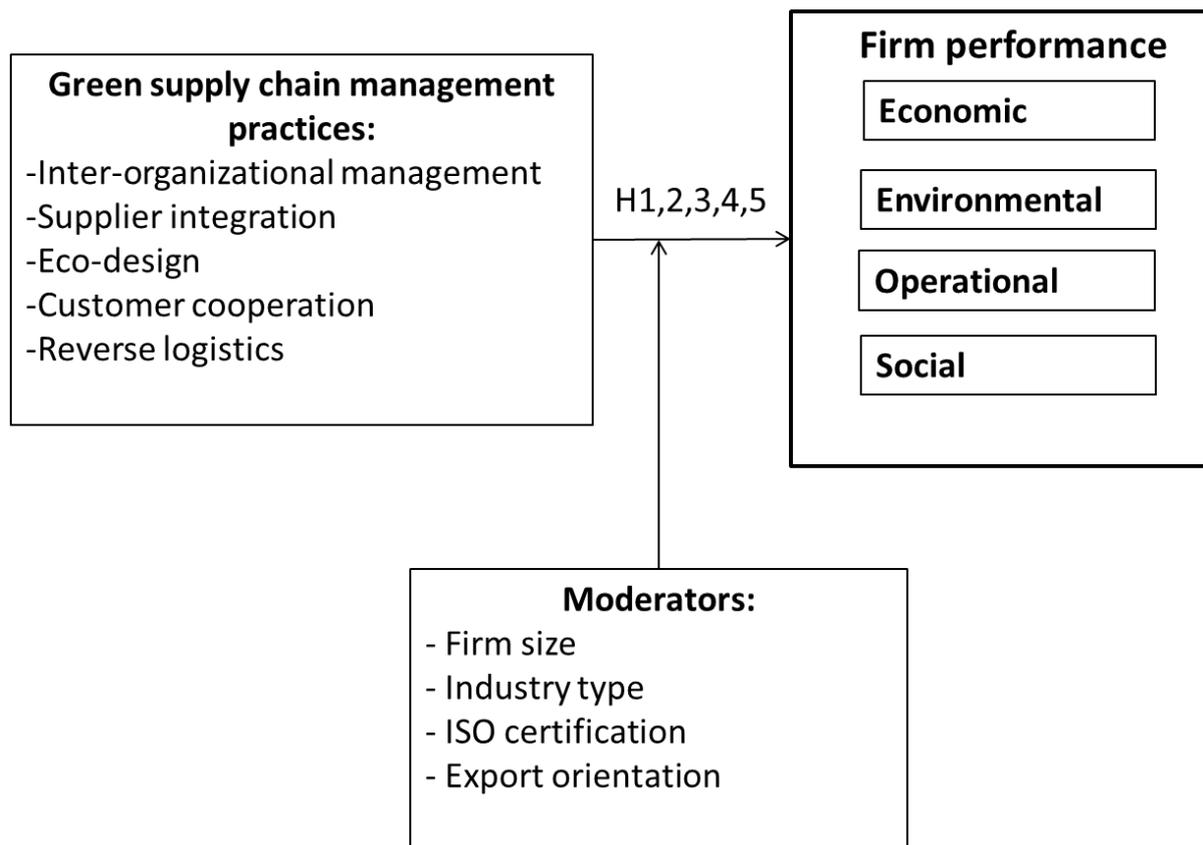
***H2. The GSCM practices are positively correlated with the economic performance.***

***H3. The GSCM practices are positively correlated with the environmental performance.***

***H4. The GSCM practices are positively correlated with the operational performance.***

***H5. The GSCM practices are positively correlated with the social performance.***

As we mentioned above, moderating variables in a meta-analysis are often drawn from control variables in empirical studies (Golicic and Smith, 2013). Therefore, as we discussed on section 2.2, four broad categories of moderators were considered in the meta-analysis. Figure 4 shows the research framework of this meta-analysis.



***Figure 4. Research framework***

### **3 Meta-analysis process**

According to Hunter and Schmidt (1990, 2004), meta-analysis is a quantitative accumulation that aims to analyze the effect sizes across the literature. Empirical researches on environmental practices and firm performance have been characterized by a large number of small-scale field studies with controversial findings regarding their impact on performance. Rosenbusch et al. (2011) indicated that these kind of empirical studies lack generalizability because of the differences in sampling criteria. Meta-analysis can be used to generalize the empirical results of previous researches (Raudenbush et al., 1991).

According to Borenstein et al. (2007) fixed effects analysis suits to identify studies considered in similar conditions with similar subjects. Therefore, we adopted a fixed-effect model for the meta-analysis due to the relationships between GSCM practices and firm performances. We followed a widely used meta-analytic procedure developed by Hunter and Schmidt (1990, 2004). Firstly, we estimated mean effect size based on the Pearson product-moment correlations reported by each study. If the study did not report correlations, we used the formula given by Hunter and Schmidt (1990) to convert the student's  $t$ ,  $F$ -ratios,  $\chi^2$  and Cohen's  $d$ , which are show in Appendix A. For instance, the effect size for the H2A was calculated using CMA for a total number of 16 correlation effects between intra-organizational environmental management and economic performance. The term "economic performance" has been used broadly with a variety of indicators. We coded studies that measured economic performance using objective or perceived growth in sales, profit, and market share. In the coding process, when the study reports multiple correlations for a single measurement, we took the range across the correlations (Rosenbusch et al., 2011). For instance, there are multiple correlation effects for different types of economic performance, such as the effects between intra-organizational environmental management (an independent variable) with ROA and ROE (dependent variables). In this case, both ROA and ROE meet our coding criteria for economic performance: growth in sales and growth in market. Thus, those two effect sizes (intra-organizational environmental management-ROA and intra-organizational environmental management-ROE) were combined into one effect size (intra-organizational environmental management-economic performance). Subsequently, we took a single estimate from the averaged correlations. This is a common procedure in meta-analysis (Cheung and Chan, 2004).

