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## Green Supply Chain Management Practices and Company Performance: A Meta-analysis approach

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### Abstract

Varying conceptualizations of green supply chain management (GSCM) practices can be observed in extant literature and there is evidence of mixed results relating GSCM practices to firm performance. These inconclusive findings have often confused managers which practices would yield desired performance outcomes. Hence, by applying meta-analysis approach in 85 independent effect sizes with a total sample size of 20011 firms, we tested the impact of GSCM practices on firm performance. Findings indicate that the relationship between GSCM practices and firm performance is positive and significant, providing empirical generalization and support to practitioners and scholars. Likewise, the GSCM practices positively and significantly influence environmental, social, operational and economic performance. This relationship is moderated by geographical region, industry type and firm size. Future studies should test how ascendants of GSCM practices affect firm's sustainability performance.

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### 1. Introduction

Environmental management is an important issue in supply chain management (SCM) [1]. The SCM requires integration and coordination of inter-organizational processes and strategy alignment across all companies in the supply chain (SC) for the purpose of satisfying the final consumer [2]. Organizational processes include sourcing,

manufacturing, distribution, marketing, information systems [2], and reverse logistics. All these processes should be strategically aligned with environmental standards and concerns from government regulators, customers, and competitors [3] to mitigate the risk of environmental hazards and reduce adverse publicity due to non-compliance with associated government penalties as well as improve SC performance. With competition at SC level [4] and since the focal company is often held responsible for the adverse environmental impacts of all organizations in its SC [3], it is necessary to identify and adopt GSCM practices that yield competitive advantages. In this direction, the research on GSCM is attracting a growing interest in academic literature [5].

Beamon [6] defined green SC as “*the extension of the traditional supply chain to include activities that aim at minimizing environmental impacts of a product throughout its entire cycle, such as green design, resource saving, harmful material reduction and product recycle and reuse.*” Thus, GSCM practices consist of different types of activities and initiatives undertaken by companies to cope with institutional pressure and to improve the overall performance of the company and in turn the overall SC performance. Although many studies have studied the influence of GSCM practices on performance, the outcomes are mixed and not conclusive. While the majority of studies found positive relationship [2,3,7–9], several studies have found negative [10–12] or no significant relationship [13–16] between GSCM practices and corporate performance. Other studies including Azevedo et al. [1] and Wu and Pagell [17] found a mix of positive and other relationships. However, results from two previous meta-analysis [18,19] found a positive and significant relationship between GSCM practices and performance.

The meta-analysis by Golicic and Smith [18] tested only the relationship between GSCM practices and firm’s financial performance but no relationship between GSCM practices and environmental, social, or operational performance is tested. The meta-analysis by Geng et al. [19] tested the relationship between GSCM practices and economic, environmental, social, and operational performance but their sample includes only studies from Asian emerging economies in the manufacturing sector. Another factor that motivates our study is that both previous meta-analyses violate the condition of independent samples [20] by using the same sample published in two or more studies as independent samples.

To reconcile differences in these mixed results, several studies [1–3,5,21,22] have stressed the need for further research on this topic. Additionally, GSCM practices have been operationalized differently and previous meta-analyses are limited; hence, *this study aims to provide new insights and empirical generalization on the relationship between GSCM practices and firm performance.*

To fulfill the research objective this study examined the empirical literature in the link on GSCM practices and firm performance. This study followed the methods of meta-analysis recommended by Hunter and Schmidt [23] and Geyskens et al. [20]. It contributes to theory and to practice by generalizing that GSCM practices have a positive and significant impact on firm’s economic, environmental, social and operational performance. In doing so, SC managers, using this study can identify GSCM practices that lead to desirable firm performance. Scholars find this study useful because it provides new insights into the link between GSCM practices and firm performance and suggests possible future research directions.

The remainder of this paper is organized as follows. The research framework adopted for this study is presented in Section 2 followed by research methodology described in Section 3. The results of the study and their implications are depicted and discussed in Section 4. The study ends with future research recommendations and conclusions.

