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Evaluating barriers to green supply chain redesign and implementation of related practices in the West Africa cashew industry

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ABSTRACT

Cashew consumption has been increasing globally, but environmental issues through the whole cashew supply chain, from production, processing and transportation, have been raised. Thus, green supply chain redesign has been put forward but implementation of related practices faces many barriers. Using the case of the Africa cashew industry, which produces over half of global raw cashew nuts but only process less than 10% to kernel, this paper systematically identifies these barriers considering stakeholders through the whole cashew supply chain. Based on evaluation of four experts, results by grey Decision Making Trial and Evaluation Laboratory reveal that successful green supply chain redesign implementation needs two elementary efforts by kernel distributors. One is increased collaboration with multi-tier suppliers (producer organizations and processors) and the other is to get strategic support from industry bodies, non-governmental organizations and development agencies. Additionally, in the short-term, kernel distributors need to overcome three key operational barriers, lack of internal top-level management commitment, lack of integrated management information and traceability systems, and uncertainty of economic benefits. Furthermore, barriers such as difficulties to assess environmental sustainability performance and lack of consumer demand for green cashew should be addressed in the long-term. This study contributes to identify barriers to the successful implementation of green supply chain redesign from perspectives of both the focal enterprise and the whole supply chain. A robust multi-criteria decision making method further reveals the most important and fundamental barriers which can offer decision support for kernel distributors and policymakers in the cashew industry.

1. Introduction

Globally, cashew consumption is increasing, and this trend is expected to continue with the growing demand for kernel from large emerging markets such as China and India (Srivatsava, 2014). Associated with this phenomenon is the increased awareness of environmental issues in cashew production and processing (Agyemang et al., 2016; Intersnack, 2016; Kanji, 2004). Africa is estimated to produce not less than half of global raw cashew nuts (RCNs) (FAOSTAT, 2017). However, local processing of RCNs into kernel in West Africa is estimated to be less than 10 percent (ACA, 2015a). As a result, many stakeholders have raised environmental concerns on transportation of RCNs to processing factories outside the region (ACA, 2010). This has caused the need for leading kernel distributors as focal enterprises of the cashew supply chain to consider redesign of cashew supply chains in West Africa. In order for enterprises to engage effectively in environmental change, they need to reexamine the ecological concerns of their supply chain configurations (Labbi et al., 2016; McGuire, 2010). Green supply chain redesign (GSCR) which emphasize on redesigning an existing supply chain can be an effective way to deal with environmental issues and gain competitiveness (Murphy and Poist, 2000; Srivastava, 2007).

In general, sustainability has become increasingly important for businesses (Badri Ahmadi et al., 2017; DeSimone and Popoff, 1997; Esfahbodi et al., 2016; Gopal and Thakkar, 2016; Kusi-Sarpong and Sarkis, 2017; Sachs, 2012). Many focal enterprises in supply chains are making efforts to integrate sustainability into their corporate strategies (Beske et al., 2014; Govindan and Cheng, 2011; Srivastava, 2007). The literature reveals that design has a pivotal role to address environmental sustainability in industry (Küçüksayraç, 2015; Miranda-

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Ackerman et al., 2017; Spangenberg, 2013; Zhu and He, 2017) and redesign of a supply chain can yield environmental and economic performance (Zhu and Sarkis, 2004). Leading kernel distributors seek to achieve competitive advantages and address environmental concerns within their resource constraints. However, implementation of such GSCR practices faces many barriers. Therefore, motivated by environmental issues in the West Africa cashew industry, the first objective of this study is to develop the concept of GSCR and then identify barriers.

Prior studies have proposed various assessment methods to examine green supply chain management (GSCM)(Bai et al., 2017; Jabbour et al., 2014; Mangla et al., 2015; Tseng et al., 2018; Vahabzadeh et al., 2015). For instance in relation to barriers to GSCM, Muduli et al. (2013) used the graph theory and matrix approach to quantify the adverse impact of barriers on GSCM implementation in the mining industry. Jayant and Azhar (2014) proposed the Interpretive Structural Modelling (ISM) technique to determine relationships among GSCM barriers and identified the most influential ones in the Indian industry. Also, Dube and Gawande (2016) used ISM and fuzzy matrix of cross-impact multiplications for classification analysis to identify barriers to implement GSCM and to understand their mutual relationship. To the best of our knowledge, there is lack of research concentrated on the problem of assessing barriers to GSCR and implementation of related practices. In the case of the West Africa cashew industry which needs to consider the GSCR strategy while resources can be limited, it is necessary to identify key barriers that need to be overcome. Hence, the second objective of this study is to apply an appropriate assessment method to reveal the most important and fundamental barriers to GSCR and the implementation of related practices in the cashew industry.

