The impact of green practices, cooperation and innovation on the performance of supply chains using statistical method of meta-analysis

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Abstract. Businesses have to change their traditional methods to reduce the unfavourable processes of climate change and at the same time, sustainable business performance is also a basic requirement. The aim of this paper is to investigate the relationship between green practices, cooperation and innovation on the performance of supply chains. Meta-analysis of 35 publications was conducted to explore the relationship between the factors. We found a strong relationship between green practices and performance, and a moderate association between cooperation and performance and between innovation and performance, and these SCM factors are interrelated. For supply chain management, the use of green supply chain practice is strongly recommended, as

this factor has best increased performance. For further research, we suggest examining the associations between SCM practices.

Keywords: supply chain, performance, green practice, cooperation, innovation.

JEL Classification: G21, L26, O16

1. INTRODUCTION

Nowadays, the environment friendly approach plays an increasingly important role in economic processes. If management is committed to being environment-friendly, innovation can improve the efficiency of green practices. However it is not enough just to transform the company into activities to achieve the goal, but it is also worthwhile for company's partners to commit to a green approach.

Using meta-analysis, we examine here the impact of relationship, integration, green practices, and innovation on supply chain supply performance, calculating the relationship between these variables and performance, which is discussed in the method chapter.

First, we present the individual factors based on the articles involved in the study. Three meta-analysis methods are used: Hunter and Scmidt's method, Hedges' fixed-effect model and Rosenthal's and Rubin's random-effect model.

During the study, we first calculate the unfiltered correlation coefficient and then the partial correlation coefficient. Although we do not think that these areas can be treated separately, it is also important to know the direct effect. Our assumption is that all four areas have a positive impact on performance.

2. LITERATURE REVIEW

Companies can achieve other goals besides maximizing profit, for example: implementing environmentally friendly practices, creating innovation, building a good working relationship system with partners. Various performance indicators of the company may affect the profitability. If the above goals are met by the company, it may be interesting to see how they affect the company's performance and ultimately profit.

In supply chain management (SCM), different strategies are used to increase performance: lean SCM, agile SCM and their hybrid (Krykavskyy et al.*,* 2019). Lean SCM is not related to collaboration and performance, but agile SCM, on the other hand, is looking for collaboration and flexibility (Idzikowski & Perechuda, 2018). Because of the duality, the hybrid strategy cannot affect every performance component (Sukati et al., 2012).

2.1. Environment friendly practices

Green supply chain management (GSCM) is a new and evolving area of supply chain management. The GSCM has a number of areas that including internal and external management (Chan et al., 2012), green procurement (Chien & Shih, 2007), green retailing (Dabija & Pop, 2013; Dabija et al., 2018), environmental orientation (Chan et al., 2012), sustainability (Popp et al., 2018; Oláh et al., 2019) and return logistics (Vlachos, 2016; Slusarczyk & Kot 2018; Kot et al., 2018).

GSCM practices have a positive effect on performance, as demonstrated by numerous studies, however, the problem is very complex as different GSM practices have been studied and performance has been defined differently by researchers (Liu & Chang, 2017; Kliestikova et al., 2018; Filimonova et al., 2020). Song et al. (2017b) and Wang et al. (2018) emphasizes the influence of the size of the company. Environment

friendly practices influence on the performance depends on the type of GSCM because the reactive effect has positive impact while the proactive effect has no demonstrable influence (Laosirihongthong et al., 2013). The impact of GSCM on the performance are influenced positively by the suppliers (Vachon & Klassen, 2005), why the effect of the low cost strategy decreases it (Laosirihongthong et al., 2013). From the point of view of GSCM practices the company's performance can be divided into four areas: environmental, operational, economic and organizational (Green et al., 2012, Wang & Dai, 2018; Horecký, 2018).

The establishment of GSCM practices has two main dimensions, one ethical, which is an internal reason that comes from responsibility, the other dimension is an economic and political reason, which implies an external constraint (Zhu & Sarkis, 2004; Hartmann et al., 2015). The reason for political encouragement is that sustainable practices are economically and socially useful activities (Wang & Dai, 2018; Wang et al., 2018). The company's partners can also encourage the introduction of GSCM practices Zhu et al. (2013) to improve cooperation (Vachon & Klassen, 2005).

