

## GREEN SUPPLIER DEVELOPMENT IN SUPPLY CHAIN – PRACTICAL APPLICATION

Piotr C. SOSNOWSKI

University of Lodz, Faculty of Management; piotr.sosnowski@uni.lodz.pl, ORCID: 0000-0002-3573-6718

**Purpose:** Reducing negative environmental impacts attracts a lot of attention among company managers around the world, which is related not only to fostering the idea of sustainable development, but also introducing the concept of circular economy. It includes sourcing and purchasing managers that are responsible for the cooperation with suppliers. One of the concepts related to this kind of cooperation is Green Supplier Development (GSD). The purpose of this article is to determine the scope of implementation of the GSD concept in production companies operating in Poland.

**Design/methodology/approach:** The author adopted mixed research design approach. The research methods used in this study are the systematic literature review and a survey conducted using the Computer-Aided Telephone Interview technique (CATI). The reviewed literature is directly related to the concepts of GSD and green supplier evaluation that can be used to select suppliers for GSD programs. The empirical study focuses on the practical aspects of GSD implementation.

**Findings:** The results concern the scope of implementation of the GSD concept, including company involvement in GSD programs, conducting GSD activities, and selecting suppliers for collaboration in the area of GSD. Furthermore, conducting GSD activities might be seen as a part of the cycle that might result in continuous improvement of environmental performance and continuous reducing of the negative environmental impact.

**Practical implications:** The main implication for business is related to the participation in GSD programs. If only the minority of companies in the sectors studied participate in such programs, then this kind of participation might be a source of competitive advantage.

**Social implications:** The main implication for government is related to facilitating possibilities of organising or participating in GSD programs or conducting GSD activities, such as tax reliefs for companies investing in this kind of operation.

**Originality/value:** The originality of this paper lies in determining the scope of implementation of GSD concept and using GSD practices in Poland.

**Keywords:** green supplier development; environmental supplier evaluation; green supplier evaluation, environmental management.

**Category of the paper:** Research paper.

## 1. Introduction

We can observe the increasing environmental requirements of clients and the implementation of environmental regulations by institutions in many countries. It is related not only to fostering the idea of sustainable development, but also introducing the concept of circular economy. As a result, management of many companies introduced practices to reduce the negative environmental impact not only in individual companies, but also across supply chains.

The purpose of this article is to determine the scope of implementation of the Green Supplier Development (GSD) concept in production companies operating in Poland. To do so, a literature review was performed and the Computer Aided Telephone Interview (CATI) survey study was conducted.

The originality of this paper lies in determining the scope of implementation of GSD concept and using GSD practices in Poland. It should be noted that there is lack of comprehensive studies on the implementation of the GSD concept, both in Poland and worldwide. It is in contrast to other topics related to reducing negative environmental impact in the supply chain, e.g., green supply chain management.

Different scholars link GSD with the introduction of GSD practices, e.g., Bai et al. (2019), or GSD programs, e.g. Pourjavad and Shahin (2020). To simplify the content of this paper, whenever GSD practice is mentioned, it also includes GSD programs.

This paper is structured in the following way. First, the GSD and green supplier evaluation concepts are described. Second, the research methodology is outlined. The results of the literature review and the CATI study are presented. Then the implications for business and for government are discussed. Subsequently, recommendations for future research are presented. Finally, the conclusion is drawn.

### 1.1. GSD concept

GSD is described as ‘the activities that aim to improve green capabilities of suppliers’ (Blome et al., 2014). Such activities include developing suppliers in case of improvable green performance, instead of terminating cooperation with them, visiting supplier plants in order to help them to improve their environmental performance, communicating with them on green performance matters acknowledging their green performance, e.g. through supplier awards. It should be noted that activities related to GSD might result from green supplier evaluation, as a basis for determining the environmental performance of suppliers.

