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Note from the field

Green training and green supply chain management: evidence from Brazilian firms

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ABSTRACT

The implementation of green supply chain management practices, such as green purchasing and cooperation with customers, presents several challenges, often due to a lack of green training. In order to analyze the relationship between green training and green supply chains, a survey of Brazilian firms with ISO 14001 certification was conducted. The main characteristics of green training in the sample were also explored. The results indicated that green training is positively correlated with the adoption of green supply chain practices in green purchasing and cooperation with customers, confirming the study's main hypothesis. The research results also indicated that green training tends to help firms improve their green supply chain management to cooperate with customers and implement green purchasing. This work extends the current literature by showing that employees' green training content and requirements for greening suppliers should be further aligned. This alignment should also involve cleaner production priorities built up through customer cooperation. As a consequence, firms will reach internal environmental targets and achieve external environmental improvements (such as through having greener suppliers). Finally, we also discovered the main characteristics of green training that can galvanize green supply chain management, including the following: green training topics that are appropriate and current for company activities, green training contents created through a systematic analysis of training gaps and needs; and employees who receive green training and have the opportunity to apply green knowledge in everyday activities.

1. Introduction and research background

According to Gotschol et al. (2014), companies should give preference to GSCM (green purchasing and collaboration with customers), a more economically sustainable and environmentally friendly approach, when trying to become greener. In the context of more sustainable operations management (Walker et al., 2014; Piercy and Rich, 2015), GSCM extends the traditional concept of supply chain management (Tiwari et al., 2015; Wong et al., 2015; Govindan et al., 2014) by improving the environmental performance of products and services across their complete life cycles (Gunasekaran et al., 2015; Ahi and Searcy, 2015; Rostamzadeh et al.,

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2015). In the context of searching for greater sustainability in supply chains (Brandenburg et al., 2014), the implementation of GSCM faces several barriers, such as the lack of financial resources to support remanufacturing (Zhu et al., 2014; Rauer and Kaufmann, 2014). Other potential barriers include the lack of trust among members in supply chains (Wood and Gray, 1991) and the lack of an appropriate commitment from top management (Luthra et al., 2015).

Although this topic has been discussed for the last decade (Srivastava, 2007), its implementation is still a challenge because of the aforementioned barriers—especially in emerging economies (Tiwari et al., 2015; Fahimnia et al., 2015; Gunasekaran et al., 2014; Muduli et al., 2013; Jabbour et al., 2013; Zhu et al., 2005), where research on the topic needs to advance for companies to make real contributions to environmental management (Pagell and Shevchenko, 2014; Tachizawa and Wong, 2015). This situation is no different in Brazil, which was until 2013 one of the world's fastest-growing economies (along with India, Russia, and China) and the most important economy of South America. According to a recent report, Brazil will keep its position as one of the world's top 10 economies through 2050 (PWC, 2015)). It is necessary to know more about GSCM in South America, which is, according to Fahimnia et al. (2015), one of the world's least-studied areas regarding the current state of the art on GSCM, accounting for just 2.1% of the available literature on the subject.

Although recent studies have shown that there is a positive scenario in which to adopt GSCM in Brazil (Alves and Nascimento, 2014), the current adoption level of GSCM practices can be further improved (Kannan et al., 2014). Of the wide range of possible GSCM practices (Zhu et al., 2005), we highlight green purchasing (GP) in this research, as this is related to the inclusion of environmental criteria in supplier selection and purchasing and to collaboration with consumers (CC), which refers to customer engagement, green feedback and guidelines on the greening of firms (Zhu et al., 2008). GP and CC practices are used in an attempt to overcome the challenges of stakeholder inclusion in environmental actions (Abreu et al., 2015) by involving customers and suppliers in the decision-making processes related to green issues across the supply chain.

According to the resource-based view of sustainable supply chains (Touboulic and Walker, 2015), the alignment between human resource management and environmental management (including GSCM)—also known as green human resource management (GHRM) (Jackson et al., 2014)—can help firms to overcome barriers to adopting CC and GP. This is because GHRM, which is defined as the alignment between traditional human resources practices (such as training and performance appraisals) and environmental policies and objectives (Jackson et al., 2014; Renwick et al., 2013), can contribute to greater employee engagement in sustainability management (Renwick et al., 2013). This is particularly true in a context in which increasingly proactive environmental behaviors are necessary (Graves et al., 2013; Ehnert, 2009).