Next, we corrected each correlation for attenuation using the reliabilities reported for each measurement. For studies that did not report reliabilities, we used the most conservative value (0.70) as the threshold (Hunter and Schmidt 1990). We did not conduct sample-weighted correlations because the sampling errors only occur when the average individual sample size are extremely small ( $n < 30$ ) (Hunter and Schmidt 1990). Therefore, this was not considered as estimation in our meta-analysis due to the large and compiled sample size, which can be seen from Table 2. The next step was to calculate the 95% confidence interval around the correlation coefficient. This interval indicated whether the effect size of the relationship was significantly different from zero (Rosenbusch et al., 2011). Moreover, we calculated  $Z$ -scores to assess the statistical significance of between-group differences of the effect size (Stam et

al., 2014). Finally, we calculated the  $Q$ -statistic which is a chi-square distributed statistic with  $k - 1$  degrees of freedom and it allows to assess the heterogeneity across the studies (Hunter and Schmidt 1990). Additionally, we estimated the fail-safe  $N$  to assess the possibility of publication bias (Orwin, 1983). The fail-safe  $N$  (or  $N_{fs}$ ) is a ‘File drawer’ analysis which determines how many studies with a zero effect size would be required to yield a non-significant  $p$ -value (Orwin, 1983) and is calculated as follows (Orwin, 1983):

$$N_{fs} = \frac{N(d - d_c)}{d_c} \quad (1)$$

In the above formula,  $N$  is the number of studies used in the meta-analysis,  $d$  is the average effect size for the studies synthesized and  $d_c$  is the criterion value.

To implement the above calculations for meta-analysis, there are a variety of software that can be used such as Comprehensive Meta-Analysis (CMA), Review Manager, Stata and SAS. Among these, we found CMA easy to use, especially due to video tutorials provided by the developer. For this paper, we used the CMA version 3 to conduct the meta-analysis.

## 4 Results of the meta-analysis

### 4.1 GSCM practices-performance relationship

Table 6 summarizes the results of meta-analysis on the relationship between GSCM practice and firm performance with a total of 130 effects. In the meta-analysis, we followed the guidelines provided by Cohen and Cohen (1983) and Cohen et al. (2003), which state that a correlation effect size of less than 0.10 is considered weak, 0.10 to 0.30 is moderate and greater than 0.30 is strong.

Our findings show that the relationship between GSCM practices and firm performance (which is the summation of economic, environmental, operational, and social performance and is calculated by the software CMA) is strong and significant ( $r = 0.389, p = 0.000$ ). Although the adoption of GSCM practices require high initial investments, the benefits such as saving energy, reducing waste and increasing operational efficiency and customer image can outweigh the costs (Gimenez and Tachizawa, 2012; Chan et al., 2012; Lee et al., 2013; Kuei et al., 2013; Abdullah and Yaakub 2014).