Bai and Sarkis (Bai, Sarkis, 2010) developed a comprehensive classification of practices related to GSD. It was divided into three groups: green knowledge and communication, investment and resource transfer and management, and organizational practices. The first two groups are related to transferring financial and nonfinancial (both material and nonmaterial)

resources to suppliers. The last group is related to joint planning goals with suppliers and performing joint activities with them. These actions aim to reduce the negative environmental impacts of suppliers.

Fu et al. (Fu et al., 2012) proposed a different approach. They listed three groups of activities related to reducing negative environmental impacts of suppliers: programs related with reducing environmental impacts of suppliers, programs related with environmental compliance of suppliers, and joint development of solutions aimed at reducing negative environmental impacts.

Furthermore, GSD is positively related to green purchasing (Blome et al., 2014). Therefore, the possibility of the existence of the link between these two concepts will be taken into account. Furthermore, GSD is positively related to supplier performance (Blome et al., 2014), innovativeness (Bag et al., 2018) and adoption of green supply chain management (Nkrumah et al., 2021).

GSD practices can be divided into two groups: environmental cooperation and environmental collaboration with suppliers (Sosnowski, 2019, p. 333). Environmental cooperation includes practices requiring passive involvement of suppliers, e.g., monitoring supplier environmental performance using data obtained from a supplier. On the other hand, collaboration includes joint actions with suppliers, e.g. joint planning environmental goals and joint actions with suppliers.

Furthermore, environmental cooperation also includes the use of environmental criteria in supplier selection and supplier assessment, and also the green supplier evaluation (see Table 1).

**Table 1.**  
*Overview of GSD practices*

Type of practice	GSD practices	Source
Environmental cooperation	Monitoring the environmental performance of suppliers	(Bai, Sarkis, 2010; Thakker, Rane, 2018)
	Using environmental criteria in supplier selection	(Bai et al., 2019; Bai, Sarkis, 2010)
	Using environmental criteria in supplier assessment	(Bai, Sarkis, 2010; Thakker, Rane, 2018)
	Conducting environmental supplier evaluation/green supplier evaluation	(Awasthi, Kannan, 2016; Bai et al., 2019; Bai, Sarkis, 2010; Thakker, Rane, 2018)
	Green knowledge transfer	(Bai, Sarkis, 2010)
	Investing in the environmental practices of suppliers	(Bai, Sarkis, 2010)
	Transfer of non-financial resources to suppliers (to enable them to achieve their environmental goals)	(Bai, Sarkis, 2010)
	Organization of trainings for suppliers on environmental issues	(Fu et al., 2012)

Cont. table 1.

Environmental collaboration	Joint planning of environmental goals with suppliers	(Bai, Sarkis, 2010; Fu et al., 2012; Thakker, Rane, 2018)
	Joint planning of environmentally friendly processes with suppliers	(Fu et al., 2012)
	Joint design of environmentally friendly products with suppliers (eco-design)	(Fu et al., 2012)
	Performing joint environmental activities with suppliers	(Bai, Sarkis, 2010; Fu et al., 2012; Thakker, Rane, 2018)
	Introducing environmental programs with suppliers	(Fu et al., 2012)

Source: own elaboration.

It should be noted that using environmental criteria in supplier selection or supplier assessment is not the same as conducting a green supplier evaluation or environmental supplier evaluation.

## 1.2. GSD and green supplier evaluation

Awasthi and Kannan (2016) described green supplier evaluation as a practice aimed at determining the effectiveness of GSD programs. They took into consideration inputs (time, costs, labor, resources, energy usage, and water), outputs (emissions, noise, waste), and processes (green packaging, green manufacturing, green product design, green transportation, green warehousing, green procurement, and reverse logistics) as criteria categories. It enables the company that has introduced the GSD program to evaluate it through the lens of the activities and results of the suppliers. Criteria for green supplier evaluation may include green design, pollution prevention, green image, green capability, and environmental policy (Akman, 2015).