Among the GHRM practices that can contribute to GSCM, we highlighted green or environmental training (GT). GT can be defined as a process of on-the-job training and continued education intended to achieve corporate environmental management targets and purposes (Daily and Huang, 2001). According to Paillé et al. (2014) and Muduli et al. (2013), GT is a type of training related to relevant environmental topics; it enables all staff (top, senior, and middle managers and the workforce) to integrate the firm's performance with environmental issues. Recent research suggests that GT is positively related to the greening of companies around the world. For example, Sarkis et al. (2010) claimed that GT was relevant to the adoption of advanced environmental practices among companies in Spain. Daily et al. (2012) stated that GT is relevant to green teams. Jabbour (2015) indicated that GT is positively related to the evolution of environmental management in firms. Other studies have reinforced the importance of GT for a green economy (Jackson et al., 2014; Renwick et al., 2013).

However, based on the available knowledge, the following gaps still remain in the current literature. First, works have suggested that organizational learning (van Hoof, 2014) and training are relevant to cleaner production programs (Stone, 2000). More specifically, Gosling et al. (2014) suggested that organizational learning is relevant to creating more sustainable supply chains. However, these works do not directly discuss the link between GT and GSCM. On the other hand, many works on green training are qualitative (Perron et al., 2006; Teixeira et al., 2012) or conceptual, such as literature reviews (Jabbour, 2013). More quantitative studies are still needed (Jabbour and Jabbour, 2016). As a consequence, this is a useful avenue for future research.

A research gap also exists regarding whether green training is positively related to green supply chain practices (such as green purchasing and cooperation with customers). Additionally, this study presented the main green training characteristics that support the above-mentioned GSCM practices.

Furthermore, considering that firm size (FS) plays a major role in the adoption of more sustainable management practices (Bai et al., 2015), this measure is expected to exert significant control over the adoption of GSCM. Assuming that green training is positively related to green supply chain management, we surveyed Brazilian companies that used the ISO 14001 certification for environmental management systems to test the validity of the proposed framework and research hypothesis. Additionally, we tested the role of firm size (FS). So far, we have found no similar works in the Scopus or ISI Web of Science databases dedicated to analyzing GT for GSCM (CC/GP) in this kind of sample.

2. Research method

This research was quantitative and based on an electronic survey. We proposed the research framework shown in Fig. 1. Survey studies are generally relational because they tend to be designed to empirically examine relationships among two or more constructs or variables (Rungtusanatham et al., 2003). Surveys are also relevant for describing important variables or characteristics of constructs (Rungtusanatham et al., 2003). The survey approach was selected in this work mainly because we tested the relationship between GT and GSCM to provide a description of GT's main characteristics. This quantitative approach was adequate for the research questions presented herein. As a consequence, we tested the following relationship (H_1): *GT is positively related to the adoption of GSCM practices.* We also explored GT's main characteristics.

The survey questionnaire included the measurement of eight GSCM practices/items (five for GP and three for CC). The selected GSCM practices were validated by Zhu et al. (2008) in the Chinese context. As discussed by Zhu et al. (2008), the scale was inspired by assumptions from the ecological modernization theory applied to GSCM and were further discussed by Sarkis et al. (2011). In addition, the questionnaire measured 10 GT practices. The GT practices were based on the validated scale from Daily et al. (2012) and were inspired by works discussing GT, such as Teixeira et al. (2012) and the ISO 10015 (2001). Table 1 shows the references for all the selected items in the research questionnaire. As explained above, all the selected items were validated by the literature.