*Table 6. Results of meta-analysis*

| <b>FIXED model</b>      | <b>Total studies</b> | <b>Total effect<sup>1</sup></b> | <b>Sample size<sup>2</sup></b> | <b>Effect size (r)</b> | <b>Standard error</b> | <b>95% Confidence Interval of r</b> |        | <b>Q-statistic</b> | <b>Z value</b> | <b>p value</b> | <b>Fail safe N</b> |
|-------------------------|----------------------|---------------------------------|--------------------------------|------------------------|-----------------------|-------------------------------------|--------|--------------------|----------------|----------------|--------------------|
| H1 Firm performance     | 50                   | 130                             | 25,680                         | 0.389                  | 0.013                 | 0.378                               | 0.399  | 1973.741           | 66.229         | 0.000          | 4271               |
| H2 economic performance | 35                   | 58                              | 10,876                         | 0.431                  | 0.017                 | 0.416                               | 0.446  | 583.547            | 47.724         | 0.000          | 1035               |
| H2A IEM                 | 16                   | 16                              | 2654                           | 0.509                  | 0.018                 | 0.480                               | 0.537  | 110.597            | 28.631         | 0.000          | 3280               |
| H2B SI                  | 11                   | 11                              | 1855                           | 0.427                  | 0.033                 | 0.389                               | 0.464  | 115.283            | 19.471         | 0.000          | 1128               |
| H2C ECOD                | 11                   | 11                              | 1883                           | 0.443                  | 0.064                 | 0.406                               | 0.479  | 228.304            | 20.409         | 0.000          | 1068               |
| H2D CC                  | 11                   | 11                              | 1803                           | 0.476                  | 0.041                 | 0.439                               | 0.511  | 74.689             | 21.777         | 0.000          | 1184               |
| H2E RL                  | 9                    | 9                               | 2681                           | 0.309                  | 0.014                 | 0.274                               | 0.343  | 47.556             | 16.441         | 0.000          | 481                |
| H3 env'l perf.          | 24                   | 35                              | 8773                           | 0.374                  | 0.018                 | 0.356                               | 0.392  | 358.806            | 36.579         | 0.000          | 8730               |
| H3A IEM                 | 8                    | 8                               | 3018                           | 0.293                  | 0.068                 | 0.301                               | 0.364  | 190.868            | 18.891         | 0.000          | 1016               |
| H3B SI                  | 11                   | 11                              | 1900                           | 0.408                  | 0.016                 | 0.370                               | 0.445  | 56.387             | 18.736         | 0.000          | 967                |
| H3C ECOD                | 7                    | 7                               | 1188                           | 0.500                  | 0.032                 | 0.456                               | 0.542  | 53.464             | 18.763         | 0.000          | 601                |
| H3D CC                  | 3                    | 3                               | 509                            | 0.443                  | 0.006                 | 0.364                               | 0.545  | 1.938              | 10.645         | 0.379          | 87                 |
| H3E RL                  | 6                    | 6                               | 2158                           | 0.289                  | 0.023                 | 0.270                               | 0.347  | 43.532             | 14.769         | 0.000          | 261                |
| H4 Op'l perf.           | 13                   | 25                              | 4598                           | 0.401                  | 0.094                 | 0.377                               | 0.426  | 662.963            | 28.609         | 0.000          | 3078               |
| H4A IEM                 | 10                   | 10                              | 2045                           | 0.370                  | 0.010                 | 0.331                               | 0.407  | 34.000             | 17.416         | 0.000          | 766                |
| H4B SI                  | 6                    | 6                               | 1340                           | 0.465                  | 0.475                 | 0.422                               | 0.3506 | 615.113            | 18.318         | 0.030          | 681                |
| H4C ECOD                | 2                    | 2                               | 322                            | 0.433                  | 0.015                 | 0.339                               | 0.518  | 1.307              | 8.230          | 0.000          | 24                 |
| H4D CC                  | 5                    | 5                               | 641                            | 0.375                  | 0.022                 | 0.308                               | 0.439  | 15.090             | 10.133         | 0.000          | 144                |
| H4E RL                  | 2                    | 2                               | 217                            | 0.267                  | 0.046                 | 0.138                               | 0.387  | 3.319              | 3.975          | 0.000          | 6                  |
| H5 Social perf.         | 8                    | 12                              | 1433                           | 0.077                  | 0.029                 | 0.025                               | 0.129  | 29.158             | 2.900          | 0.082          | 604                |
| H5A IEM                 | 3                    | 3                               | 533                            | 0.573                  | 0.052                 | 0.515                               | 0.630  | 17.266             | 15.009         | 0.000          | 158                |
| H5B SI                  | 1                    | 1                               | 194                            | 0.050                  | 0.000                 | -0.092                              | 0.190  | 3.692              | 0.692          | 0.489          | -1.75              |
| H5C ECOD                | 2                    | 2                               | 343                            | 0.126                  | 0.276                 | 0.020                               | 0.229  | 32.473             | 2.328          | 0.608          | -0.125             |
| H5D CC                  | 3                    | 3                               | 389                            | 0.050                  | 0.000                 | -0.050                              | 0.148  | 0.000              | 0.978          | 1              | 92                 |
| H5E RL                  | 3                    | 3                               | 512                            | 0.014                  | 0.0014                | -0.073                              | 0.101  | 4.526              | 0.318          | 0.751          | 0                  |

1: Number of effect sizes used in each analysis

2: Number of companies included in total effects

IEM: Intra-organizational management; SI: Supplier integration; ECOD: Eco-design; CC: Customer cooperation; RL: Reverse logistics

#### 4.1.1 GSCM practices and economic performance

Our results showed a strong and positive relationship between GSCM practices and economic performance with effect size  $r = 0.431$  ( $p = 0.000$ ). Moreover, the majority of the selected indicators belong to this domain (48 effects). Based on the financial perspective, when companies invested in GSCM practices, they are able to reduce inventory investments, increase recovery of assets and contain costs and lead to economic performance improvement (Huang et al., 2012). Therefore, this result confirmed the findings of previous literature regarding the relationship between GSCM practices and economic performance in the AEE measured by growth in sales, profit, and market share.

Our study also uncovers different indicators that may affect the strength of the relationship between GSCM practices and firm performance in the AEE. We compared the impact from different GSCM practices on economic performance and found that firm performance benefits more from intra-organization environmental practices (H2A,  $r = 0.509$ ,  $p = 0.000$ ) than from the collaborative practices with customers (H2D,  $r = 0.476$ ,  $p = 0.000$ ) and suppliers (H2B,  $r = 0.427$ ,  $p = 0.000$ ). This result confirms that the adoption of internal environmental management is the key to bringing better economic performance. Our results confirm previous studies arguing that successful adoption of GSCM practices by a company depends on the intra-organizational environmental management (Kuei et al., 2013; Youn et al., 2013). In this perspective, we conclude that high levels of intra-organizational environment practices could improve flexibility and tend to enhance economic performance.

The results confirmed the strong and positive relationship between suppliers' integration and economic performance (H2B,  $r = 0.427$ ,  $p = 0.000$ ). Hence, working closely with suppliers on environmental activities can reduce unnecessary expenses and improve product quality; therefore, lead to better economic performance (Lee et al., 2013; Lin and Ho, 2011; Wong et al., 2014). On the other hand, integration with suppliers for environmental purposes allows manufacturers to work jointly with their suppliers to develop the most appropriate plan for accommodating final customer requests (Yu et al., 2014).