However, some scholars took a different approach. Bai et al. (Bai et al., 2019) distinguished two types of green supplier evaluation: green supplier evaluation for selection and green supplier evaluation for development. The first kind aims to determine whether the supplier is best suited for cooperation in the context of its environmental impacts. The purpose of the second kind is to establish whether the supplier is best suited for development related to its environmental impacts. They also listed (Bai et al., 2019) environmental performance attributes (resource consumption, pollution release, green products) and environmental practice attributes (e.g., pollution control, green design) for green supplier evaluation for development. Criteria for green supplier evaluation for development (GSD program criteria) include operational performance measures (e.g., cost and time) and environmental performance measures, e.g., energy usage, emissions (Pourjavad, Shahin, 2020).

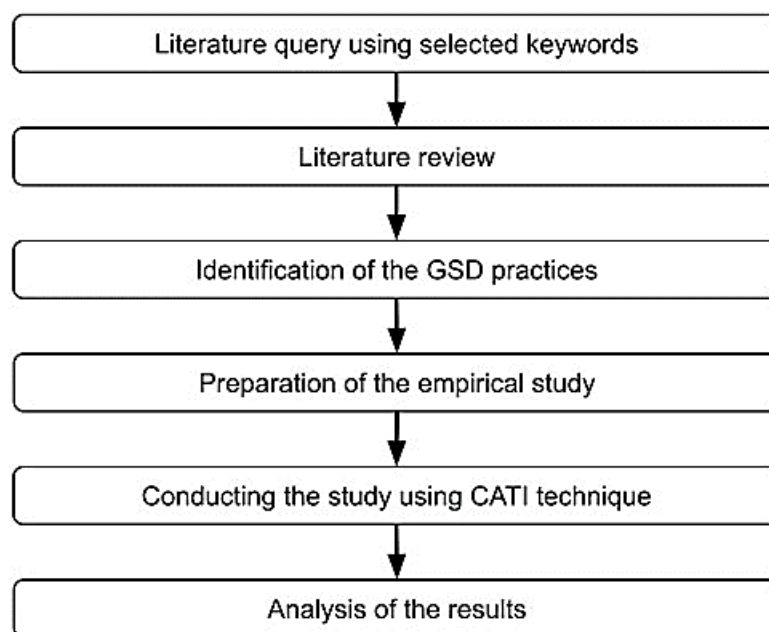
Sosnowski (2022) defined environmental supplier evaluation as a set of systematic and objective activities - such as preliminary assessment, periodic assessment and assessment of the impact of cooperation with the supplier on the buyer-company and the supply chain - aimed at assessing the supplier's activities, capabilities, and effectiveness in reducing various negative environmental impacts. Hence, it might but does not have to be used as a selection tool for the

GSD program. Additionally, both GSD and green supplier evaluation are listed as areas of green supply chain management (Pourjavad, Shahin, 2020).

The evaluation areas for GSD are the following (Bai et al., 2019; Pourjavad, Shahin, 2020): resource consumption, pollution release, green products (including green design and green packaging), green logistics (including green logistics, green warehousing and green transport) and operational performance (including costs, time, quality, flexibility, innovativeness, labour and process management). In addition to areas related to environmental performance, this list also contains operational performance areas.

## 2. Research methodology

The study consisted of several stages. The first stage was the initial review of the literature. Its purpose was to determine the current state of the literature related to the area of GSD with the special emphasis on conducting GSD practices. The second stage was to choose the literature selection criteria for the main systematic literature review. The systematic literature review was performed then. Subsequently, the CATI study was conducted. Next, the results were discussed. In the end, the conclusion and research implications were determined. The research methodology is visualized in Fig. 1.