In addition, we measured the FS variable using four types of patterns in Brazil based on the number of employees: micro-sized firms (up to 19 employees), small firms (20–99 employees), medium-sized firms (100–499 employees), and large firms (500 or

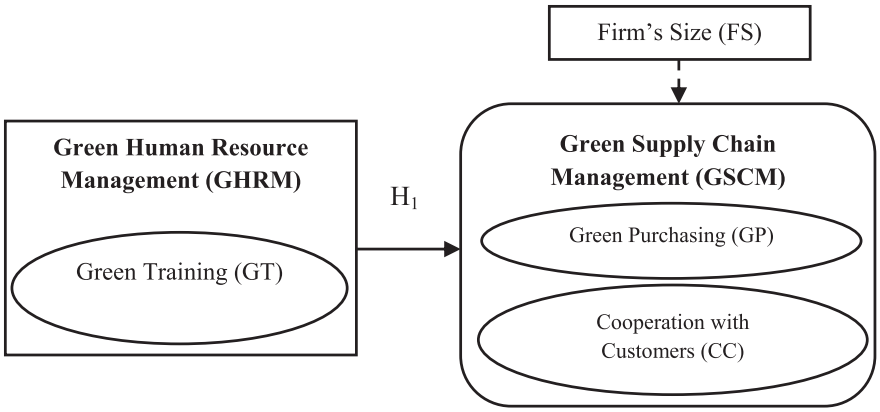

Fig. 1. Research framework.

Table 1
Constructs/Items used in the research's questionnaire.

Concept	Items	Adapted from
GT (Green Training)	GT1—Contents of GT are raised through a systematic analysis of training gaps and needs	Daily et al. (2012); Teixeira et al. (2012); ISO 10015 (2001); ISO 14001 (2004)
	GT2—The responsibilities and duties of official green trainers are precisely defined	Daily et al. (2012); Teixeira et al. (2012); ISO 14001 (2004)
	GT3—GT is offered to all employees (including outsourced)	Daily et al. (2012); Teixeira et al. (2012); ISO 14001 (2004)
	GT4—There is an adequate infrastructure (physical space, material, people) for the delivery of GT	Daily et al. (2012); Teixeira et al. (2012); ISO 10015 (2001)
	GT5—GT sessions occur within the company	Daily et al. (2012); Teixeira et al. (2012); ISO 10015 (2001)
	GT6—GT sessions occur outside of the company	Daily et al. (2012); Teixeira et al. (2012); ISO 10015 (2001)
	GT7—There are adequate assessments of employees' performance after attending GT sessions	Daily et al. (2012); Teixeira et al. (2012); ISO 10015 (2001)
	GT8—Generally, employees are satisfied with the GT offered;	Daily et al. (2012); Teixeira et al. (2012); ISO 10015 (2001)
	GT9—The topics approached during GT are appropriate and current for company activities	Daily et al. (2012); Teixeira et al. (2012)
	GT10—Employees who receive GT have the opportunity to apply green knowledge in everyday activities	Daily et al. (2012); ISO 10015 (2001)
GSCM (Green Supply Chain Management)	GP1—Selection of suppliers with ISO 14001 certification	Zhu et al. (2008)
	GP2—Cooperation with suppliers to achieve green goals	
	GP3—Available green guidelines to suppliers	
	GP4—Assessment of green issues of second-tier suppliers	
	GP5—Conducting green audits within the suppliers	
	CC1—Cooperation with customers for cleaner production	
	CC2—Cooperation with the customers to develop greener packaging	
	CC3—Cooperation with customer for eco-design	

Note: GT was measured with a Likert scale from 1 to 5, where 1 means "strongly disagree," and 5 means "strongly agree"; GSCM was measured with a Likert scale from 1 to 5, where 1 means "not implemented" and 5 is "fully implemented."

more employees). Based on data from 2013, there are about 3700 ISO 14001-certified firms in Brazil (ISO, 2013). An online link to this research questionnaire was sent by email to Brazilian environmental/sustainability/operations managers and to owners of manufacturing firms with ISO 14001 certification (as listed in the INMETRO [Instituto Nacional de Metrologia, Qualidade e Tecnologia] database).

About 330 potential participants were contacted by email and by phone in 2012 and 2013, and 95 questionnaires were collected; thus, a return rate of 28.78% was obtained. Of the participants in the final research sample, 66.32% were from the manufacturing sector (among all participants: 20% from automotive companies, 13.68% from the chemical sector, 10.53% from the electronics sector and 22.11% from other manufacturing areas); 9.47% were from the coal, oil, and gas equipment sector; and 24.21% were from mixed sectors. This sample's representation comprised 2.1% micro-sized firms, 18.9% small firms, 42.1% medium-sized firms, and 36.9% large companies, all of which had ISO 14001 certification.