2.2. Integration and relationship

In our understanding the main characteristics of cooperation are integration and relationships. Integration steps have a positive impact on performance Rai et al. (2006; Tse et al. (2016); Zhang et al. (2016); Huo et al. (2017); Feng et al. (2017); Song et al. (2017a); Kovacova et al. (2018); Nikulin & Szymczak (2020), which is conveyed by or as part of the agility (Tse et al. 2016). Depending on the size of the company, this effect appears differently (Song et al., 2017a). Resource integration is one of the tools of market orientation, which is a performance enhancer (Lin et al., 2010; Meyer et al., 2016). Trust is important for cooperation (Al-Hakim& Wu, 2017; Cygler et al., 2018), and it has a positive effect on performance (Al-Hakim & Lu, 2017; Botezat et al., 2018; Fu et al., 2018). Fawcett et al. (2012) shed light on the importance of supply chain trust on the collaborative innovation. Collaboration is a higher level relationship than cooperation as in collaboration a common vision is involved which is not the case in cooperation. According to the research of Fawcett et al. (2012), foundation of trust leads to better collaboration, improves innovation and makes the performance more competitive. The trust effect only exists in long-term relationships, not on a case-by-case basis (Fu et al., 2018). The Chinese guanxi-based approach to culture promotes integration and thus plays an indirect role in improving performance (Feng et al., 2017).

Performance orientation can poison relationships, however, customer orientation helps to improve performance (Liu et al., 2018, Al-Hakim & Lu, 2017). The performance of the supply chain depends on the relationship with the customers, which can lead to a strategic partnership with SC members in which information sharing also essential (Sukati et al., 2012; Zhang et al., 2016; Rai et al., 2006). Information sharing is essential for strategic partnership development, although its effect on the performance is not always has been proved significant (Huo et al. 2017). Info communication tools play an important role in collaboration Rai et al. (2006); Huo et al. (2017) and thus indirectly affect performance (Zhang et al., 2016). Such a tool is the ERP system, which facilitates the integration in the supply chain through information sharing (Xu et al., 2017).

The SCM network is created from the international cooperation of companies, which creates a horizontal structure and focuses more on the core business (Chen & Paluraj, 2004). The more intense the competition, the closer the SC partners must work together (Chan et al., 2012).

2.3. Innovation

SC performance and stability is positively influenced by innovation Grawe et al. (2009); Meyer et al. (2016); Meyer & Meyer (2017), especially if the supply chain persists in the long run (Modi & Mabert, 2010). The key to the success of innovation is to focus on customers and/or competitors, because they help to

drive innovation, but the cost focus reduces the achievements in improvements (Grawe et al., 2009). One should also remember that it is necessary to effectively manage these innovation activities and to be able to quickly and flexibly respond to developments in the market (Lendel et al., 2016). Customer focus is also expressed by mass customization, which can better meet the needs of innovation, and creates value for customers that has a positive impact on performance (Flint et al., 2008).

Innovations in the supply chain have a positive impact on flexibility Arawati (2011) and performance Lin et al. (2010), although technical innovation in relationships is not necessarily present (Al-Hakim & Lu, 2017). Hong et al. (2018) emphasizes the importance of knowledge transfer as it promotes innovation and performance improvement. The extent of innovation is difficult to measure and it does not necessarily mean a great deal of improvement Modi & Mabert (2010), however the performance of new products from innovation can already be measured. The performance of the new product is influenced by two dimensions, technological and market newness. The product is the most successful when the technical innovation is low, but the market dimension is high in novelty, on the other hand, if the market's newness content is low, the new product may fail (Feng et al. 2016).

Due to the novelty of the GSCM practice, its relationship with innovation is not surprising (Hartmann et al., 2015). Innovations in this area are also supported by governments, and this innovation has a strong leverage effect (Joo & Suh, 2017). Nevertheless quality should not be overlooked in innovation, as it also has a positive impact on performance (Song et al. 2017c).

2.4. Meta-analysis

Meta-analysis helps to synthesize the results of already published studies, but the method has also disadvantages. So, we always have to consider making a large comprehensive meta-analysis or doing a relatively large-scale new research. The main advantage of meta-analysis is that a large sample can be tested compared to an independent study, but the choice of incorrect literature leads to erroneous conclusions, which is a major disadvantage of the method.