In addition, customer cooperation practices showed significantly positive association with economic performance (H2D,  $r = 0.476$ ,  $p = 0.000$ ). This result confirmed that cooperation with customers for environmental purposes can improve economic performance of manufacturers in the AEE (Lai and Wong, 2012; Yu et al., 2014). It further supports the argument that collaborating with customers on GSCM practices enables companies to have a

better understanding of customers' environmental demands, thus allowing the manufacturers to provide better products and services to achieve economic performance (Rao and Holt, 2005; Peng and Lin, 2008; Chan et al., 2012; Lee et al., 2012).

Our findings show that reverse logistics has the lowest impact (H2E,  $r = 0.309$ ,  $p = 0.000$ ) with nine effects on economic performance among all five practices. This could be due to the fact that reverse logistic has received less attention than other practices until now, due to the high investment need and the lack of recycling infrastructure and relevant technologies in the AEE (Zhu and Sarkis, 2004). However, a 95% confidence interval of  $r$  from 0.274 to 0.343 also indicates the relationship between reverse logistics and economic performance is at medium-level. These results are consistent with previous literature that state the re-use of materials and recycling initiatives will lead to savings in raw materials, water and energy usage and thus result in improved economic performance (Rao and Holt, 2005). This is due to the fact that reverse logistics can affect economic performance directly and indirectly. For instance, recycle, reuse and recovery practices can reduce pollution and, therefore lead to better marketing advantages and increased market share (Lai et al., 2013).

#### **4.1.2 GSCM practices and environmental performance**

Research related to GSCM practices suggested a significant effect size (H3,  $r = 0.374$ ,  $p = 0.000$ ) on the relationship with environmental performance. There were 25 effects in this domain. In general, all GSCM practices showed a positive and significant effect on environmental performance: a significant and strong correlation with eco-design (H3C,  $r = 0.500$ ,  $p = 0.000$ ), supplier integration (H3B,  $r = 0.408$ ,  $p = 0.000$ ) and customer cooperation (H3D,  $r = 0.443$ ,  $p = 0.379$ ); and a moderate correlation with intra-organizational environmental management (H3A,  $r = 0.293$ ,  $p = 0.000$ ) and reverse logistics (H5E,  $r = 0.289$ ,  $p = 0.000$ ).

The meta-analysis indicated that eco-design (H3C,  $r = 0.500$ ,  $p = 0.000$ ) has the highest impact on environmental performance. The 95% confidence interval from 0.456 to 0.542 showed a large correlation among all effects. This result demonstrated that the most important part of a product's life cycle is taking the environmental consideration in the design stage (Laosirihongthong et al., 2013; Zailani et al., 2012). In this perspective, eco-design can bring environmental improvement, decrease energy consumption and improve waste treatment (Lin et al., 2013). Therefore, eco-design is a helpful and useful technique to

improve manufacturers' environmental performance by addressing product functionality while simultaneously minimizing life-cycle environmental impacts (Zhu and Sarkis, 2004).

With regard to suppliers' integration (H3B,  $r = 0.408$ ,  $p = 0.000$ ), focal companies can work with their suppliers to align the process of production, service, and transportation (Wong et al., 2014). For instance, manufacturers can discuss with their suppliers for green design of products in the early research and development stage (Tseng and Chiu, 2013). In this perspective, suppliers can use more environmentally-friendly materials and packaging to incorporate the environmental concerns in order to meet the environmental requirement from manufacturers (Zhu and Sarkis, 2004).

Customer's cooperation showed a stronger impact than the suppliers' integration on the environmental performance. One possible reason may be that most companies in the AEE are market-oriented (Guoyou et al., 2013). However, although there is a strong and positive correlation between customer cooperation and environmental performance (H3D,  $r = 0.443$ ,  $p = 0.379$ ), the  $p$ -value at 0.379 indicated this relationship is not significant. The results indicated that when manufacturers adopt the GSCM practices with customers are not guaranteed improve on the environmental performance.

#### **4.1.3 GSCM practices and operational performance**

The result of (H4A,  $r = 0.370$ ,  $p = 0.000$ ) confirmed previous research on the strong and significant relationship between intra-organizational environmental management and operational performance. Ann et al. (2006) argued that the implementation of intra-organizational environmental management did not result in operational timesaving and quality improvements. However, most of the prior studies showed that intra-organizational environmental management is a systematic and comprehensive mechanism to improve operational performance (Zhu et al., 2010; Zhu and Sarkis, 2004; Yu et al., 2014). Lai and Wong (2012) and Yang et al.(2010) both found that the adoption of intra-organizational environmental management practices can improve operational performance in terms of product quality and delivery time. In line with this, intra-organizational environmental management removes functional barriers and enables the cross-functional cooperation (Zhu and Sarkis, 2004). Therefore, it allows for better collaboration on production capacity to improve operational flexibility and efficiency (Vachon and Klassen, 2008).