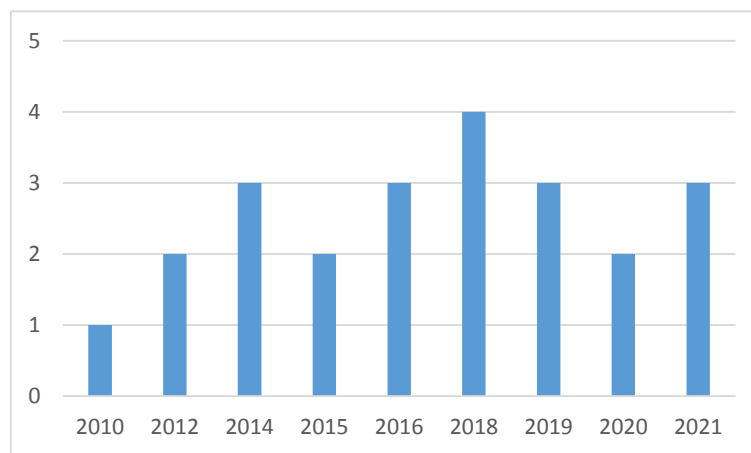
**Figure 1.** Research methodology.

Source: own elaboration.

The results of the initial literature review are presented in the previous chapter of this paper. The main systematic literature review was conducted using SCOPUS as a research database. Based on the results of the initial literature review, the literature selection criteria were chosen:

1. The title, abstract, or keywords contain the phrase ‘green supplier development’.
2. The language of the publication is English or Polish.
3. Document types taken into account are articles, reviews, books, book chapters, and conference papers. Editorials and letters are excluded from consideration.

The query returned 23 sources. There was no limit to the date of publication. However, the oldest source is dated 2010. The number of sources found per year is visualised in figure 2. All the publications found were in English. The literature review was conducted in January 2022 and its results are presented in the Findings and discussion section.



**Figure 2.** Number of sources per year.

Source: own elaboration.

The distribution of sources in each year is steady. However, it does not exceed 4 sources per year. Taking into account the results of the literature review, the research questions were formulated:

- Q1. Do companies organize or participate in GSD programs or GSD projects?
- Q2. Do companies conduct a green supplier evaluation aimed at starting or continuing cooperation with suppliers in environmental programs?
- Q3. Do companies conduct cooperation and/or collaboration with suppliers related to the implementation of the GSD concept?

The survey questions are in accordance with the research questions.

The CATI study was conducted on the group of 101 medium and large companies from the following production sectors operating in Poland in the following sectors: chemical, pharmaceutical, IT and optical equipment, electrical and automotive. The choice of sectors resulted from the relatively high level of environmental impact. The choice of company size resulted from the assumption that bigger companies have more complex management systems than smaller companies and therefore the management in these companies is more willing to

cooperate and collaborate with its suppliers. The size of the company was determined by the number of employees. A medium company employs between 50 and 249 employees, and a large company employs 250 and more employees. The structure of the survey group is illustrated in table 2.

**Table 2.**

*Structure of the survey group*

The main area of operations*	The main source of capital	Employment volume		Grand Total
		250 and more	From 50 to 249	
AUTO	Domestic	5	17	22
	Foreign	6	3	9
	Total	11	20	31
CHEM	Domestic	10	27	37
	Foreign	5	3	8
	Total	15	30	45
IT	Domestic	3	15	18
	Foreign	4	3	7
	Total	7	18	25
<b>Grand Total</b>		<b>33</b>	<b>68</b>	<b>101</b>

\* AUTO – automotive production; CHEM – chemical, pharmaceutical, and plastic production; IT – IT, electronic, and electrical production.

Source: own elaboration.

One can observe that the numbers of companies in the studied sectors are similar to each other. No less than 25% of the companies studied in every sector were big companies that employ 250 or more people.

### 3. Findings

It should be noted that the evaluation for GSD is aimed directly at determining the supplier performance (both environmental and operational). Therefore, the supplier performance in different areas affects the results of the evaluation of GSD programs or practices.

#### 3.1. Review of the literature - findings

After conducting a literature review, 10 articles were identified as key sources related to the scope of this article. The full list is presented in Table 3.