The meta-analysis is applied in many fields of science, for example, psychology, which used the method first (Papp, 2015). In economics, finance, in logistics, the impact of supply chain integration on performance and knowledge management were also researched by meta-analysis (Bhosale & Kant, 2016). Hunter & Schmidt (2004) emphasize the importance of meta-analysis noting that it has more statistical power than a single study. Ataseven & Nair (2017) analysed 40 publications to find relationships amongst internal and external integrations in supply chains. Bhosale & Kant (2016) used metadata analysis to explore the relationship between multiple dimensions of knowledge management and supply chain performance using scientific and industrial research. There are two articles found using the method of meta-analysis to research environmentally friendly practices (Geng et al., 2017a; Geng et al., 2017b). They found that GSCM practices improved performance of fore areas, operational, economic, social, and environmental performance.

3. RESEARCH METHOD

3.1. Hypotheses

In our study, we covered the areas that were most common in the selected articles, these areas include relationships, environmentally friendly supply chain practices, integration and innovation that are correlated with performance.

On the basis of the articles reviewed in the literature review and examined in the meta-analysis, it can be stated that performance is positively influenced by the green approach.

H1: The green supply chain practice has a positive correlation with performance, medium to strong.

Alashhab & Mlybari (2020) developing a robust green SC planning optimization model accentuate the positive relationship of green SC and maximization of network (SC) profit. Many examples can be found in recent publications to find positive relationship between firm performance and green SC practices. Ifran et al. (2020) proved in the textile industry that managing a greener SC with green product design is a critical requirement of the better performance. Cantele & Cassia (2020) noted that a greener, sustainable SC positively affects the business success if it is measured on competitiveness and customer satisfaction. The positive relationship of green SC practices and performance is published by Govindan et al. (2020) and Wong et al. (2020) dealing with different aspects of green SC and performance. Govindan et al. (2020) found the positive association improving over time, while Wong et al. call the attention on the importance of green customer integration in cost reduction that lead to better performance. When the green SC effect is examined on performance other factors modifying influence should also be taken into account as the paper of Agyabeng et al. (2020) suggests. Agyabeng et al. (2020) found that the effect of internal green supply chain practices on financial performance can be improved by applying green human resource management and supply chain environmental cooperation together.

H2: Performance has a medium to strong positive correlation with metrics describing the quality of relationships.

Handfield & Bechtel (2002) proved in their model that improving relationships amongst supply chain partners through building trust enhanced performance with developed supply chain responsiveness. Simpson et al. (2007) found that improving the relationship of supply chain members with increased relationship-specific investment the environmental performance was also enhanced. Similar results were found in Fynes et al. (2004) suggest that the quality of the supply chain relationship has a positive effect on supply chain performance, so the formation of a close partnership can result in better performance.

If the relationships persist in the long run, the merger creates different forms of integration. Therefore, in our opinion, integration also has a positive impact on performance, since integration is a higher level of relationships, it can have even a greater impact on performance.

H3: Integration is a medium to strong positive correlation with performance.

Lee et al. (2007) examined the relationship between internal integration and integration with the suppliers and found that as the internal and external integration increased the supply chain performance was also enhanced. They stated that the core issue in integration development in the supply chain was to give the supply chain partners access to the inventory information. Swafford et al. (2008) point out that integration by the means of IT causes higher supply chain flexibility, more agile supply chain and as a result, improved business performance, and the improvement in IT is an initiator of enhancement for the other investigated factors. Flynn et al. (2010) examining supply chain integration effect on operational and business performance found that there was a positive relationship, and integration on different levels of the supply chain affected differently the overall performance of the supply chain.

H4: There is a medium to strong correlation between innovation and performance.

Lee et al. (2011), examining the impact of supply chain innovation on organizational performance, found a positive relationship and stated that innovative SC design enhanced collaboration with SC members, increased efficiency, and also improved quality management performance. Zhu et al. (2004) classified manufacturers into three groups depending on the level of GSCM innovation. These groups are early adopters, followers, and laggards, and have demonstrated that the impact of innovation depends on the intensity of innovation. Manufacturers in the group of early adopters' performance was higher than the performance of the other two groups. The innovative feature of a supply chain depends on the relationship of the SC members in which the key SC partner's innovativeness has a decisive role. If a SC member is in a

good relationship with the key SC partner it's the effect of this partner on SC innovation strategy is increased.