## 2. Theoretical framework and hypotheses development

GSCM practices are initiatives that companies adapt to comply with environmental legislation, to minimize negative impacts of their operations [16], and to improve their performance [9] as well as SC performance [1]. GSCM practices include both coercive and vulnerary initiatives [7,11] and should incorporate both inter-organizational practices [24,25] and intra-organizational practices [3]. These practices require that the focal company (manufacturer) to collaborate with suppliers and consumers [26].

It is worth to note that various papers use different conceptual frameworks to test the relationship between GSCM practices and corporate performance. Consequently, there is no universally accepted framework of GSCM practices [14,16]. Based on the study by Golic and Smith [18], this paper operationalizes GSCM practices into four constructs—*Upstream Supplier Facing, Eco-Design, Green manufacturing, and Downstream Consumer Facing*; firm performance includes four constructs—*Environmental, Social, Operational, and Economic Performance*. Fig 1 presents the theoretical research framework used in this study. The constructs of GSCM practices are the independent variable and constructs of firm performance represent the depended variable. Control variables in primary studies are usually

considered as moderating variables in meta-analysis [18]. A moderating variable in the meta-analysis is a third variable that may affect the relationship or correlation between independent and depended variables [19,23]. In this study, we tested three moderating variables: (i) firm size, (ii) geographical region, and (iii) industry type. Firm size is tested as moderator since larger firms have more resources to implement GSCM practices [13]. Industry type and geographical region are used as moderators since primary studies are drawn from various samples in both industry type and country.

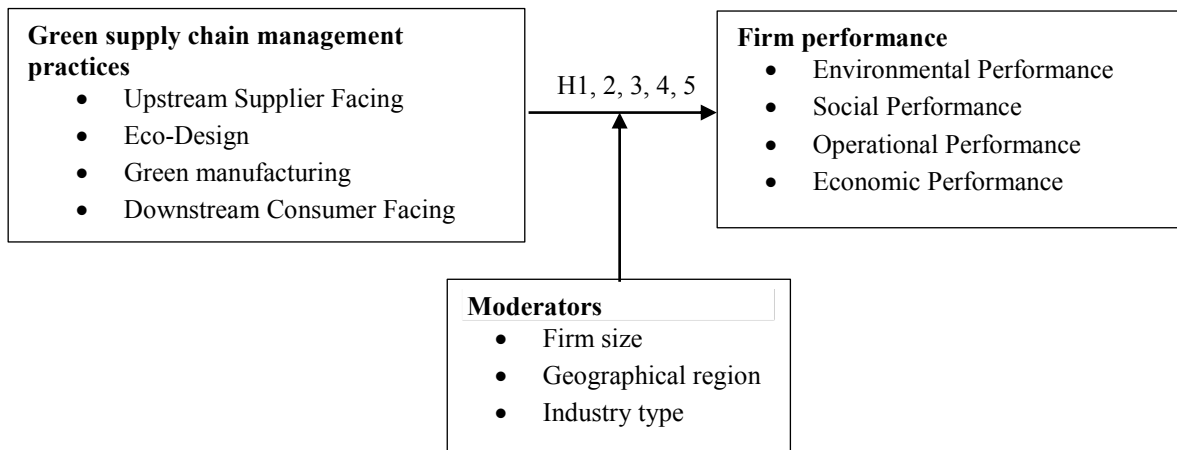


Fig 1. Research framework.

Upstream supplier facing includes activities that aim to ensure the purchased items are reusable, recyclable, and do not contain hazardous material [3,7,21]. Eco-Design is the design of products and services with environmental objectives and impact in mind [26–28]. Green manufacturing includes activities that aim for continues improvements of products and industrial processes to minimize harmful environmental impacts [22,29,30]. Downstream consumer-facing includes activities that aim to improve environmental capabilities of distributors, retailers, and consumers [1,16,21,31]. Environmental performance is concerned with saving energy and reducing emissions, pollution, and waste [7,11,14,19]. Social performance includes items such as corporate image improvement, reduction in environmental risks, improvement of the quality of life and health of workers and community through cleaner air and water, reduced emissions [3,21,22] etc. Operational performance is measured by cost reductions, product quality improvements, and improvements in delivery and flexibility [7,9,14,16,21]. Economic performance includes financial benefits such as an increase in market share, productivity, and sales [7,21,32,33].