Perspective of supply chain members as well as external agents of the supply chain play a crucial role in GSCM (Walker et al., 2008; Zhu et al., 2014). Similarly, it is important to consider the supply chain viewpoint in assessment of barriers to GSCR and implementation of related practices. Therefore, building on the previous literature, the first contribution of this study is the systematic development of a framework guided by stakeholder perspectives to identify barriers to GSCR and implementation of related practices considering the supply chain internal stakeholders' perspective as operational and external stakeholders' perspective as strategic. The operational barriers focus on the role of supply chain members which include focal enterprises as well as suppliers and customers/consumers. The strategic barriers focus on the role of external supply chain actors such as governments and industry bodies. Moreover, considering advantages of the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method and the related limitation of uncertainties due to subjective judgements (Tseng, 2009), this paper applies the grey-DEMATEL method to identify both the most important and fundamental barriers.

To achieve research objectives of this paper, the next section presents a literature review to explain the concept of GSCR and identifies barriers. In Section 3, we introduce the DEMATEL method and data collection for analysis. The study results and discussion are in Section 4. Finally, we provide conclusions with limitations of the paper in Section 5.

2. Research background and GSCR barriers in the West Africa cashew industry

2.1. Related environmental issues and the GSCR concept

The literature on agrifood supply chains draws much attention to environmental issues such as the dependence on fossil fuels and the need to reduce environmental footprint (Heller and Keoleian, 2003; Sonesson et al., 2016). It is estimated that not less than 19 percent and up to 31 percent of global greenhouse gas (GHG) emission, as well as 50 percent share of eutrophication, come from agrifood supply chains (Iakovou et al., 2014; Tukker et al., 2011, 2006; Vermeulen et al., 2012). In the cashew industry, previous studies (Agyemang et al., 2016; Brito De Figueirêdo et al., 2016; Jekayinfa and Bamgboye, 2006; Mohod and Jain, 2011) highlight environmental sustainability issues. Through Life Cycle Assessment (LCA), Brito De Figueirêdo et al.(2016) revealed that the use of fertilizers and pesticides are directly and indirectly responsible for the major environmental impacts such as acidification and eutrophication in cashew farms. Also, according to Agyemang et al.(2016), transportation, processing operation and waste management produce significant GHG emission in the global supply chain of the cashew industry in West Africa. To this end, exploring the potential to redesign agrifood supply chains and implementation of related GSCR practices are necessary to mitigate environmental sustainability concerns.

Conventional supply chain design considers decisions related to the number, location, and capacities of various supply chain facilities and the optimal flow of raw materials or finished products through the supply chain (Beamon, 1998; Varsei and Polyakovskiy, 2017). However, green supply chain design needs a means to frame the design of products and processes with environmental awareness regarding strategic decision making (Miranda-Ackerman et al., 2017; Srivastava, 2007). Nevertheless, the problem many enterprises face is to redesign their existing supply chains and implement related practices to improve environmental performance (Bing et al., 2015; Van der Vorst et al., 2009). Therefore, GSCR can be defined as reconfiguring an existing supply chain design to make profit and address environmental aspects of the change in supply chain design.

A wide range of GSCR practices can improve supply chain environmental performance (Zhu and Sarkis, 2004). These practices include environmental management by focal enterprise such as environmental compliance and auditing programs, and commitment and support of GSCR from managers. Also, it includes external GSCR practices such as cooperation with suppliers for environmental objectives, cooperation with customers for cleaner production and eco-redesign product, environmental audit for suppliers' internal management, evaluation of multi-tier supplier environmentally friendly practice. Hence, through GSCR practices, agrifood supply chain enterprises can address environmental issues related to input of energy per unit of production, processing, packaging, storage, refrigeration, and transportation; ratio of renewal to non-renewable energy consumption, percentage of waste utilized as resource; waste generated per unit of food produced; food lost due to spoilage and mishandling; packaging waste generated; percentage of food waste composited compared to landfilled (Heller and Keoleian, 2003). In the cashew industry, kernel distributors as focal enterprises can cooperate with producers to promote intercrop of cashew trees with leguminous and grass species to enhance environmental performance (Brito De Figueirêdo et al., 2016). Again, kernel distributors can cooperate with RCNs processors to utilize the waste (shell) from the 75 percent weight of RCNs (Azam-Ali and Judge, 2001). Moreover, kernel distributors can cooperate with RCNs processors to reduce environmental impact from different technologies and scales of RCNs processing, as well as transportation routes of RCNs in cashew supply chains (Agyemang et al., 2016).