3.2. Test sample

The items involved in the study were published between 2004 and 2018. In the 35 articles included in the study, we searched for relationships between the most common factors and performance indicators, these indicators are correlation coefficients and path coefficients in some publications. The goodness of the size of the meta-analysis is described by the fail-safe number (Field & Gillett, 2010). The number of studies selected in our publication is comparable to the number of publications used in meta-analysis in different research areas. Floyd et al. (2014) used 26 studies to determine the relationship between online product reviews and retail sales. Moghimi et al. (2016) meta-analysed the factors of selection, optimization, and compensation (SOC) strategies in the workplace and grouped the SOC elements into positively related and non-significant association groups, selecting 26 publications. By meta-analysis, which was used for 33 publications, Hughes-Morgan et al. (2018) studied how competitive actions affect firm performance and suggest strong factors for managers to increase competitiveness.

3.3. Method

Meta-analysis method was applied to the topic to collect and analyse data. The main advantages of meta-analysis are that the meta-analysis method is an evidence-based approach and is based on more data than an individual study and consists of publications in different fields, thus achieving a higher level of generalization than the initial publications. There are some disadvantages of the meta-analysis. One disadvantage is that it necessitates relatively complicated statistical procedures. A further disadvantage of using meta-analysis is that it takes a lot of time and energy to gather applicable publications and extract useful information from them.

Performing meta-analysis, according to Field & Gilett (2010), path coefficients (Loehlin, 2004) and correlation coefficients were used (Kerékgyártó et al., 2009). After the calculation of correlation coefficients, the estimation of the value of the correlation coefficient for the whole population is performed (Field, 2001; Hunter & Schmidt, 2004; Field & Gillett, 2010). Then the quality of the resulting indicator should be determined with a confidence interval or other indicator (Hunter & Schmidt, 2004; Ataseven & Nair, 2017).

There are other methods for determining population correlation, such as the fixed and random model (Field, 2001; Zygmunt, 2018; 2020). The goodness of the quantity of the article involved in the meta-analysis is measured by the fail-safe number published by Rosenthal (1978) and Rosenberg (2005).

Field & Gillett (2010) define the list of tasks needed for meta-analysis in six steps.
1) Selection of publications using key words.
2) Selection of publications related to the criteria of the study based on objective evaluation.
3) Calculation of statistical metrics (for example: correlation coefficients).
4) Estimate the importance of this indicator in the study population.
5) Is there a publication in our study that could influence the outcome?
6) Description of important results obtained.

The fourth step is to decide whether to perform a meta-analysis of a fixed effect or a random effect. Social science research generally assumes random effects, Hunter & Schmidt (2004) give a method for this. The mean effect sizes can be calculated by using the formula bellow (Eq. 1). The following method and formulas are included in Field (2001), which form the basis of the analysis of our study.

$$\bar{r} = \frac{\sum_{i=1}^{k} n_i r_i}{\sum_{i=1}^{k} n_i} \tag{1}$$

The weighted average of the correlation indices reported in each study gives an estimate of the correlation between the two variables, where weights are the number of observations in each study. Then the weighted sample standard deviation squared ($s_r{}^2$) for each correlation (r) is calculated, where the number of observations (n_i) is the weighting factor (Eq. 2):

$$s_r^2 = \frac{\sum[n_i(r_i-\bar{r})^2]}{\sum n_i} \tag{2}$$

If the standard deviation does not exist or is small, the computed correlation is well representative of the population.

Hunter and Schmidt suggest using interval estimation to analyse the differences between correlations, using the formula (Eq. 3):

$$\bar{r} \pm z_{\alpha/2}\sqrt{\sigma_\rho^2} \, , \tag{3}$$

where,

$$\sigma_\rho^2 = s_r^2 - \frac{(1-\bar{r}^2)^2}{\bar{N}-1} \, , \text{ where } \bar{N} = T/K. \, , \text{ T total number of samples, K number of studies} \tag{4}$$

The formula gives the lower and upper values of the population correlation coefficient. In the formula, z is the value where the distribution function of the normal distribution is 1-α / 2.

One of the decisive arguments for using the fixed or random effects model is the homogenity of the studies, because if the studies are homogeneous, then the effects are fixed in the studies, so we can choose a fixed effect model. Schi-square statistic can be used to calculate homogeneity of effect size (Eq. 5).

$$\chi^2 = \sum_{i=1}^{k} \frac{(n_i-1)(r_i-\bar{r})^2}{(1-\bar{r}^2)^2} \tag{5}$$

Where, the n_i is the samle size the correlation is calculated from. If the value of the chi-square statistic is lower than the confidence level quantile, the publications can be considered homogeneous.