Based on the definition of constructs of GSCM practices and firm performance in previous paragraph and literature reviewed several hypotheses are developed. Because the majority of the reviewed studies found a positive correlation between GSCM practices and firm performance including economic performance [34], environmental [7,21], social [3,22], and operational performance [2,21], the first hypothesis is proposed:

*H1: Implementation of GSCM practices positively impact firm performance.*

Zhu and Sarkis [7] found a positive relationship between the adaptation of GSCM practices and improvements in environmental and economic performance. Similarly, Zhu et al. [27,35] and other studies [18,19,21] found a positive and significant relationship between GSCM practices and economic and operational performance. Gimenez and Tachizawa [36] and several other articles [3,9,21,33] found that the implementation of GSCM practices positively impacts social and economic performance. Vachon and Klassen [16,37] found that cooperation with consumers and suppliers improves operational and economic performance. In sum, based on the above discussion and literature reviewed, it is hypothesized that:

*H2: Implementation of GSCM practices positively impact environmental performance.*

*H3: Implementation of GSCM practices positively impact social performance.*

*H4: Implementation of GSCM practices positively impact operational performance.*

*H5: Implementation of GSCM practices positively impact economic performance.*

It is worth noting that for each of the above hypothesis, we have tested four other sub-hypotheses, which consider

one by one constructs of GSCM practices and constructs of firm performance used in this study. Thus, in total, we have tested 25 hypotheses, and the outcomes of these hypotheses are presented in Section 4 of this study.

### 3. Methodology

Since the aim of this study is to synthesize and generalize the effect of GSCM practices on firm performance, a meta-analysis of empirical research [20] is the best approach to test our hypotheses. A meta-analysis of effect sizes of the focal link is conducted following recommendations from several studies [20,23] which can be used to generalize quantitative results of previous research [19]. The effect size used in this study is the Pearson product-moment correlation coefficient ( $r$ ), which have been used mostly in operations management research [20].

#### 3.1. Data collection and inclusion criteria

In line with the research objective of this study, we searched for empirical studies using keywords in SCOPUS and Web of Knowledge databases. The keywords used in the searching procedure include *sustainability, environmental, green, social, corporate social responsibility, supply chain, value chain, performance, outcome, benefit, practices, initiatives, activities, empirical, and quantitative*. These terms were combined using Boolean logic and references from two previous meta-analyses [18,19] were queried to look for any omitted study.

This searching process resulted in 350 articles after dropping the papers written in other languages than English and published in not peer-reviewed sources. To obtain only papers that test the link between GSCM practices and firm performance we read each abstract and screen content of each paper. This phase yielded 98 papers. Next, we started to extract and code data from each article and looked for possible articles that use the same sample. This is a critical step in meta-analysis since it ensures the independence of samples [20]. After removing articles that used the same sample and used the same constructs in more than one study [38], 85 independent studies were left for conducting the meta-analysis. We coded data from each article per each construct of GSCM practices and firm performance as well as data relating to moderating variables used in this study. The correlation coefficient was directly recorded if it was provided in the primary studies or it was derived from other statistics using formulas given by Lipsey and Wilson [44, p. 201].