2.2. Barriers to GSCR and implementation of related practices

Notwithstanding motivations to implement GSCR practices, even highly environmentally conscious enterprises may still face some obstacles (Rauer and Kaufmann, 2015). Many studies have focused on various types of enterprises and industries to identify and analyze barriers to GSCM implementation (e.g., Govindan et al., 2014; Mathiyazhagan et al., 2017; Soda et al., 2017). However, very few of these studies addressed barriers related to GSCR practices in an agrifood supply chain (e.g., Shrivastava et al., 2017). It is evident that there is no much insight on how to strategically address barriers, particularly in identifying the most important and fundamental barriers to GSCR and implementation of related practices. Hence, the scarcity of such

investigation can be considered a research gap. Moreover, to the best of our knowledge, no previous published study focuses on barriers to GSCR and implementation of related practices in cashew supply chains.

For GSCR and implementation of related practices, various actors play significant role or functions in the supply chain (Sarkis et al., 2010). In this study, we focus on identifying barriers based on the internal and external role or functions of the various actors of the supply chain. Thus, our study focuses on developing barriers which are within the supply chain environment (internal), related to members of the supply chain (focal enterprises, suppliers and customers/consumers). On the other hand, the barriers based on perspectives of stakeholders who are outside the supply chain environment (government, industry bodies, etc.) are considered as external barriers. These barriers can also be considered as operational (internal) or strategic (external) (Zhu et al., 2014). Operational barriers consider the role of kernel distributors as the focal enterprise of the cashew supply chain and the role of other internal supply chain actors. Strategic barriers relate to external actors of the supply chain. Appendix A (Table A1) presents a summary of all identified barriers.

2.2.1. Operational barriers related to kernel distributors

A kernel distributor as the focal enterprise of a cashew supply chain plays a critical role by linking multi-tier suppliers (producers and processors) to customers and/or consumers (Seuring and Müller, 2008). The distributor has great influence on some, if not all, of enterprises in the supply chain (Amato and Amato, 2009), and plays a significant role which can influence implementations of related GSCR practices (Matopoulos and Bourlakis, 2010). The common operational barriers related to kernel distributors include the following four factors.

2.2.1.1. Lack of top-level management commitment (L.TopMgt). Leadership is an integral element for implementation of any strategic initiatives in GSCM (Zhu and Sarkis, 2004). Enterprises that integrate sustainability into supply chain management achieves higher levels of sustainable performance (Del Brio et al., 2008; Rice, 2003). Lack of interest and commitment by top-level management may reduce the organizational capacity to consider the possibility for GSCR and implementation of related practices (Dubey et al., 2015; Hsu and Hu, 2008; Sharma, 2000). West Africa as an emerging region which processes RCNs for the global market is not commonly known as compared to other leading and competitive RCNs processing countries in Latin America and Asia (Fitzpatrick, 2011). As such, not many top-level managers of kernel distribution enterprises are committed to GSCR considering processors in Africa.

2.2.1.2. Financial costs and constraints (F. Costs). Cost of green practices is a constraint to GSCM implementation (Min and Galle, 2001; Zhu and Geng, 2013). Although implementation of a GSCM strategy can generate a long-term cost reduction, many of the required practices for initial implementation can increase cost (Simpson et al., 2007). GSCR and implementation of related practices may require the development of supply chain systems and processes, which often increases the costs of traditional operations (Luthra et al., 2011; Mudgal et al., 2010). Many kernel distributors that want to implement GSCR practices may need additional financial investments into the supply chain (Ravi and Shankar, 2005), such as supporting many small-sized processors in volarization of RCNs shell by gasification rather than being burned in open air (Tippayawong et al., 2011). Such financial investments in suppliers may be beyond the financial capacity of kernel distributors (Bhaskaran et al., 2006).

2.2.1.3. Difficulties to assess environmental sustainability performance (DffAssEnvPf). GSCR requires competent skills and capability to measure all relevant or sensitive environmental indicators that can provide information for kernel distributors to redesign or know whether GSCR implementation is performing up to expectation (Ravi and Shankar, 2005). Likewise, the ability of kernel distributors to have quality and comparative environmental data is essential to inform GSCR and achieve better impact from implementation of related practices (Faisal et al., 2007; Rao and Holt, 2005). For example, in measuring carbon footprint, available quality data is necessary (Reap et al., 2008) but this can be very difficult for a kernel distributor to obtain from the various members of the supply chain in different countries since these member have to follow the same guidelines for the measurement and to report (Busse et al., 2016; Gestring, 2016).

2.2.1.4. Lack of an integrated management information and traceability system (L.MIS &T). Implementation of an efficient management information and traceability system can ensure information flow and exchange along the cashew supply chain which can be used for GSCR (Luthra et al., 2011; Sarkis, 2012). Many kernel distributors of West Africa cashew are limited in GSCR efforts because they lack traced information from the supply chain (ComCashew, 2016). For instance, kernel distributors can be guided by traced information to develop customized and effective supplier development programs for small-sized processors and smallholder farmers to effectively implement green supply chain (GSC) practices. Based on its importance, the lack of an integrated management information and traceability can be a barrier for GSCR implementation by kernel distributors.