The remaining correlations represent the strong and significant effect on operational performance by eco-design (H4C,  $r = 0.433$ ,  $p = 0.000$ ), suppliers' integration (H4B,  $r = 0.465$ ,  $p = 0.000$ ) and customer cooperation (H4D,  $r = 0.375$ ,  $p = 0.000$ ). These results may indicate that for a focal firm, new product eco-design and collaboration with customers and suppliers are key contributors to operational performance (Yang et al., 2010). In line with Lee et al. (2012), our results confirmed the positive relationship between eco-design and operational performance. Taking environmental consideration into product development and design stages lead to better operational performance (Keoleian and Menerey, 1993). Similarly, operational performance is sensitive to input and collaboration with suppliers and customers (Lee et al., 2012). Therefore, supplier integration and customer cooperation can ensure on-time delivery can lead to better operational performance (Wong et al., 2011).

Finally, our result illustrates a moderate and significant impact (H4E,  $r = 0.267$ ,  $p = 0.000$ ) of reverse logistics on operational performance. The reason may be due to the fact that recycling and collecting reusable parts and components can reduce the operational cost in materials sourcing. Manufacturers can investigate the end-of-life and recycled products participating in customers' product return programs (Abdulrahman et al., 2014). In this perspective, better operational performance can be achieved by reducing waste and improving material disposal (Mitra and Datta, 2014). However, the Fail-safe N of 6 indicated the significance result can be reducing by another 6 publications. Therefore, the low numbers of Fail-safe N indicated that although reverse logistics could significantly increase the operational performance in this period of time. However, future studies in the reverse logistics-operational performance relationship still needed in order to reduce the publication bias for the significant relationship.

#### **4.1.4 GSCM practices and social performance**

The correlation between GSCM practices and social performance was insignificant (H5,  $r = 0.077$ ,  $p = 0.082$ ). Moreover, some surprising results are achieved from the analysis of individual practices which are discussed below.

Among all types of GSCM practices, only intra-organizational environmental management (H5A,  $r = 0.573$ ,  $p = 0.000$ ) have a significant impact on social performance. Some previous studies argued that the implementation of intra-organizational environmental management does not result in better image-building and public relations (Avila and Whitehead, 1993). In contrast, Ann et al. (2006) found that intra-organizational environmental management, such as the adoption of ISO certification, can help shape competitive positions in the marketplace

in Malaysia's manufacturing industry. Our results confirmed the strong and significant correlation between intra-organizational environmental management and social performance.

The correlations between supplier integration (H5B,  $r = 0.050$ ,  $p = 0.489$ ) and eco-design (H5C,  $r = 0.126$ ,  $p = 0.608$ ) showed no significant relation with the social performance. Moreover, the value of fail-safe N of -0.125 also confirmed that there is a substantial publication bias of the significance of this relationship. In this perspective, Laosirihongthong et al. (2013) argued that there was a disconnect between the supplier integration for environmental issues and eco-design as well as social performance. This is possibly due to the fact that manufacturers in the AEE have not recognized that eco-design and supplier integration can help achieve better corporate image. Moreover, our results showed an insignificant correlation between customer cooperation (H5D,  $r = 0.050$ ,  $p = 1$ ) and social performance. This is in contrast with previous studies arguing that satisfying customers through the cooperation will help companies outperform rivals in the competitive market (Chan et al., 2012).

Surprisingly, the meta-analysis of H5E showed that the correlation between reverse logistics and social performance was weak and insignificant (H5E,  $r = 0.014$ ,  $p = 0.751$ ). The practices of reverse logistics can improve the image and reputation of a company and potentially increase the value of a firm by increasing its social performance (Chan et al., 2012). However, reverse logistics are seen as impractical as the culture of recycling is not deeply entrenched in the AEE (Laosirihongthong et al., 2013). From this perspective, Lai et al. (2013) suggested manufacturers in the AEE to have close communication with their stakeholders to identify some reverse logistics practices such as recycling that can improve social performance.

## **4.2 Moderator analysis**

Table 7 presents the effect of four moderators including industry type, ISO-certification, export-orientation, and firm size. The results suggested that the companies in automotive industry have the strongest relationship between GSCM practices and firm performance ( $r = 0.453$ ,  $p = 0.000$ ). Moreover, there was a considerable difference in the findings across companies with different sizes. The correlation coefficient was  $r = 0.304$  ( $p = 0.000$ ) in studies collected data from ISO-certified companies and  $r = 0.400$  ( $p = 0.000$ ) in studies where it was not specifically stated whether the companies had ISO certification.