#### 3.2. Meta-analysis procedures

Every effect size is first transformed into Fisher's  $z$  and after analyses were performed all results are transformed back to  $r$  correlation [20]. We used the fixed-effects model of meta-analysis because the selected papers included in this study examine the link between GSCM practices and firm performance [18]. If multiple effect sizes per study were reported in the primary articles, a single composite effect size is calculated using formulas by Hunter and Schmidt [23]. Next, we meta-analytically estimated mean correlation and calculated 95% confidence interval around the mean correlation. To examine the existence of moderators, a chi-square distributed statistic with  $k - 1$  degrees of freedom or  $Q$ -statistic is calculated [23], where  $k$  is number of samples. Finally, to provide confidence that publication bias is not a concern, we calculated the so-called file drawer number and Egger's regression. The failsafe analysis estimates the number of unlocated studies that would affect the overall significance of our findings [18,23]. Egger's regression test is often used to detect publication bias in meta-analyses [40]. In other words, if p-value of Egger's test is not significant, it means that there is no evidence to indicate publication bias. Analyses were performed in *Comprehensive Meta-Analysis (CMA)* software.

### 4. Results and their implications

To test our study's hypotheses, the correlation between multidimensional constructs of GSCM practices and firm performance was calculated.

*Table 1* depicts meta-analytic results. For each relationship we report: the number of independent samples ( $k$ ), total sample size ( $N$ ), the mean correlation ( $r$ ), the standard deviation ( $SE$ ), the 95% confidence interval around the mean ( $CI$ ), the chi-square statistic for heterogeneity ( $Q$ ), the failsafe number ( $N_{fs}$ ), and the Egger's regression intercept p-value ( $E_p$ ).

The total number of independent effect sizes is 85 with a sample size of 20011 firms. The overall association between GSCM practices and firm performance is significant and positive ( $r = 0.2912$ ,  $p < 0.001$ ). This indicates that

adaptation of GSCM practices is fruitful for companies and provides evidence in support of H1. Similar results are reported by previous meta-analysis [18,19]. Results also indicate that separately each GSCM practice is positively and significantly correlated with overall firm performance, but Eco-design has the highest impact on firm performance ( $r = 0.3604$ ,  $p < 0.001$ ). Similar results are also found in other studies [7,21].

The overall impact of GSCM practices on environmental performance is positive and significant ( $r = 0.3144$ ,  $p < 0.001$ ), with a sample size of 12089 firms. This supports H2 and among GSCM practices, green manufacturing and eco-design have the highest impact on environmental performance, with a mean correlation of  $0.5007$  and  $0.4883$ , respectively.

Table 1. Bivariate meta-analytic results.

	k	N	r	SE	5% CI	95% CI	Q	N <sub>fs</sub>	E <sub>p</sub>
H1: GSCMP <sup>a</sup> → firm perf	85	20011	0.2912	0.009	0.277	0.306	975.62***	5416	0.2750
H1a: UppSt → firm perf	53	13784	0.2650	0.011	0.248	0.282	727.20***	1938	0.0921
H1b: EcDsg → firm perf	45	8416	0.3604	0.013	0.339	0.382	330.34***	2117	0.4171
H1c: GrPrd → firm perf	26	5872	0.2582	0.016	0.232	0.284	216.64***	431	0.7424
H1d: DwnSt → firm perf	40	7795	0.3121	0.013	0.290	0.334	210.03***	1755	0.4651
H2: GSCMP → env perf	51	12089	0.3144	0.012	0.295	0.333	966.05***	1573	0.4283
H2a: UppSt → env perf	36	9518	0.2435	0.013	0.222	0.265	733.72***	647	0.2102
H2b: EcDsg → env perf	23	3623	0.4883	0.019	0.457	0.520	160.73***	900	0.9985
H2c: GrPrd → env perf	15	2388	0.5007	0.024	0.461	0.541	109.31***	315	0.4209
H2d: DwnSt → env perf	20	3347	0.3887	0.020	0.356	0.421	111.49***	514	0.7992
H3: GSCMP → soc perf	14	2313	0.3240	0.025	0.283	0.365	45.14***	232	0.8478
H3a: UppSt → soc perf	6	928	0.4481	0.038	0.386	0.511	16.57**	82	0.4120
H3b: EcDsg → soc perf	8	1491	0.2915	0.031	0.240	0.343	17.68*	89	0.9436
H3c: GrPrd → soc perf	4	580	0.2635	0.052	0.178	0.349	1.35	36	0.5711
H3d: DwnSt → soc perf	7	1158	0.2516	0.035	0.194	0.309	13.57	50	0.7949
H4: GSCMP → opr perf	39	8524	0.2913	0.013	0.270	0.312	343.83***	1211	0.1153
H4a: UppSt → opr perf	26	5229	0.3070	0.016	0.281	0.333	258.62***	483	0.2381
H4b: EcDsg → opr perf	24	5233	0.3020	0.017	0.274	0.330	147.08***	601	0.0479
H4c: GrPrd → opr perf	10	3589	0.1690	0.020	0.135	0.203	76.35***	54	0.2735
H4d: DwnSt → opr perf	24	4978	0.2647	0.017	0.237	0.293	95.02***	628	0.2756
H5: GSCMP → eco perf	53	12652	0.2888	0.011	0.271	0.307	558.56***	1938	0.7548
H5a: UppSt → eco perf	33	9521	0.2752	0.013	0.254	0.297	440.22***	709	0.7017
H5b: EcDsg → eco perf	32	4952	0.3415	0.016	0.314	0.369	226.73***	853	0.3930
H5c: GrPrd → eco perf	16	2355	0.2991	0.024	0.260	0.339	138.09***	85	0.5458
H5d: DwnSt → eco perf	26	4628	0.3201	0.017	0.292	0.348	156.63***	628	0.7835