2.2.2. Operational barriers related to other supply chain internal actors

Many other barriers to GSCR and implementation of related practices in the cashew supply chain occur outside the immediate managerial control of kernel distributors, which are related to the role of other internal actors in the supply chain. These actors include multi-tier suppliers, customers/consumers, and various competitors for enterprises at each stage and along the supply chain, including competitors of producers, competitors of processors, competitors of a focal enterprise (a distributor).

2.2.2.1. Poor multi-tier suppliers' commitment (P.SupComit). Poor suppliers' commitment or low level of trust between enterprises impede the implementation of GSCM practices (Hoejmose et al., 2012; Walker et al., 2008). Many environmental issues in cashew supply chain occur upstream (Agyemang et al., 2016; Brito De Figueirêdo et al., 2016). Therefore, upstream suppliers' commitment to implementation of GSCR practices is vital. However, suppliers' commitment in the cashew supply chain is often characterized by the low level of trust, especially at the link between producers and RCNs buyers /processors in Africa (Honfoga et al., 2016; Kilama, 2013). Thus, it is difficult for kernel distributors to initiate practices in GSCR which require multi-tier suppliers to be committed to GSCR-related efforts.

2.2.2.2. Unwillingness to exchange information among supply chain members (ExchInfoSup). Many studies have suggested that enterprises in supply chains that are more willing to develop close relations in sharing information are better able to implement GSCR practices (Carter and Rogers, 2008; Luthra et al., 2015). Due to the very dynamic nature and inherent complexities in an agrifood supply chain, high intensity of sharing accurate information is even more critical to support GSCR and implementation of related practices (Gold et al., 2017; Iakovou et al., 2016). For instance, exchanging information on the use of pesticide in a farm and energy consumption for processing is essential to inform GSCR. Nevertheless, multi-tier suppliers are often unwilling to exchange information for fear of exposing their weaknesses or giving other suppliers competitive advantage (Walker et al., 2008).

2.2.2.3. Lack of environmentally sustainable (green) cashew suppliers (L.GreenSup). The literature suggests that a limited number of suppliers capable of generating adequate performance in delivering green cashew can be a barrier to GSCR and implementation of related practices (Balasubramanian, 2012; Sajjad et al., 2015). Across West Africa, not many producer organizations (POs) and processors have

been able to acquire recognized certifications to qualify them as green or eco-label suppliers for the global market. Many processors have not been able to get international environmental management certification such as ISO 14,001 which are acceptable or recognized by the global kernel market. Such certification by suppliers signal to kernel distributors about efforts of producers and processors to be committed to further practices in GSCR.

2.2.2.4. Low customer and consumer demand for green cashew (LowGreenDd). Another important barrier to the implementation of practices in GSCR is determined by the demand for green cashew (Bhaskaran et al., 2006; Laroche et al., 2001). Kernel distributors' willingness and commitment to GSCR and implementation of related practices depend on the role of kernel purchasing with environmental considerations. Cashew as a premium nut has high demand and consumption from developed and emerging economies (McNeil, 2014; Red River Foods, 2014). More than 90 percent of global market kernel consumption is outside Africa (Muigai, 2016). Previous studies have pointed out the importance of customers or end-consumers' pressure on the focal enterprises for eco-label products or GSCM practices (Conrad, 2005; Hall, 2000). Consumers in developed countries with the high cashew demand tend to prefer greener products.Nonetheless, the percentage of such green demand is still low (CBI, 2014). Hence, low customer or consumer demand for green cashew is a barrier to GSCR and implementation of related practices.

2.2.2.5. Low level of customer awareness of green cashew (LowCustAw). Lack of knowledge about environmental aspects of a product by consumers can be a barrier to GSCR and implementation of related practices (Govindan et al., 2014; Min and Galle, 2001; Morali and Searcy, 2013). In recent years, locally processed RCNs from West Africa is emerging on the global market, and the associated green concerns in the global cashew supply chain are being promoted by non-governmental organizations (NGOs). Also, regional industry bodies and development agencies support marketing efforts to promote locally processed West Africa RCNs as an environmentally sustainable product (Dahm, 2012). Again, international media attention (e.g., Hirsch, 2013) on the cashew industry draws attention of consumers which drives large-sized kernel distributors to consider GSCR and implementation of related practices (Green et al., 1996; Hall, 2000). However, this promotion is far limited.

2.2.2.6. Uncertainty of economic (financial and operational) benefits (UncertEco). Multi-tier suppliers may not cooperate in GSCR and implementation of related practices if they have a different interest from the entire supply network (Mudgal et al., 2010). Also, many kernel distributors may retain the status quo of conventional supply chain design if the benefit for implementation of practices in GSCR is not guaranteed. Enterprises will only implement GSCR practices if it leads to a specific financial or operational benefits (Bowen et al., 2001). However, an agrifood supply chain like many business environments consists of numerous inherent uncertainties (Bouzon et al., 2018; Van der Vorst et al., 2009). The uncertainty of economic benefits by each member of the supply chain including the kernel distributor itself, caused by market competition along the supply chain (Luthra et al., 2011), makes it difficult for kernel distributors to commit to GSCR and implementation of related practices.