The data were analyzed with structural equation modeling (SEM) using partial least squares (PLS) with the support of the SmartPLS 2.0 M3 software.

3. Research results

The research results analyzed the following two main questions posed by this work. First, is there a positive link between GT and GSCM? Second, what are the main characteristics of GT that can drive GSCM?

Because we analyzed the data through SEM, given the collinearity issues that arise from running the model using the traditional, repeated indicators approach, we chose to use a two-stage approach (Kock and Lynn, 2012), which was the only one for which we could manage the problems of the collinear data that we faced (see Table 2).

In order to process the collected data, a path diagram was built to show the relationship between the dependent and independent

Table 2
Convergent validity and internal consistency reliability (factor weighting scheme; mean 0, Var 1; Max. Iteration 300).

Latent variables	Items/ Indicators	Indicator reliability	AVE	Composite reliability
Green Training	GT1	0.807		
	GT2	0.734		
	GT3	0.669		
	GT7	0.740	0.5821	0.9066
	GT8	0.745		
	GT9	0.837		
	GT10	0.794		
CC	CC1	0.882		
	CC2	0.850	0.7535	0.9017
	CC3	0.871		
GP	GP1	0.812		
	GP2	0.895		
	GP3	0.849	0.6161	0.8878
	GP4	0.695		
	GP5	0.644		

Note: Some items were removed because they have indicators of reliability <0.6. All items have indicators of reliability >0.6, AVE >0.5, and CR >0.7.

variables, including their related variables (Esposito Vinzi et al., 2010; Kristensen and Eskildsen, 2010). After processing the path diagram, a measurement model was built to determine if the obtained coefficients were significant (Hair Jr. et al., 1998).

Initially, as shown in Fig. 2, we found that the GT construct needed to be refined with a reduced number of variables; we excluded the GT4–GT6 items mainly because those variables had reliability lower than 0.6 and AVE lower than 0.5, both of which were lower than recommended (Latan and Ghozali, 2012).

Fig. 2 above shows the first step of the two-stage approach. In this stage, all the first-order constructs were linked to assess the validity and reliability of the outer model PLS. Fig. 2 shows that the loading factors for all the indicators were greater than 0.6 and that the values of AVE and CR generated by each construct were compliant (see Tables 2 and 3). After all the criteria were met, the score of each latent variable was used for the second step to test the hypothesis of the inner model PLS.

After excluding items GT4–GT6 and adopting a two-stage approach, the convergent validity, internal consistency reliability, and discriminant validity showed improved statistical fit, as suggested by the literature (Latan and Ghozali, 2012; see Table 3).

Going ahead with the statistical analysis, to obtain better statistical fit and check the statistical significance of the obtained coefficients, a structural model was estimated based on bootstrapping with 2000 subsamples (Tables 4 and 5). This test obtained the following results (Fig. 3). The R-squared (R^2) values were, according to Cohen (1992), large and satisfactory. The variance inflation factor (VIF) was less than 1.412, which is considered adequate (Latan and Ghozali, 2012). GT's effect size (f2) on GSCM was 0.292, which is significant (Latan and Ghozali, 2012). The R^2 set was considered small when it was less than 0.25, medium when it was less than 0.50, and large when it was less than 0.70. Therefore, it was considered small and appropriate (Latan and Ghozali, 2012). Enough Q2 predictive validity was obtained, as the dependent variable's validity was 0.310 (Latan and Ghozali, 2012). Finally, the goodness of fit (GoF absolute), which is a general measure of a