Hedges and Olkin and Rosenthal and Rubin developed two similar meta-analysis methods. There are two significant differences between the two, the Rosenthal method ignores the random effect, and effect sizes have to be combined according to Rosenthal. As a first step in the methods, Fisher's z values should be calculated from the correlation coefficient r for each study (Eq. 6):

$$z_{r_i} = \frac{1}{2}\ln\left(\frac{1+r_i}{1-r_i}\right) \tag{6}$$

The transformed effect size is determined using weights in a way that the ith publication has the weight of that actual paper (Eq. 7).

$$\bar{z}_r = \frac{\sum_{i=1}^{k} w_i z_{r_i}}{\sum_{i=1}^{k} w_i} \tag{7}$$

With optimal substitution $w_i = n_i - 3$ the same effect size can be calculated (Eq. 8).

$$\bar{z}_r = \frac{\sum_{i=1}^{k}(n_i-3)\bar{z}_{r_i}}{\sum_{i=1}^{k}(n_i-3)} \tag{8}$$

Sampling variance of the average effect size is determined from the weights of studies (Eq. 9).

$$SE(\bar{z}_r) = \sqrt{\frac{1}{\sum_{i=1}^{k} w_i}} \tag{9}$$

The variance (v_i) at Fisher's z value is given by the following formula (Eq. 10).

$$v_i = \frac{1}{n_i - 3} \tag{10}$$

Then the standard error of the formula calculated as follows (Eq. 11).

$$SE(\bar{z}_r) = \sqrt{\frac{1}{\sum_{i=1}^{k}(n_i - 3)}} \tag{11}$$

From this it is already possible to obtain the Z-value of the average effect size, which is a kind of goodness indicator of the obtained effect size, the equation of chi-square statistics is bellow (Eq. 12).

$$Q = \sum_{i=1}^{k}(n_i - 3)\left(z_{r_i} - \bar{z}_r\right)^2 \tag{12}$$

The method described above is an example of a fixed-effect model, but can be used to make a random-effect model, which is also found in the cited literature (Field, 2001; Field & Gillett, 2010; Rosenberg, 2005).

Random effect model (Eq. 13-16):

$$\bar{z}_r = \frac{\sum_{i=1}^{k} w_i^* z_{r_i}}{\sum_{i=1}^{k} w_i^*} \tag{13}$$

$$w_i^* = \left(\frac{1}{n_i - 3} + \tau^2\right)^{-1} \tag{14}$$

$$\tau^2 = \frac{Q - (k-1)}{c} \tag{15}$$

$$c = \sum_{i=1}^{k}(n_i - 3) - \frac{\sum_{i=1}^{k}(n_i - 3)^2}{\sum_{i=1}^{k}(n_i - 3)} \tag{16}$$

The fifth step is to measure the goodness of the study, which is the reliability of the meta-analysis. There may be studies that have not appeared and they may contain data that may contradict our results. Thus, it is necessary to examine how many unpublished studies would be able to refute the results obtained. One way is to do it the fail-safe N recommended by Rosenthal. The problem with this is that it does not take into account the size of the samples in the studies. To calculate the fail-safe N, the z-value for the study must be calculated from the observed correlation coefficient. Then the value of the Rosenthal fail-safe N is determined in Eq. 17.

$$N_{fs} = \frac{\left(\sum_{i=1}^{k} z_i\right)^2}{2{,}706} - k \tag{17}$$

Where k is the number of studies included in the study, 2,706 is the square of the quantile of the standard normal distribution at the 95% confidence level (Rosenberg, 2005; Field & Gillett, 2010). The

suggestion is that the number of studies should be multiplied by five and then ten should be added, and if this value remains below the fail-safe N, the research result is reliable.

4. RESULTS AND DISCUSSIONS

4.1. Correlation coefficients

In the first column (Table 1) the k values are for the number of studies involved, and correlation coefficients of fixed and random effects are also included in the table (Eq. 1, Eq. 6).

Table 1

Correlation coefficients

	Hunter-Schmidt	Fixed effect	Random effect
Relationship (k=19)	0,37	0,44	0,42
Green practice (k=17)	0,53	0,60	0,59
Integration (k=12)	0,43	0,47	0,46
Innovation (k=14)	0,36	0,52	0,48

Source: Author's own research, 2020.

These correlation coefficients have a moderate and strong effect on performance in terms of the factors studied (Guilford, 1950). All the four factors has moderate correlation, substantial relationship with performance except relationship and innovation in the Hunter smith model where the values are 0.37 and 0.36 respectively.