**Table 3.***Key sources in the literature review*

<b>Authors, years</b>	<b>Title</b>	<b>Relevance</b>
Bai, Sarkis, 2010	Green supplier development: Analytical evaluation using rough set theory	Identifying GSD practices
Fu et al., 2012	Evaluating green supplier development programs at a telecommunications systems provider	Providing a typology of GSD programs
Blome et al., 2014	Green procurement and green supplier development: Antecedents and effects on supplier performance	Determining relationship between green purchasing and GSD
Akman, 2015	Evaluating suppliers to include green supplier development programs via fuzzy c-means and VIKOR methods	Identifying green supplier evaluation criteria
Awasthi, Kannan, 2016	Green supplier development program selection using NGT and VIKOR under fuzzy environment	Determining criteria for GSD
Thakker, Rane, 2018	Implementation of a Green Supplier Development Process Model in the Indian automobile industry	Providing a GSD process model
Bag et al., 2018	Importance of innovation and flexibility in configuring supply network sustainability	Determining relationship between GSD and innovativeness
Bai, Satir, 2020	Barriers for green supplier development programs in manufacturing industry	Determining GSD barriers
Pourjavad, Shahin, 2020	Green supplier development programmes selection: a hybrid fuzzy multi-criteria decision-making approach	Identifying criteria for GSD
Nkrumah et al., 2021	Examining green capabilities as drivers of green supply chain management adoption	Determining relationship between GSD and adoption of green supply chain management

Source: own elaboration.

The identified key sources focus on various aspects of GSD characteristics, evaluation for GSD and different relationships between GSD and other concepts.

One, and maybe the only way to evaluate GSD practices or programs is through the lens of change of actions and results of suppliers. Therefore, not only supplier performance, but also the change in supplier performance and dynamics of change in supplier performance should be taken into account to precisely evaluate GSD practices. This kind of information can be obtained only over a certain period of time. Therefore, long-term cooperation with the supplier can be a success factor in introducing GSD practices.

There are two ways of practical application of green supplier evaluation in GSD:

- 1) to determine whether the supplier is best suited for participation in GSD practices,
- 2) to establish whether GSD practices are effective.

The use of criteria in these two types of evaluation depends on the specifics of the GSD practices.



In addition to that, Thakker and Rane (2018) developed a GSD process framework, with the following elements:

- drivers (government green policies, customers, management, competition for green products),
- key process input variables (e.g., list of GSD programs, GSD implementation strategies, assessment of green suppliers),
- success factors (top management support, proactive procurement management, suppliers’ ISO certification),
- enablers (green technology, supplier incentives, mutual trust and relationship),
- key process input variables (e.g., reducing negative environmental impacts, introducing waste management system).

It should be noted that they focused on the GSD process itself, rather than the GSD program introduced in collaboration with suppliers.

Monitoring and reviewing supplier performance related to GSD is also a stage of the GSD model proposed by Thakker and Rane (2018). All stages of this model are the following:

1. Strategy development.
2. Planning and implementation.
3. Supplier relationship management.
4. Performance measurement.
5. Value discovery.

They also listed conducting green supplier evaluation as a way to determine key process output variables (Thakker, Rane, 2018).

Taking into account the stages of the model described above, the GSD practices given in table 1 and the definition of environmental supplier evaluation by Sosnowski (2022), we can determine the order of actions taken by the company management needed to implement GSD (see: figure 3).

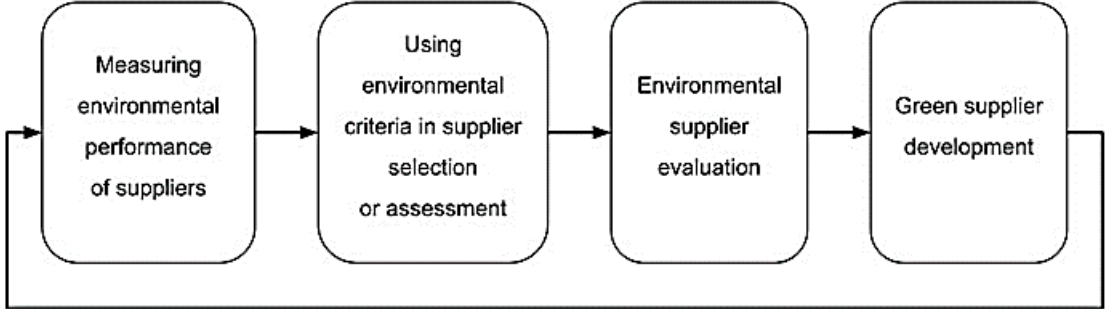


Figure 3. GSD implementation cycle.