2.2.3. Strategic barriers related to external actors of the supply chain

Successful implementation of GSCR practices in the cashew industry is not only a function of internal supply chain actors within the supply chain environment; it also depends on influence of external stakeholders/institutions that are indirectly involved in the supply chain. They include govenrments, development agencies, and NGOs.

2.2.3.1. Inefficient/lack of national and regional policies and regulations that support GSCR and implementation of related practices (NatPolLack). Government regulations and policies play a crucial role in implementation of practices in GSCR (Diabat and Govindan, 2011; Zhu and Sarkis, 2007). Lack of necessary government regulations and policies may impede or slow down the pace of implementation. Among many government policies and regulations that can influence GSCR and implementation of related practices in the cashew industry are those that enforce environmental management in cashew factories, promote local processing (Olajiga, 2017), and support the use of RCNs' shell as source of electric energy for cashew processing (Zaal, 2017). Hence, a significant barrier to GSCR and implementation of related practices is inefficient or lack of government policies and regulations.

2.2.3.2. Inadequate support and guidance from industry bodies, NGOs and development agencies (IndustSupLack). According to Sarkis et al. (2010), capacity regarding knowledge, skills, training and professional advice on the implementations of practices in GSC is critical. Besides governments, other external institutions interested in environmental issues of the cashew supply chain can support and guide kernel distributors in GSCR implementation, especially in providing complementary knowledge and skills to support supply chain members (Albino et al., 2012). In the West Africa cashew industry, regional and national industrial industries bodies, NGOs and international development agencies play a crucial technical role in providing expertise to supply chain members to collaborate and implement sustainability practices (Dahm, 2012; Heinrich, 2012). However, such initiatives are by far limited to a handful of kernel distributors.

3. Methodology

This section presents the research method and details of data collection for an analysis of barriers to GSCR and the implementation of related practices in the West Africa cashew industry.

3.1. The grey-based decision-making trial and evaluation laboratory approach

The DEMATEL technique (Fontela and Gabus, 1976; Gabus and Fontela, 1972) is a structural modeling approach to identify key factors and explore the causal-effect relations among the factors by visualizing the relations through a causal diagram (Fu et al., 2012; Xia et al., 2015). Essentially, DEMATEL is capable of grouping whole factors as either a cause or an effect category which can lead to the systematic realization of the various components of the system to eventually resolve complicated issues (Govindan et al., 2016). The DEMATEL method has been widely applied in many fields of research, including in management decision-making related to sustainability concerns (Dou and Sarkis, 2013; Kumar and Dixit, 2018; Lin et al., 2018; Mathivathanan et al., 2018; Xia et al., 2015).

Nonetheless, the result of conventional DEMATEL is characterized by problems related to subjective evaluation, incomplete information, and uncertainty (Bai et al., 2017). Subjective evaluations are typically unclear and difficult for decision makers to describe by exact numerical values (Bai and Sarkis et al., 2011). Also, complicated systems in the real world are often uncertain or lack information (Ren et al., 2017). The problem in multi-criteria decision systems under the conditions of uncertainties and incomplete information can be addressed by the grey system theory (Fu et al., 2012; Zhu et al., 2011). It can conduct theoretical analysis of systems with imprecise information and incomplete samples (Tseng, 2009). We used a combined technique integrating the grey approach with DEMATEL in this paper.

According to Fu et al. (2012), the grey DEMATEL is composed of the following steps.

Step 1: Define grey scales for comparisons

In the first stage, a five-level pairwise influence comparison scale

Table 1
The grey linguistic scale with grey numbers.

Linguistic terms	Grey numbers
No influence (N)	[0, 0]
Very low influence (VL)	[0, 0.25]
Low influence (L)	[0.25, 0.5]
High influence (h)	[0.5, 0.75]
Very high influence (VH)	[0.75, 1]

which makes the scale clear and easy to understand for respondents is defined in the questionnaire. They are, 0 = no influence (N), 1 = very low influence (VL), 2 = low influence (L), 3 = high influence (H) and 4 = very high influence (VH). Since the defined scale in the questionnaire is uncertain, we follow previous studies (Fu et al., 2012; Xia et al., 2015) and define the grey linguistic scales for the respondents' assessments in Table 1.