**Notes:** <sup>a</sup>GSCMP means green supply chain practices; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

There are only 14 studies that have studied the link between GSCM practices and social performance. Our results suggest that this correlation is significant and positive ( $r = 0.3240$ ,  $p < 0.001$ ) and adopting green purchasing practices as well as collaborating with suppliers has the highest impact on social performance ( $r = 0.4481$ ,  $p < 0.001$ ). Thus, results provide evidence for supporting H3.

Our results indicate that correlation between GSCM practices and firm's operational performance is significant and positive ( $r = 0.2913$ ,  $p < 0.001$ ) and is tested in 39 studies, with a total sample size of 8524 firms. This result provides support for H4. Green purchasing and eco-design are the most positively correlated GSCM practices with

operational performance with a mean correlation of 0.3070 and 0.3020, respectively. Similar results were reported by Rao and Holt [33], and Younis et al. [9].

The relationship between GSCM practices and economic performance is strong and positive with a mean correlation of 0.2888 ( $p < 0.001$ ,  $N = 12656$ ). All other GSCM practices are significantly and positively correlated with economic performance. Economic performance benefits more from eco-design ( $r = 0.3415$ ,  $p < 0.001$ ) compared to other GSCM practices. Consequently, H5 is confirmed and results show that the adoption of GSCM practices is beneficial.

Publication bias is not a concern for our meta-analysis since failsafe numbers range between 36 to 5416, which indicate the number of studies to be found in the literature that are not included in our meta-analysis. Furthermore, none of the correlations have a significant Egger's regression p-value. Therefore, we may conclude that our results are robust.

A significant  $Q$  ( $p < 0.05$ ), suggests the existence of possible moderators. Table 2 shows the results of moderator analysis. Results indicate that mean correlation ( $r = 0.2781$ ,  $p < 0.001$ ) of large corporations is smaller than mean correlation ( $r = 0.2962$ ,  $p < 0.001$ ) of companies which are not large. This is in contrast with our expectations since large companies have more resources to implement GSCM practices [13]. Next, we grouped studies based on the geographical continent and results indicate that almost two-thirds of studies were conducted in Asia, with a mean correlation of 0.4412. This correlation is the highest among other continents and similar results are reported by Golic and Smith [18]. Two papers are classified under "World" as they include companies from different continents. Finally, moderator analysis indicates that companies in the automotive industry have the highest correlation ( $r = 0.4977$ ,  $p < 0.001$ ) between GSCM practices and performance compared to other industries. This is in line with results from the previous meta-analysis by Geng et al. [19] and Golic and Smith [18]. In this direction, Zhu et al. [27] highlighted that GSCM practices are widely adopted in the automotive industry.