Source: own elaboration based on Sosnowski, 2022; Thakker, Rane, 2018.

The first stage is measuring environmental performance of suppliers. The second stage is using environmental criteria in supplier selection or supplier assessment. The next stage is environmental supplier evaluation taking into account the information resulting from the

previous stage. The fourth stage is performing GSD practices. After that, the cycle is repeated to determine the results of performing GSD practices, as illustrated in figure 2. Using this cycle might result in continuous improvement of the environmental performance and continuous reducing negative environmental impact.

### 3.2. CATI – findings

More than 40% of all companies studied use environmental criteria in supplier selection and supplier assessment, and most use this kind of criteria in both supplier selection and supplier assessment. It is shown in table 4.

**Table 4.**

*Using environmental criteria in supplier selection or assessment*

<b>Using environmental criteria in supplier selection or assessment</b>	<b>Number</b>	<b>Percentage</b>
Yes, in supplier selection	11	10,89%
Yes, in supplier assessment	3	2,97%
Yes, in both	27	26,73%
No	60	59,41%
<b>Total</b>	<b>101</b>	<b>100%</b>

Source: own elaboration.

However, less than 25% of the companies studied organize or participate in GSD programs (see: Table 5) or perform an environmental supplier evaluation (see: Table 6). It should be noted that the question regarding organizing or participating in GSD programs does not include determining the role of the focal companies in such programs. Furthermore, introducing the GSD concept does not necessarily mean introducing GSD program: it might be limited to, e.g., conducting environmental supplier evaluation.

**Table 5.**

*Company involvement in GSD programs or GSD projects*

<b>Type of involvement</b>	<b>Number</b>	<b>Percentage</b>
Organisation of GSD programs or projects	12	11,88%
Participating in GSD programs or projects	13	12,87%
None	76	75,25%
<b>Total</b>	<b>101</b>	<b>100%</b>

Source: own elaboration.

Hence, there are companies that use environmental criteria in supplier selection and/or supplier assessment, but do not conduct environmental supplier evaluation. However, more than 75% of all companies studied neither organize nor participate in GSD programs or projects.

**Table 6.***Conducting environmental supplier evaluation*

<b>Conducting environmental supplier evaluation</b>	<b>Number</b>	<b>Percentage</b>
Yes, in order to start or continue cooperation with suppliers	16	15,84%
Yes, in order to select suppliers to GSD programs or projects	5	4,95%
Yes, both reasons	5	4,95%
No	75	74,26%
<b>Total</b>	<b>101</b>	<b>100%</b>

Source: own elaboration.

Less than 20% companies studied conduct cooperation and/or collaboration with suppliers related to the implementation of the GSD concept. It is shown in Table 7.

**Table 7.***Conducting cooperation and/or collaboration with suppliers related to the implementation of the GSD concept*

<b>Conducting cooperation and/or collaboration with suppliers related to implementing the GSD concept</b>	<b>Number</b>	<b>Percentage</b>
Yes	19	18,81%
No	82	81,19%
<b>Total</b>	<b>101</b>	<b>100,00%</b>

Source: own elaboration.

Hence, more studied companies organise or participate in GSD programs than cooperate and/or collaborate with suppliers in order to implement the GSD concept.

Furthermore, only one GSD practice is conducted by more than 10 studied companies: monitoring the environmental performance of suppliers (see: table 8). Although it should be noted that without monitoring the environmental performance of suppliers, it might be impossible to implement any other GSD practice.