Step 2: Develop a crisp matrix for each evaluator

We asked each of four evaluators to pairwise compare the GSCR implementation barriers and then constructed a grey direct-relation matrix. Subsequently, we used the demonstrated method of Converting Fuzzy data into Crisp Scores (CFCS) to deal with the grey scale (Wu and Lee, 2007). Then, we normalized the grey direct-relation matrix and developed a crisp matrix for each evaluator.

Step 3: Construct the prominence-causal diagraph

In the third stage, we interviewed four evaluators and assigned relative importance weights to each according to their positions and knowledge of the global supply chain of West Africa cashew. Then, we determined the overall crisp matrix using weighted averages. The direct-relation matrix was then normalized, and the total relation matrix for the four evaluators was the ultimate result. Finally, a prominence-causal digraph was constructed. A sensitivity analysis was completed by altering the weights assigned to each of the four evaluators. We also developed relevant prominence-causal digraphs for the sensitivity analysis.

3.2. Data collection from evaluators

In order to analyze barriers to GSCR and implementation of related practices in the West Africa cashew industry, this study purposively samples four evaluators to comprehensively represent the views of supply chain focal enterprises and experts in the industry. They include two top-level managers from two large-sized kernel distributors of more than 5000 metric tons per annum in North America and two supply chain specialists of the West Africa cashew industry. The two kernel distribution managers work in enterprises that have been active in the West Africa cashew industry and initiated green practices in the supply chain such as supporting POs implement green agricultural practices. Over more than 5 years, they have made efforts to promote local processing and increase the volume of kernel they procure from the region. The managers have extensive knowledge about cashew supply chains, working directly with processors and support initiatives for producers to enhance sustainability. Also, the two cashew supply chain specialists provide expert advice to supply chain members of the West Africa cashew industry. They have extensive experience in the industry working for development agencies and NGOs that provide support to the industry. The brief profile of 4 evaluators and their organizations are provided in Table 2.

4. Results, discussion and implications

4.1. Results

The direct-relation matrix of barriers completed by the four evaluators are shown in Tables B1–B4 in Appendix B. Based on the number of years' experience, management position, and organization the evaluator works within the industry, we first assigned weights of 0.325, 0.325, 0.175, 0.175 for Evaluator 1, 2, 3 and 4, respectively. Subsequently, we used the three steps for our DEMATEL approach introduced in Section 2.1. Table 3 shows the overall total-relation matrix (T). Based on the benchmark of 0.8764 derived from adding one standard deviation to the mean ($\theta = 0.7876 + 0.0888 = 0.8764$), we show the important relationships among the barriers. All the relationships meeting or exceeding the benchmark value are underlined and in bold font in Table 3.

The degree of prominence and net cause-effect values are presented in Table 4. The prominence value (D + R) represents the total cause and effect influences. It is the sum of the causal influence (R) and the effect influence (D). The higher the D + R value in the ranking of barriers, the higher the significance of the barrier. A row value (R) represents the total direct and indirect influence of the barrier on the rest of barriers and a column value (D) is the total direct and indirect effect of other barriers on that barrier. The net cause-effect value is calculated by subtracting the effect influence (D) from the cause-effect value (R). A barrier with a high net cause-effect value indicates that it is a fundamental barrier which affects other barriers.

The graphic representation of the overall DEMATEL prominence–-causal relationship is shown in Fig. 1.

In order to avoid the potential bias due to the weight assigned to each evaluator, we conducted sensitivity analysis as suggested by previous studies (Xia et al., 2015; Zhu et al., 2014). Sensitivity analysis is a process to test robustness or consistency of a result. Based on the management position, number of years' experience in the industry and type of an organization each evaluator works with, we changed the weights assigned for the four evaluators. For Condition A, the weights assigned for the four evaluators are 0.3, 0.3, 0.2 and 0.2, respectively; for Condition B, the weights assigned are 0.35, 0.35, 0.15 and 0.15; for Condition C, the weights assigned are 0.275, 0.275, 0.225 and 0.225; for Condition D, the weights assigned are 0.375, 0.375, 0.125 and 0.125. We calculated the Euclidean distance differences of prominence-causal relationships for the total 12 barriers to compare the baseline condition with other four sensitivity conditions from Condition A to Condition D, and the final results are shown in Fig. 2. All Euclidean distance difference values are lower than 2.50. Thus, we can conclude that the relationship evaluation is robust and relatively consistent in the overall relationship evaluations because the bias related to weights assignment is not a major issue.