*Table 7. Moderator analysis*

| <b>FIXED model</b>     | <b>Number of articles</b> | <b>Sample size<sup>1</sup></b> | <b>Effect size(<i>r</i>)</b> | <b>Standard error</b> | <b>95% Confidence Interval of <i>r</i></b> |       | <b>Q test</b> | <b>Z value</b> | <b><i>p</i> value</b> | <b>Fall safe N</b> |
|------------------------|---------------------------|--------------------------------|------------------------------|-----------------------|--|-------|---------------|----------------|-----------------------|--------------------|
| Auto                   | 5                         | 3,266                          | 0.453                        | 0.059                 | 0.425                                      | 0.480 | 139.834       | 27.554         | 0.000                 | 964                |
| Electronics            | 7                         | 6,393                          | 0.377                        | 0.009                 | 0.356                                      | 0.398 | 61.194        | 31.589         | 0.000                 | 1669               |
| Various industries     | 38                        | 16,021                         | 0.380                        | 0.068                 | 0.366                                      | 0.393 | 1051.039      | 50.200         | 0.000                 | 6487               |
| ISO certified          | 7                         | 3,267                          | 0.304                        | 0.071                 | 0.272                                      | 0.335 | 197.126       | 17.809         | 0.000                 | 799                |
| Not specified          | 43                        | 22,413                         | 0.400                        | 0.016                 | 0.389                                      | 0.411 | 1082.314      | 63.020         | 0.000                 | 1860               |
| Export orientated      | 4                         | 1,626                          | 0.391                        | 0.022                 | 0.380                                      | 0.390 | 24.989        | 14.505         | 0.000                 | 157                |
| Not specified          | 46                        | 24,054                         | 0.348                        | 0.017                 | 0.304                                      | 0.402 | 1284.668      | 63.625         | 0.000                 | 8536               |
| Companies of all sizes | 43                        | 21,102                         | 0.380                        | 0.059                 | 0.368                                      | 0.391 | 1206.618      | 57.617         | 0.000                 | 7920               |
| SMEs                   | 7                         | 4,578                          | 0.428                        | 0.018                 | 0.404                                      | 0.452 | 94.247        | 30.784         | 0.000                 | 1455               |

1: Number of companies

With regards to the industry type, we distinguished samples among automotive, electronics and various industries. With respect to this classification, we found that automotive industry ( $r = 0.453, p = 0.000$ ) has a larger impact on the relationship than various industries ( $r = 0.380, p = 0.000$ ) and electronics ( $r = 0.377, p = 0.000$ ). This is in line with previous meta-analysis by Golicic and Smith (2013) who found that automotive industry had the strongest effect among auto and various industries in all regions. They indicated the reason was that the automotive industry has received significant attention on environmental activities (Golicic and Smith, 2013). However, Zhu et al.(2007) found that the automotive manufacturers in China only considered cooperation with suppliers on GSCM practices and lagged in cooperation with customers. Therefore, GSCM practices could only improve their environmental and operational performance slightly, and did result in significant economic performance (Zhu et al., 2007). In contrast, our study confirmed that the automotive industry has the strongest impact on achieving firm performance from adopting GSCM practices in the manufacturing sector in the AEE. There are two possible reasons for this result. Firstly, GSCM practices are widely adopted in the automotive industry (Zhu et al., 2007). Secondly, the automotive sector is a leading industry in implementing GSCM practices in AEE (Wong et al., 2011). Additionally, we found positive impacts in the electronics industry. This may be due to the foci of the papers on Taiwan and South Korea, as these countries are world leaders in the electronics industry (Huang et al., 2012).

An analysis of the impact of ISO-adoption on the relationship among GSCM practices and firm performance suggested that both ISO-certified ( $r = 0.304, p=0.000$ ) and not specified companies ( $r = 0.400, p = 0.000$ ) show the strength of the GSCM practices-performance relationship. Previous studies indicated that ISO-certified companies are more likely to have adopted GSCM practices (Ann et al., 2006; Rao and Holt, 2005; Zailani, Eltayeb, Hsu, and Tan, 2012). The process of adopting ISO certification provided high level of awareness and experience with environmental issues for companies which facilitated the adoption of GSCM practices (Ann et al., 2006). Moreover, Zhu et al. (2008) explained the positive relationship between ISO 14001 certification and the adoption of GSCM practices in terms of organizational learning. They argued that the experience and knowledge on the adoption of ISO 14001 certification generated momentum which motivated the adoption of GSCM practices. Similarly, Zailani et al., (2012) also indicated that in the Malaysian context, companies with ISO 14001 certification are likely to require certain collaborations to their suppliers regarding GSCM practices. However, our results indicated that the manufacturers in

the AEE are able to benefit from the GSCM practices with or without adopting ISO certification. One possible reason is that manufacturing companies in the AEE are heavily dependent on overseas markets (as shown in Figure 1). They faced several critical environmental challenges from eco-design to recovery and recycling during the process of exporting. For instance, although Bristol–Myers, Squibb, IBM, or Xerox do not require their suppliers in China to have ISO 14001 certification, they require their suppliers to have an environmental management system consistent with ISO 14001 certification (Zhu et al., 2012). Similarly, General Motors do not force their Chinese suppliers to obtain ISO 14001 certification but require them to implement their own ‘Greening Supply Chain’ project (Zhu et al., 2012).

Moreover, our meta-analysis compared samples from 1,626 export-orientated manufacturing companies and 24,054 other manufacturing companies that have not indicated their orientation with respect to export status. The results of the meta-analysis confirmed that both types showed strong and significant correlation, but there is a stronger effect for export-orientated manufacturing companies ( $r = 0.391$ ,  $p = 0.000$ ) than manufacturing companies with an unspecified export status ( $r = 0.348$ ,  $p = 0.000$ ). The reason may be due to the requirement for export-orientated manufacturers to comply with the legislation enforced by different governments, such as the WEEE (European Community Directives on Waste Electrical and Electronic Equipment) to enter international markets (Lai, Wong, and Venus Lun, 2014).

Our findings support the impact of the relationships between GSCM practices and firm performance in studies with both SMEs and large companies. Moreover, the results showed that the GSCM practices-performance relationship in large companies ( $r = 0.428$ ,  $p = 0.000$ ) have a stronger effect than SMEs ( $r = 0.380$ ,  $p = 0.000$ ). In contrast, previous literature indicated that firm size does not affect the GSCM practices-performance relationship (Wong et al., 2012; Zhu et al., 2010). One of the reason for our result may be that most SMEs lack human and financial resources with expertise on the adoption of GSCM practices (Lee et al., 2012). In this regard, they are often making an effort in terms of managerial changes to meet the environmental and social standards (Lee, 2008). On another hand, Mohanty and Prakash (2013) argued that SMEs only adopt environmental practices when they are facing a pressure from both environmental regulation and the ecological requirements of the market together.