**Table 8.***Conducting GSD practices*

<b>Type of practice</b>	<b>GSD practices</b>	<b>Yes</b>	<b>No</b>
<b>Environmental cooperation</b>	Monitoring the environmental performance of suppliers	15	4
	Green knowledge transfer	3	16
	Investing in the environmental practices of suppliers	5	14
	Transfer of non-financial resources to suppliers (to enable them to achieve their environmental goals)	3	16
	Organization of trainings for suppliers on environmental issues	3	16
<b>Environmental collaboration</b>	Joint planning of environmental goals with suppliers	6	13
	Joint planning of environmentally friendly processes with suppliers	8	11
	Joint design of environment-friendly products with suppliers (eco-design)	6	13
	Performing joint environmental activities with suppliers	7	12
	Introducing environmental programs with suppliers	0	19

Source: own elaboration.

Taking into account the results shown in table 8 we can distinguish GSD practices that are used more often: monitoring the environmental performance of suppliers, joint planning of environmentally friendly processes with suppliers, performing joint environmental activities with suppliers, joint planning of environmental goals with suppliers, and joint design of environment-friendly products with suppliers (eco-design).

The low number of companies that are cooperating and/or working in collaboration with suppliers related to the implementation of the GSD concept could result from a low level of environmental awareness of management, economic disruptions related to the Covid-19 pandemic or an early stage of the implementation of this concept: the questions in the survey were about involvement in GSD programs and the implementation of GSD practices without taking into account planning such activities.

In addition, no company selected the introducing environmental programs with suppliers. It might result from the fact that it is not necessary to implement environmental programs with suppliers. It can be done without collaboration, with suppliers only as participants.

#### **4. Implication for business**

The main implication for business is related to the participation in GSD programs. If only the minority of companies in the sectors studied participate in such programs, then this kind of participation might be a source of competitive advantage. Provided there are more possibilities of this kind than companies willing to participate.

One of the possibilities of practical implementation of the GSD concept is introducing the GSD cycle consisting of measuring environmental performance of suppliers, using environmental criteria in supplier selection or supplier assessment, environmental supplier evaluation, and performing GSD practices.

#### **5. Implication for government**

The main implication for government is related to facilitating possibilities of organising or participating in GSD programs or conducting GSD activities, such as tax reliefs for companies investing in this kind of operation. As a result, it might help reduce the negative environmental impacts of these companies.

## 6. Recommendations for future research

The main recommendation for future research is determining the relationship between change in supplier performance, the dynamics of change in supplier performance, and evaluation of GSD practices.

Another recommendation is the study on the determinants of GSD implementation: drivers, barriers, and enablers. A similar study was conducted by Thakker and Rane (2018), but did not include barriers to GSD implementation. Identifying this kind of barrier might be significant to the limited popularity of GSD programs.

The last recommendation is to identify the relationship between the implementation of GSD practices and the practical application of the GSD concept. It might be aimed to answer the question: do companies use GSD as a coherent, stand-alone management tool?

## 7. Conclusion

In summary, evaluating GSD practices includes evaluating supplier activities and results. Therefore, the success factors of the introduction of GSD practices include the environmental performance of the suppliers, the change in the supplier performance, and the dynamics of change in the supplier performance.

The answers to the research questions were formulated in the Findings and discussion section of this paper. However, due to the scope of conducting GSD practices by the companies studied, it may not be justified to generalize the results with respect to Q3 to all companies in the focal sectors.

One of the possibilities of practical implementation of the GSD concept is introducing the GSD cycle consisting of measuring environmental performance of suppliers, using environmental criteria in supplier selection or supplier assessment, environmental supplier evaluation, and performing GSD practices. Using this cycle might result in continuous improvement of environmental performance and continuous reduction of negative environmental impact.

Further research on the determinants of GSD implementation could provide a basis for other possibilities of practical application of GSD.

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