The strongest effect is the green practices on performance. While Hunter-Schimdt's lowest impact is due to innovation, the relationship dimension is similar. According to the other two methods, the relationship is the last, and innovation is the second most influential factor. The reason for this divergence would be worth examining later. Thus, the smallest effect among the variables examined is probably between relationship and performance.

So environment friendly practices are not only important to save the nature in today's world, but they are also useful to make business performance better which finding is similar to the majority of papers dealing with the topic (Liu & Chang, 2017). The moderate impact of innovation in the Hunter-Schmidt model can be because innovation can be risky, which may have a worse impact on performance. Another reason for the moderate impact of innovation may be that it is more difficult to measure innovation than other factors. Innovation can affect not just directly the performance, but it effects through the other features of the supply chain (Grawe et al., 2009; Meyer et al., 2016). Because each factor is in a medium or strong correlation range, it's worth paying attention to each one.

According to Hunter-Schmidt, calculation correlation (Eq. 3), on the other hand, it shows how real the result is. In the Hunter-Schmidt column, the first indicators are in line with the interval in Table 2. Calculation of confidence interval of Fisher's z values can be done by using $\bar{z}_r$ and $\mathrm{SE}(\bar{z}_r)$ values. Then the Fisher's z values are transformed to correlation applying the inverse of the equation 6 (Eq. 6). Determination of the confidence interval of random effect model is performed as the fixed effect model based on the Fisher's z values.

Table 2

Confidence interval

	Hunter-Schmidt		Fixed effect		Random effect	
	Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Relationship	-0,05	0,79	0,42	0,47	0,3	0,52
Green practice	0,14	0,92	0,59	0,62	0,49	0,69
Integration	0,08	0,77	0,45	0,5	0,32	0,58
Innovation	-0,04	0,75	0,5	0,54	0,33	0,6

Source: Author's own research, 2020.

The intervals in the Hunter-Schmidt column are the largest, while they are the lowest in the fixed-effect model. The intervals between the fixed and random models do not change the quality of the tightness of the connection. In the Hunter-Schmidt column, since the intervals are high, our conclusion can be only that the positive effect is more likely here. The factors of relationship and innovation have negative values in Table 2, that means that these two categories may have no effect on performance. The two dimensions, relationship and integration lie at the two ends of the Hunter-Schmidt interval magnitude order, but the order is changing in every model. Relationship has the widest, while integration has the narrowest confidence intervals. However each interval in the Hunter-Schmidt method is broad which indicates a great variety of studies.

The results show that the extent of the interval in the Hunter-Schmidt model and the random model is influenced by the number of studies involved. In the Hunter-Schmidt model, the more studies are included in the study, the wider the confidence intervals are, and however, the situation is reversed in the random model.

Our results are in line with the publication of Walker et al. (2008), the random effect model resulted in wider confidence intervals than the fixed effect model due to the heterogeneity of the studies.

Because of the great variety, the question is whether the studies involved in the research can be considered homogeneous. The results of the homogeneous tests are shown in Table 3. The Hunter-Schmidt homogeneity test can be calculated with Eq. 5, the fixed effect and random effect test are determined using Eq. 12.

Table 3

Homogeneity test statistic

	Hunter-Schmidt	**Fixed effect**	**Random effect**
Relationship	270,68	318,08	19,61
Green practice	348,49	386,08	11,69
Integration	137,78	203,54	9,09
Innovation	364,95	664,86	8,33

Source: Authors' own research, 2020.

To determine homogeneity, the following limits are calculated: 30.14 for the relationship; 27.59 for green practice; and 21.03 for integration and 23.68 for innovation. Heterogeneity can be observed in the

Hunter-Schmidt model and in the fixed-effect model, while in case of the random effect model homogeneity cannot be discarded, thus, the presence of an effect in the background cannot be ruled out in the first two methods. The measure of homogeneity is broadly in line with the confidence interval test results, where heterogeneity is high, the confidence interval is broader. Here, the greater the number of studies, the more heterogeneous the population that can be observed by all methods.

Finally, fail-safe numbers were calculated to check that the number of articles is correct. In the study, the fail-safe number for Rosenthal was as follows: relationship: 4963 (105 required), green practices: 10628 (95 required), integration: 2714 (70 required), and innovation: 6068 (80 required). So it can be seen that it is no longer necessary to include more articles in the study, but if more studies are added the relationships between the metrics can be even clearer.