## **5 Implications and Conclusions**

Our meta-analysis study of the extant literature on the GSCM focuses on the manufacturing sector in the AEE. The meta-analysis revealed several relationships between GSCM practices and performance. Through a systematic literature review, we identified and analyzed 50 articles with 130 effects that involved a total of 11,127 manufacturing companies in the AEE. Subsequently, we developed a conceptual framework consisting of five major relationships in the GSCM practices and performance. The results of our meta-analysis indicate that the GSCM practices lead to better performance in three aspects: economic, environmental, and operational. More specifically, the GSCM practice–performance relationship is the strongest for economic performance, which is followed by operational and environmental performance, respectively. Surprisingly, the GSCM practices did not have any significant impact on the social performance. Moreover, the results also indicate that several GSCM practice–performance relationships are moderated. This is an important finding for several reasons. Firstly, our meta-analysis implies that the adoption of GSCM practices contributed to firm performance, but at different levels. Secondly, this finding also instills more confidence in the adoption of GSCM practices as a profitable environmental strategy that can be used to reduce environmental impact while increasing the economic performance. In this regard, as the competition in manufacturing industry becomes more between supply chains and less among individual firms, Peng and Lin (2008) stated that the adoption of GSCM practices is becoming an important and valuable strategy to reduce costs whilst satisfying different stakeholders’ requirements. Our meta-analysis indicated that the adoption of GSCM practices is becoming more significant in contributing to firm performance as the supply chains become more complex. As for the globalization, the adoption of GSCM practices will play a larger role in manufacturing companies in the AEE not only in reducing environmental impact but also in contributing to the firm performance.

### **5.1 Theoretical implications**

This study has important implications for the research community on sustainability and in particular, GSCM in emerging economies. The relationship between collaboration-oriented practices (supplier integration and customer cooperation) with firm performance was inconsistent. In the subgroup analysis, customer cooperation has an overall stronger effect size than supplier integration among economic and environmental performance measures. This result provides an indication that customer cooperation may contribute to performance

more in the AEE. But the sample size of customer cooperation is smaller than supplier integration, which may also indicate that supplier integration has the potential to have a strong contribution to firm performance. Due to the smaller number of studies on customer cooperation, future research could extend the topic by bringing more empirical studies on this relationship to clarify this finding.

In the moderator analysis, we found that the strength of the GSCM practice-performance relationship was the lowest in various industries in the AEE. The results showed that studies which collected data from a single industry (automobile and electronics) have a stronger GSCM practices-performance relationship than studies that collected data from companies in various industries. It might be worthwhile to examine the reason why some industries are more likely to gain performance benefits from implementation of GSCM practices compared to others. For instance, unit costs, average industry margins, turnover, inventory levels and competitive intensity of different industries may influence the effect of GSCM practices. Because studies that collected data from a wide variety of industries are more generalizable, scholars may develop a more comprehensive understanding of the GSCM practices-performance relationship if they gather data from diverse industries rather than a specific industry. Other findings show that companies of all sizes have higher impact on the strength of the GSCM practice-performance relationship than studies that only focused on SMEs. This may indicate that manufacturing SMEs in the AEE might lack resources, such as engineers and facilities for GSCM adoption. This conjecture could be investigated through further research focused on the SMEs.

Our research showed that majority of empirical studies on GSCM practices have been conducted in China, Taiwan, and South Korea. Further research could look at less explored countries. Moreover, a performance gap was identified between supplier integration, eco-design, reverse logistics, and social performance. Therefore, future research could take a closer look at these relationships and undertake new studies on how GSCM practices impact social performance. Researchers need to have more empirical data on explaining whether supplier integration, eco-design, and reverse logistics dedicated to social performance are squandered.

Moreover, almost half (42%) of the reviewed paper do not specify any underpinning theories. However, from the observation of the meta-analysis, studies that implied theories have a stronger GSCM practices-performance relationship than studies that did not. This

observation indicated that including a theory during the study design may lead to more rigorous and hence precise results. Although this is a preliminary observation from the meta-analysis, we believe this is a significant step towards a better understanding of GSCM research. Future studies need to establish the theoretical background that underpins the research design.

In addition, in furthering the empirical studies on GSCM practices - performance relationship, researchers are encouraged to present a detailed correlation matrix between practices and performance measures. This will help conduct more comprehensive meta-analyses in future that can contribute to theory development in GSCM.

## **5.2 Managerial implications**

Our research has practical implications for managers of manufacturing companies in the AEE. Firstly, our research established strong empirical evidence that GSCM practices can affect the firm performance regardless of the company size, industry, ISO-certification, and export-orientation. Our research findings suggested that when manufacturers in the AEE take environmental consideration into their supply chain management, they not only achieve better performance on sales, profit, and market share, but also save energy and reduce waste, pollution and emissions. Nevertheless, the efficiency of the firm's operations such as scrap rate, delivery time, inventory levels, and capacity utilization can be improved as well. The positive relationships between the adoption of GSCM practices and the environmental, operational and economic performance have the potential to promote the adoption of GSCM as a strategy to improve the firm performance.