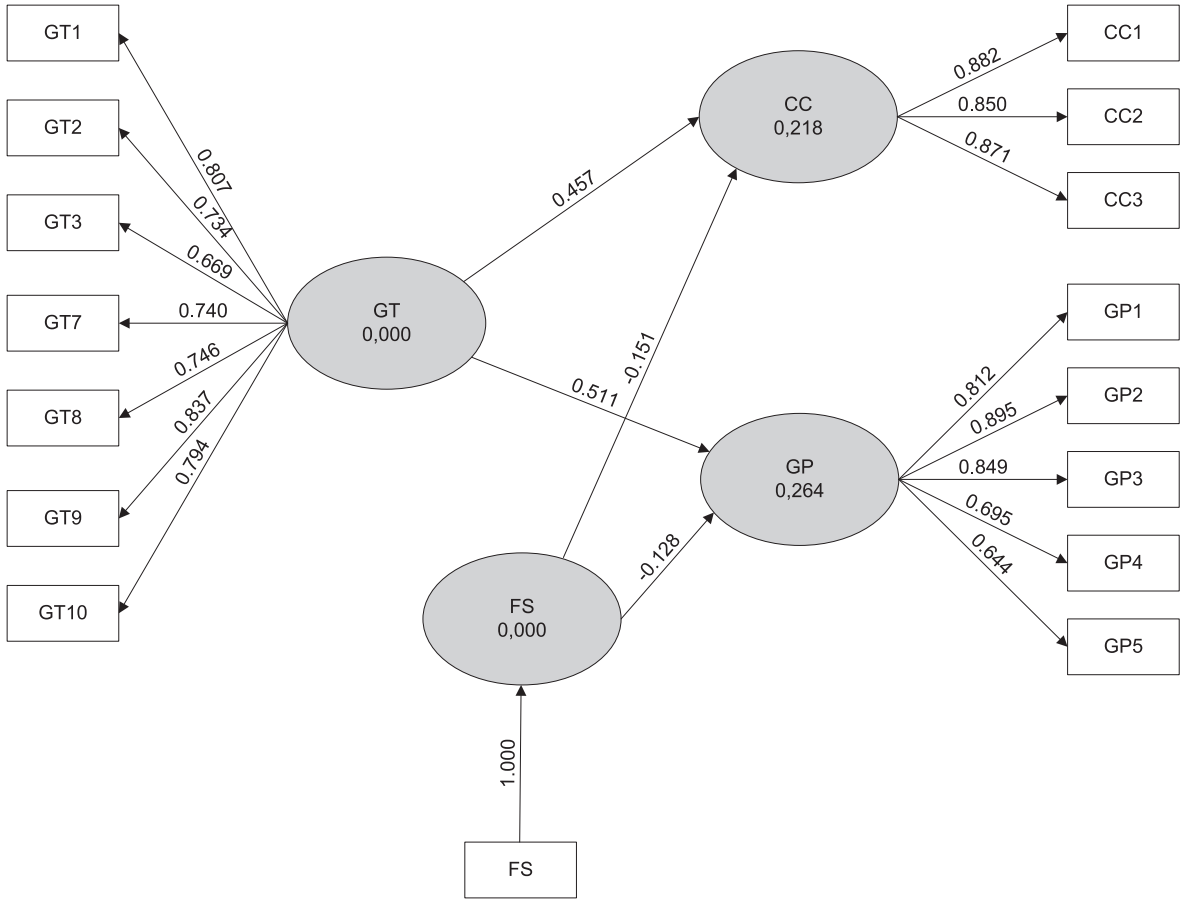

Fig. 2. Path diagram outer model with SmartPLS 2.0 M3 using Two-Stage Approach.

Table 3
Discriminant validity.

Variables	CC	GP	GT
CC	**(0.8680)**		
GP	0.5565	**(0.7849)**	
GT	0.4417	0.4979	**(0.7630)**

Note: Square roots of average variances extracted (AVEs) shown diagonally must be higher than the others correlations.

model's statistical adequacy, was equal to 0.458, which is considered large; therefore, the model was considered valid, based on Latan and Ghozali (2012).

According to Latan and Ghozali (2012) and Hair Jr. et al. (2011), *t* values of 1.65, 1.96, and 2.58 are considered equivalent to significance levels of 10%, 5%, and 1%, respectively. As a consequence, it is possible to conclude that the relationship between GT and GSCM was significant at the 1% level and that the FS-GSCM relationship ($t = 2.0571$) was not significant at the 1% level (following Fig. 3 and Table 5).

Thus, responding to the first research question, the research results (Table 5) show that H_1 should be considered valid, as GT was positively related with GSCM. Fig. 2 shows that GT was more heavily related to GP than to CC.