4.2. Partial correlation coefficients

The calculation of partial correlation coefficients gives a clearer picture of the relationship between each indicator and performance. In this way, the relationship between the two variables is independent of any effect of the study. The partial correlation coefficient is calculated as the inverse of the correlation matrix, where the elements are denoted by P and the names of the variables are in the index. Calculation of partial correlation coefficients is similar to the calculation of correlation coefficients (Eq. 1) just here partial correlation coefficients are used instead of simple correlation coefficients.

In table 4, the number after each category represents the number of studies involved, correlation coefficients are also included in the fixed and random columns.

Table 4

Partial correlation coefficients

	Hunter-Schmidt	Fixed effect	Random effect
Relationship (k=16)	0,14	0,19	0,15
Green practice (k=15)	0,35	0,44	0,4
Integration (k=11)	0,23	0,27	0,24
Innovation (k=11)	0,24	0,31	0,27

Source: Author's own research, 2020.

These partial correlation coefficients have a weak and moderate direct effect on the performance of the studied factors. The strongest effect is the green practices on performance, while the lowest effect is determined by the relationship dimension according to all three methods. Here, innovation is the second-largest impact on performance, according to the Hunter-Schmidt method, although integration is also close to the Hunter-Schmidt model that was indicated by the anomaly described at the correlation coefficient.

Here, too, the positive impact of green practices on business performance is demonstrated, as above. The magnitude of the direct impact of innovation shows that it is worth doing well in this area. This statement holds true because innovation is more effective than integration or relationships.

Calculating the confidence interval plays an important role in showing the range of most likely values in the population correlation, on the other hand, it shows how real the result is. In the Hunter-Schmidt column, the first indicators are in line with the interval in Table 5. The first index for the last three dimensions exceeds the 2 limit. In the case of innovation, the number is very high. This is because the correlation scatter within the sample and the degree of error are very small, so the average correlation is divided by a small number.

Table 5

Confidence interval

	Hunter-Schmidt		Fixed effect		Random effect	
	Lower	Upper	Lower	Upper	Lower	Upper
Relationship	-0,23	0,51	0,16	0,23	0,04	0,27
Green practice	0,05	0,65	0,42	0,47	0,3	0,5
Integration	0,1	0,36	0,23	0,31	0,18	0,30
Innovation	0,19	0,28	0,29	0,33	0,22	0,32

Source: Author's own research, 2020.

The intervals in the Hunter-Schmidt column are the largest, while the lowest in the fixed-effect model. The intervals between the fixed and random models do not change the quality of the tightness of the connection. In the Hunter-Schmidt column, since the intervals are high, it is only possible to determine that the positive effect is more likely. Exception is the innovation, because there is a relatively narrow interval. Thus, the partial correlation coefficient calculated for innovation describes well the direct effect on performance. In case of a connection, zero and negative values are not excluded from the interval. So the direct impact of the connection can be slightly negative for performance. Due to the wide intervals of the Hunter-Schmidt method, this reflects the diversity of studies.

It is also true that the number of studies involved shows a correlation with the magnitude of the confidence interval in Hunter-Schmidt model and in the random model.

Because of the great variety, the question is whether the multitude of the studies involved can be considered homogeneous. The homogeneous test serves this purpose, the values of which are shown in Table 6.

Table 6

Homogeneity test statistic

	Hunter-Schmidt	Fixed effect	Random effect
Relationship	140,75	177,54	20,68
Green practice	131,43	169,97	8,29
Integration	23,89	29,01	9,66
Innovation	14,24	37,7	6,13

Source: Author's own research, 2020.

In order to decide on homogeneity, the limit should also be set, which is: relationship 26.3; green practice 25; 19.68 for integration and 19.68 for innovation. In Hunter-Schmidt and in the fixed-effect model, heterogeneity can be observed, while in case of random effect homogeneity cannot be discarded. The test sample is not heterogeneous in the Hunter-Schmidt model for innovation. So, with the first two methods, the presence of a background effect, except for innovation, cannot be ruled out. The measure of homogeneity is broadly in line with the confidence interval test results, where heterogeneity is high, the

confidence interval is broader. It is also observed here that the greater the number of studies involved, the more heterogeneous the population. This can be observed more in connection with Hunter-Schmidt and the fixed-effect model than with the random effect, where it is not possible to observe such a relationship.