4.2. Discussion of results

The results of the grey-DEMATEL analysis show the barriers with high prominence and/or high net cause-effect values in Table 4 and Fig. 1. Barriers that are central and well networked have high prominence values. They affect and/or are affected by other barriers. Therefore, in the short-term, kernel distributors, government, NGOs and development agencies effort should aim at addressing these barriers. On the other hand, barriers with high cause-effect values are primary causal factors that should eventually be addressed for GSCR and implementation of related practices

The barriers with the highest prominence values are A4 (lack of integrated management information and traceability system), A1 (lack of top-level management commitment), A10 (uncertainty of economic (financial and operational) benefits), A5 (poor multi-tier suppliers' commitment), and A11 (inefficient/lack of national and regional government policies and regulations that support the implementation of GSCM). Such a result indicates that the barriers to GSCR and implementation of related practices are not very much concentrated on one actor in the industry. Moreover, it shows that many of the barriers are related to internal members of the supply chain. Therefore kernel distributors need to find innovative means to enhance collaboration with multi-tier suppliers to overcome these barriers.

The barriers with the high cause-effect values include A12 (inadequate

Table 2
Brief profiles of 4 evaluators and characteristics of their organizations.

Evaluator	Type of Organization	Size (Employee number)	Position	Role	Years of Experience in the industry
1	Large sized kernel distributor	250	Procurement Manager	Sourcing kernel for distribution	10
2	Large sized kernel distributor	300	Procurement Manager	Sourcing kernel for distribution	8
3	NGO	1500	Global Cashew Sector Lead	Provide expert advice to supply chain members	22
4	Development Agency	40	Director of Project	Provide expert advice to supply chain members	13

Table 3
The total-relation matrix (T).

Barriers	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	0.8261	0.869	0.7634	**0.8971**	0.814	0.7782	0.7573	0.7665	0.7979	**0.9316**	0.818	0.6903
A2	0.8222	0.6771	0.6859	0.7858	0.6808	0.6582	0.6575	0.6854	0.658	0.845	0.7298	0.5875
A3	**0.8854**	0.832	0.6782	0.8725	0.7619	0.7776	0.7611	0.7479	0.8047	**0.9289**	0.8003	0.6838
A4	**0.9724**	**0.91**	0.8425	0.8567	0.856	0.8627	0.8149	0.8131	0.8457	**1.0128**	0.8538	0.6997
A5	**0.9559**	**0.8999**	0.8248	**0.9513**	0.7708	0.8484	0.8428	0.8222	0.8088	**1**	0.8637	0.7146
A6	0.8581	0.7955	0.7578	0.853	0.7558	0.6692	0.7308	0.6815	0.7383	**0.8796**	0.769	0.6233
A7	0.8631	0.7899	0.7403	0.8399	0.7593	0.7378	0.6595	0.6991	0.7505	0.8529	0.7721	0.6458
A8	**0.8951**	0.8408	0.7004	0.8417	0.7848	0.7285	0.7453	0.6766	0.7898	**0.919**	0.7936	0.6523
A9	0.8119	0.6961	0.6312	0.757	0.6847	0.6685	0.6927	0.7102	0.625	0.8275	0.7019	0.5911
A10	0.8643	0.8202	0.6845	0.831	0.7783	0.7699	0.7515	0.7496	0.7561	0.8079	0.7815	0.6203
A11	**0.9299**	**0.8855**	0.7725	**0.9194**	0.8343	0.8047	0.8146	0.8022	0.8315	**0.9684**	0.7637	0.7066
A12	**0.8979**	0.8677	0.7836	**0.9013**	0.8166	0.7931	0.7776	0.7863	0.8157	**0.9332**	0.8224	0.6175

Table 4
The degree of prominence and net cause-effect values.

Barriers	R sum	D sum	R + D	R-D
A1	9.7095	10.5822	**20.2917**	−0.8728
A2	8.4733	9.8836	18.3568	−1.4103
A3	9.5344	8.865	18.3994	**0.6694**
A4	10.3404	10.3068	**20.6472**	0.0336
A5	10.3032	9.2973	**19.6005**	**1.0059**
A6	9.1119	9.097	18.2089	0.0149
A7	9.1103	9.0056	18.1158	0.1047
A8	9.3679	8.9406	18.3084	**0.4273**
A9	8.3976	9.222	17.6196	−0.8244
A10	9.2152	10.9067	**20.1219**	−1.6915
A11	10.0331	9.47	**19.5031**	**0.5631**
A12	9.8129	7.8327	17.6456	**1.9802**

Note: The bold values represent the top five prominence and net cause-effect values of the barriers.

support and guidance from industry bodies and development agencies), A5 (poor multi-tier suppliers' commitment), A3(difficulties to assess environmental sustainability performance), A11 (inefficient/lack of national and regional government policies and regulations that support GSCR and implementation of related practices) and A8 (low customer demand for environmentally sustainable (green) cashew. Again, since the barriers with high cause-effect values are spread across various actors of the supply chain, it affirms the need for more collaboration and partnership among both internal and external stakeholders of the supply chain to enhance environmental sustainability within the supply chain.