Regarding the second research question the GT practices from the sample that were most intensely related to GSCM practices were items GT9 ("The topics approached during GT are appropriate and current for company activities."), GT1 ("The contents of GT are raised through a systematic analysis of training gaps and needs."), and GT10 ("Employees who receive GT have the opportunity to apply green knowledge in everyday activities."), in that order.

The most relevant GP practices were GP2 ("cooperation with suppliers to achieve green goals") and GP3 ("green guidelines available for suppliers"). On the other hand, the most relevant CC items were CC1 ("cooperation with customers for cleaner production") and CC2 ("cooperation with customers to develop greener packaging").

These results suggest that firms adopting GSCM practices should empower their employees with green awareness and skills through GT (such as GT9). If employees have more environmental

Table 4
Inner model analysis (bootstrapping → sign changes = individual changes; cases 95; sample 2000).

Latent Variables	R-Squared (R^2)	Adjusted R^2	Effect size (f^2)	Q^2 predictive Validity	VIF	GoF absolute
GT	–	–	0.292	–	1.412	–
CC	0.218	0.201	–	–	1.251	–
GP	0.264	0.248	–	–	1.330	–
GSCM	0.308	0.293	–	0.310	–	0.458

Note: For computing the adjusted R^2, we used the formula below, as SmartPLS cannot compute it automatically: $\tilde{R}_Y^2 = 1 - (1 - R_Y^2)n - 1/n - k - 1$, where $\tilde{R}_Y^2$ = adjusted R^2; R_Y^2 = R-squared; n = sample size; and k = number of predictor variables. For computing the Q^2 predictive validity, we used the formula below because SmartPLS cannot compute it automatically: $Q^2 = 1 - \sum_D E_D / \sum_D O_D$, where D = omission distance; E = number of squares; and O = number of square errors. For computing the absolute GoF, we used the formula below because SmartPLS cannot compute it automatically: $GoF = \sqrt{\overline{AAVE} \times \overline{AARS}}$, where AAVE = Average AVE and AARS = Average Adjusted R^2.

Table 5
Hypothesis testing for relationship among variables (Sig. 5% two-tails with DF = 96 → Student's t = 1.980).

Relations	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	Standard error (STERR)	T Statistics (|O/STERR|)	Decision
Green Training → GSCM	0.5497	0.5538	0.0618	0.0618	8.9006	Accept

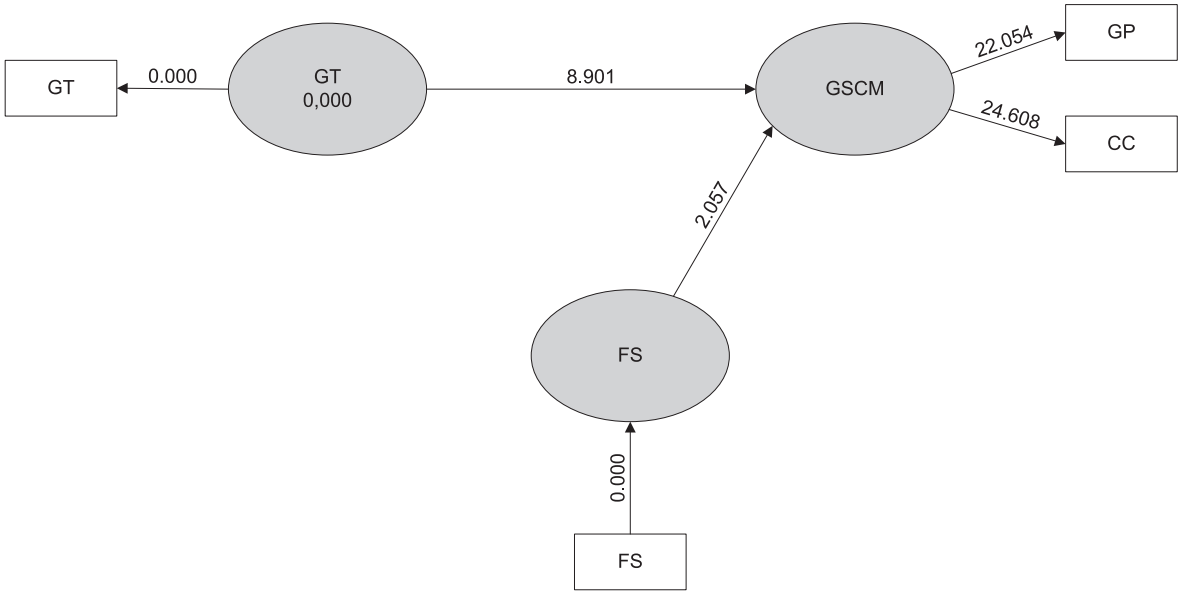

Fig. 3. Path diagram inner model with SmartPLS 2.0 M3 using Two-Stage Approach.