Table 2. Results of moderator analysis.

	k	N	r	SE	5% CI	95% CI	Q	N <sub>fs</sub>	E <sub>p</sub>
Large companies	25	5385	0.2781	0.017	0.251	0.306	171.97**	499	0.1810
Other companies	60	14626	0.2962	0.010	0.279	0.313	802.64**	2601	0.6458
America	15	4380	0.1718	0.018	0.142	0.202	92.04**	133	0.4347
Europe	16	2820	0.3006	0.022	0.264	0.337	77.49**	298	0.0203
Asia	52	8315	0.4412	0.013	0.420	0.462	311.31**	4022	0.7018
World	2	4497	-0.0607	0.023	-0.098	-0.024	5.76*	N/A	N/A
Automotive	11	1200	0.4977	0.035	0.440	0.555	81.88**	82	0.4312
Electronics	8	1569	0.3979	0.030	0.348	0.448	33.16**	90	0.0905
Various industries	66	17242	0.2639	0.009	0.248	0.279	785.5**	3242	0.0612

Notes: \* $p < 0.05$ , \*\* $p < 0.001$ ; N/A – not enough data to be calculated.

This study makes a significant contribution in supporting previous results that GSCM practices have a positive impact on firm performance. The results from four constructs of GSCM practices in this study indicate that environmental sustainability incorporates all companies in the SC. Other studies might analyze GSCM practices under different constructs to examine if there is a difference between results presented in this study. Moderator analysis suggests that correlations of different firm sizes are almost the same, but correlations differ by a larger degree regarding the geographical region and industry type. We identified only two studies that investigated companies from more than one continent, thus we recommend to scholars to include companies in various geographical regions. This is necessary because global SCs include companies from different geographical regions. Likewise, results indicate that SC managers working in the automotive industry are more interested and have higher pressure to implement GSCM practices. Additionally, the results of this study reveal that SC managers of manufacturing firms should adopt a mix of GSCM practices and not only one specific GSCM practice to improve the firm performance. Thus, in this direction, the results from this study can be used to support SC practitioners in their reports and requests to top-management of the company, that there is a need to work together with suppliers and consumers in the same time to

achieve the desired sustainability performance.

It is worth to highlight that this study has several limitations. First, the decision about the studies included in the meta-analysis might be considered subjective, although a-priori constructs of both GSCM practices and firm performance are developed based on the literature reviewed. Second, although there is no indication of publication bias in our analysis, there might be other studies not included in our study that examine the link between GSCM practices and firm performance. Finally, we did not correct correlation coefficients in meta-analysis for any artifacts including measurement error, range restriction, and dichotomization of a truly continuous variable.

## 5. Conclusions and future research recommendations

This study synthesized the empirical literature on the relationship between GSCM practices and firm performance. Both GSCM practices and firm performance are operationalized using four constructs. The results show that the overall association between GSCM practices and performance is positive and significant. Findings also indicate that there is a need to work together with suppliers and consumers to achieve desired environmental, social, economic, and operational performance.

Because only 14 studies examined the effect of GSCM practices on social performance, we suggest future studies to be conducted in this direction. Future research should also consider if there is a difference in performance based on the pressures for implementing GSCM practices. It is also worthwhile to analyze in more detail the reasons why some industries and geographical regions have higher benefits from adopting GSCM practices. Only around half of the studies specify the underpinning theories for the link of GSCM practices and firm performance and various constructs were used to test this relationship. Thus, there is a need to develop a theoretical background and a more comprehensive framework of constructs. Finally, future research should expand GSCM practices to include social SC practices and test their impact on different dimensions of firm performance.

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