Secondly, this study provides manufacturers with insights on different levels of results on performance increase from each GSCM practice. Our results reveal the strong and significant relationship between eco-design and environmental, operational and economic performance. Therefore, companies should recognize the importance of eco-design in order to receive benefit from GSCM practices. The companies interested in eco-design practices may consider for instance ISO/TR 14062, which is an international standard providing a direction for adoption of eco-design (Drack et al., 2004). In addition, policy makers in the AEE should have a proactive role in formulating relevant environmental standards and legislations to encourage manufacturing firms to adopt eco-design principles because companies in the AEE are like to adopt GSCM practices with proper guidelines and regulations (Zhu et al., 2012).

Thus, policy makers in the AEE may use the "carrot plus stick" approach to motivate manufacturing firms to adopt GSCM practices (Zailani et al., 2012).

Thirdly, reverse logistics despite all the practical uses by many manufacturers in developed countries are still not a popular practice among manufacturers in the AEE. Our findings on reverse logistics showed an overall moderate impact on three performances: economic, environmental and operational. Even though the results showed a moderate effect, it shed lights on manufacturers' view in the AEE by providing insights on the improved performance. Moreover, the result between reverse logistics and social performance was weak and insignificant. One of the reason may be the impracticality of reverse logistics as the culture of recycling is not yet deeply entrenched in the AEE (Laosirihongthong et al., 2013). Another reason may be the high costs and other constraints involved in reverse logistics (Zailani et al., 2012). Therefore, reverse logistics should not be viewed as a cost center by manufacturers as it is a contributor to firm's performance in economic, environmental, and operational perspective. In fact, reverse logistics is often considered as a core competency in developed countries (Laosirihongthong et al., 2013). Therefore, governments in the AEE could take more efforts to enlighten manufacturing firms on the adoption of reverse logistics.

Finally, our findings provide managers with multiple performance measurements that will help them explain the benefits of adopting GSCM practices more easily. Due to the requirements of environmental issues that affect businesses globally, manufacturers in the AEE have begun to change their focus to balance the economic growth and the damage to the environment. Our findings encourage manufacturing companies in the AEE to seriously consider adopting GSCM practices to improve resource utilization. Companies need to share the stories on the benefits they got from adopting GSCM practices with other firms to spread and create interest in the concepts of GSCM. Importantly, the adoption of GSCM can bring both commercial success to manufacturing companies as well as fulfil their moral obligation to protect the earth.

### **5.3 Recommendations**

In terms of further research, the limited empirical evidence on the relationship between GSCM and social performance indicate more studies are needed in this domain. Although manufacturing industry in the AEE beat their competitors through cheap labor and economies of scale, they are increasingly encountering the issues of product safety and labor working conditions. Although the results of the meta-analysis showed that intra-organizational

environmental management has a strong and positive impact on social performance in the subgroup analysis, there is a disconnection between the adoption of GSCM practices and social performance. It appears that manufacturers in the AEE may have not recognized or fully exploited the positive impact that GSCM practices can bring to their products and their corporate image. On the other hand, the significant relationship found in the subgroup analysis between intra-organizational environmental management and social performance indicates that social performance is a distinguished type of outcome. The social performance can be achieved from the adoption of intra-organizational environmental management in terms of increasing product and company image, protecting employee health and safety, ensuring customer loyalty and satisfaction.

Our meta-analysis confirmed the positive and significant relationship between GSCM practice-performance. Although these relationships seem linear, only one of the reviewed papers has observed that GSCM is a “win-win” strategy (Lai et al., 2014a). The authors indicated that GSCM practices involve a collaboration that firms and their supply chain partners seek to create value for each other in adopting GSCM practices to entertain performance benefits. Therefore, it will be interesting to examine whether the adoption of GSCM practices only contribute to the focal company’s performance or also bring benefit to their supply chain partners.

In addition, further studies can apply these results in less explored regions in the AEE and other emerging economies such as Brazil and Turkey. Moreover, the impact of reverse logistics and the association between GSCM and social performance are worth exploring due to the limited empirical studies in these areas. We also suggest that further research be directed toward uncovering other moderators such as cultural differences and illustrating specific mechanisms in how GSCM practices affect firm performance.

Furthermore, this study does not consider the specific relationship between the adoption of GSCM practices and the individual metrics of each performance dimension. Future research could identify the trade-off between the individual indicators within a performance category; if there is enough number of papers with sufficient detail to allow this. For example, a specific GSCM practice may improve companies’ economic performance in general; however, this practice may increase sales growth while reducing profits.

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**Appendix A. Formulas for transformation to correlation**

| <b>Statistic to be converted</b> | <b>Formula to calculate correlation</b> | <b>Note</b>                                      |
|----------------------------------|---|--|
| Student's t                      | $r = \sqrt{\frac{t^2}{t^2 + df}}$       | Can be used for either paired or unpaired t test |
| F-ratios                         | $r = \sqrt{\frac{F}{F + df(error)}}$    | Can only be used for one way ANOVA               |
| $X^2$                            | $r = \sqrt{\frac{X^2}{n}}$              | n=sample size<br>Can be used when df=1           |
| d                                | $r = \frac{d}{\sqrt{d^2 + 4}}$          | d= Cohen's d                                     |