awareness, they may be able to support the greening of suppliers across the supply chain (GP2). On the other hand, this process may also make customers consider cleaner production improvements (CC1). Consequently, GT may bridge firms, suppliers, and customers in the greening process.

4. Discussion

Some managerial implications emerged from the above-mentioned results. Employees' GT content must be aligned with the requirements for greening suppliers. This alignment should also consider cleaner production priorities built up through costumers' cooperation. As a consequence of these actions, firms will reach internal environmental targets and make external environmental improvements through their greener suppliers. Secondly, GT offered may have to be extended from internal employees to the supply chain as a whole—including to suppliers and customers—to achieve a better fit in green management.

These results confirmed the relevance of GHRM and GSCM integration (Jabbour and Jabbour, 2016) in a context of more sustainable human resource management (Ehnert, 2009). They also supported Stone (2000), whose findings suggested that GT is a key aspect of cleaner production initiatives. In this context, GT can also be considered a key aspect of better green management cooperation with customers. GT may also be a source of green organizational learning and knowledge because it is related to the adoption of GP and CC across the supply chain. This confirms not only the relevance of GHRM (Jackson et al., 2014; Renwick et al., 2013) but also the specific role that GT plays in making organizations greener (Sarkis et al., 2010). In this context, GT is a source of competitive advantage for firms (Touboulic and Walker, 2015). When focusing on GT, companies should invest in the content of training sections, the systematic analysis of training gaps and needs, and opportunities for employees to apply green knowledge.

5. Conclusions

Based on the stated research questions, this work determined whether green training (GT) was positively related to the adoption of GSCM practices such as GP and CC (the main variables of GT that influence GSCM). The main characteristics of GT were also explored. This work added empirical evidence on GSCM in South America, an under-studied region (Fahimnia et al., 2015). It contributed to a better understanding of the integration between GSCM and GHRM (Jabbour and Jabbour, 2016). After researching the relationship between GT and GSCM in 95 firms with ISO 14001 certification in Brazil, we concluded that the tested framework as a whole presented good validity (GoF), and that GT—mainly items GT9, GT1 and GT10—was positively and significantly related to GSCM in the analyzed firms, which confirmed the main research hypothesis.

The results showed the relevance of green training, confirming that organizational learning (Gosling et al., 2014) and the alignment of human resources practices (Jackson et al., 2014) are crucial to the greening of firms, as they reduce barriers to GSCM adoption. Specifically, we confirmed that the adoption of more advanced environmental management practices—such as GSCM—requires more attention from green training programs, as suggested by Sarkis et al. (2010). GT should consider how to involve stakeholders, mainly customers, in the search for GSCM.

Some important characteristics of GT can bolster the green supply chain, such as GT9 ("The topics approached during GT are appropriate and current for company activities."), GT1 ("The contents of GT are raised through a systematic analysis of training gaps and needs."), and GT10 ("Employees who receive GT have the opportunity to apply green knowledge in everyday activities.").

Finally, the role of firm size in the interaction between GSCM and GT may be a relevant research avenue, as it did not seem to be significant in this research.

This work has some limitations. First, social desirability bias has become a concern in sustainability studies, as the respondents try to perform as they believe interviewers expect. Under this circumstance, less accurate responses can be obtained (Roxas and Lindsay, 2012). Furthermore, this work was only related to the Brazilian context, and only focused on ISO 14001-certified firms. Finally, this study's research sample did not represent the distribution of ISO 14001 sectors and firms across Brazil. Future research should consider the effect of the industrial sector (as a control variable) and other complex characteristics of GSCM implementation, such as GSCM governance.

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