Finally, it is necessary to examine whether the number of articles covered is appropriate. In the study, the fail-safe number for Rosenthal was as follows: relationship: 409 (90 required), green practices: 3039 (85 required), integration: 551 (65 required) and innovation: 1488 (65 required). So no more publications needed to include in the study, but adding in more, the relationships between the different metrics can be better characterised.

Summarizing the results of the study, there are some important findings for management that can be used to improve company performance. According to the common opinion on the protection of the environment, the avoidance of pollution and the use of fossil energy, it has a negative effect on the performance of businesses or economies. Despite the general opinion, the application of green practices has a significant impact on performance, so it is highly recommended that company leaders think about developing GSCM. About the other examined factors we can say that relationship, integration and innovation are similarly important to deal with, all the factors affects each other and it is obvious from the results of the study that the interaction of these factors is essential. The consequence of this interaction is, that because of the lack of detailed knowledge about their relation each of them is significant factor to enhance SC performance. Thus, a concise consequence of the research for SCM is that the relationship, GSCM, integration and innovation factors significantly affect firm performance, however, the impact of GSCM and innovation is significantly higher than the others and every factor of the study need to be maintained with because they are interconnected with each other.

5. CONCLUSIONS

In the case of green practices, we found a strong relationship with performance and a negative and zero value is unlikely. The confidence interval is very wide in the Hunter-Schmidt model, which would be worth exploring further. There is a strong heterogeneity associated with this, with the exception of the random model. The remaining effect after filtering out other effects has a moderate relationship with performance.

Cooperation means two concepts: relationship and integration. Meta-analysis studies show a moderate relationship with cooperation dimensions and performance. In the case of a cooperation, the negative and zero values in the Hunter-Schmidt model are not excluded. Thus, the presence of the effect is questionable, and its clarification may be the subject of a subsequent investigation. There is a high degree of heterogeneity between the data except the random model. The partial correlation coefficient indicates a weak direct effect. The negative dimension of performance in the cooperation dimension cannot be ruled out.

Innovation has a moderate impact on performance. Zero is included in the confidence interval. So the effect is questionable, but the probability of the correlation coefficient being zero is very small. Confidence intervals and heterogeneity indicate high variability in the data in Hunter-Schmidt and in the Fixed Model. It has a medium direct relationship with performance. The confidence interval for the partial correlation coefficient is relatively narrow, and the value of the variance is also very low. This indicates that the correlation coefficients in the articles were influenced by other variables. But when these effects were filtered out, the variability was gone. The population is homogeneous, except for the fixed-effect model.

All the hypotheses were verified. So it is worth taking steps in the area under investigation. Co-operation should also be strengthened, because a good relationship with partners is needed for the other two areas. This is also evidenced by the partial correlation coefficient of green practices and innovation.

Based on the values of the fail-safe number, the analysis is appropriate because the number of studies involved in the study is not low anywhere.

In our research, an interesting dual feature can be discovered in innovation. The effect is the third strongest variable on the Hunter-Schmidt model, while it is the second strongest explanatory factor in the second and third tests that reason would be worth to investigate further.

The limitations of this study are related to the limitation of the meta-analysis itself and this specific research. Walker et al. (2008) described the limitations of meta-analysis, pointing to four critical issues. First, selection of studies for the analysis may involve many possibility of bias. Second, the heterogeneity of the results of the selected publication can affect negatively the meta-analysis research. Another limitation of the method is that individual publications do not provide sufficient information to include the study into the analysis. Finally, data analysis can also be a constraint, namely which model of meta-analysis is used in the research process. In this study, the steps of the meta-analysis were applied systematically, taking into account the above limitations, to minimize biases due to the limitations of the method. To eliminate the model selection problem, we used both fixed effect and random effect models in the analysis.

Based on the results, further research directions can be carried out. It would be important to explore the reason why there is a positive relationship between green practices and performance, yet there is a wide confidence interval in the Hunter-Schmidt model. Further research could answer the question why the association between relationship and performance, and integration and performance is doubtful, as the confidence interval values of these factors are negative in the Hunter-Schmidt model. It would worse more investigation why the factor of innovation's effect is lower in the Hunter-Schmidt model than in the fixed effect and random effect model. The results show that there is a correlation between the size of the coated test substance and the size of the heterogeneity and confidence interval within the chosen methods. It can be examining later whether there is a correlation between them and, if so, what the reason may be. Furthermore, the most important further research is to determine the association between SCM factors.

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