4.3. Implications

4.3.1. Managerial implications related to barriers that need to be addressed in the short-term

Barriers A1(L.TopMgt), (A4 (L.MIS &T) and A10 (UncertEco) are three operational barriers with the highest prominence values and low net cause-effect values. All these three barriers are strongly influenced

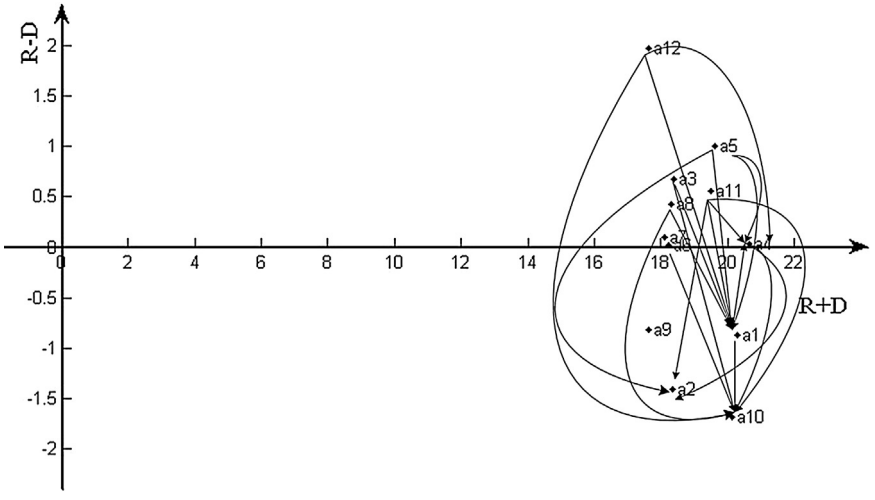

Fig. 1. An overall DEMATEL prominence–causal relationship diagram.

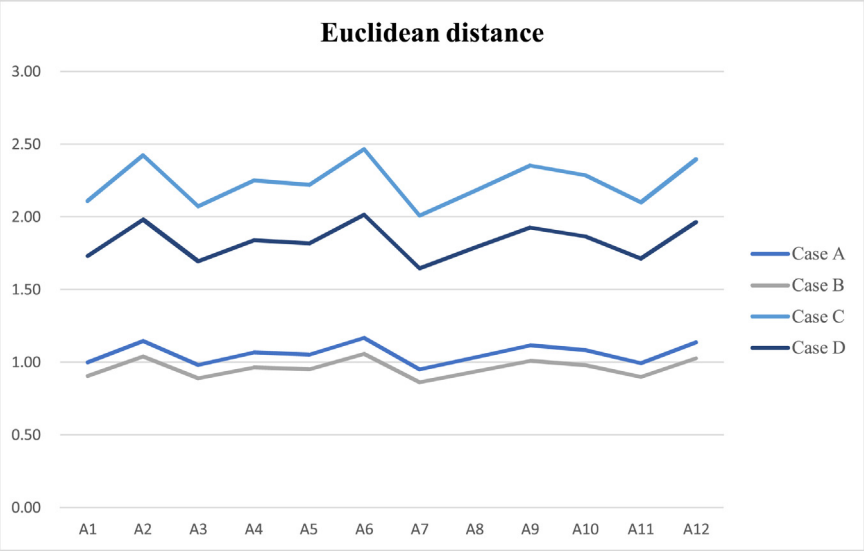

Fig. 2. Euclidean distance of prominence-causal results for sensitivity analysis.

by inefficient or lack of national and regional government policies and regulations that support GSCR and implementation of related practices (A11). The results suggest that effective support of government is needed to address these barriers in the short-terms. West Africa governments should take a proactive strategy to stimulate the interest of top-level mangers of kernel distribution enterprises in GSCR strategy and promote the implementation of integrated management information and traceability system. Also, intervention programs such as the recently introduced "One District-One-Factory" in Ghana should encourage multi-tier collaboration among cashew supply chain members to enhance the certainty of economic benefits in GSCR.

The highest prominent barrier is lack of integrated management information and traceability system (A4). The move towards "big data" as an important information technology to efficiently evaluate environmental footprint and guide decisions within agrifood supply chains has given the opportunity to ease this barrier (Ahearn et al., 2016; Syahruddin and Kalchschmidt, 2012). Such information system provides environmental measures on parameters such as soil erosion, hazardous material use, energy consumption and water use, that can give access to kernel distributors to have detailed environmental data to initiate and continuously support GSCR and evaluation of practices. According to evaluators, linking environmental sustainability data collected within cashew supply chains from different actors and systems currently, suffer from low interoperability. Recently, through Sustainable Nut Initiative (SNI), leading kernel distributors in North America and Europe have collaborated to initiate a system (3S program) which aims to stimulate traceability and sustainability in the global cashew supply chain. Nonetheless, the 3S program and many other similar innovations are predominantly in the pilot phase and need support to become useful tools for the industry. As shown in Table 4 and Fig. 1, this barrier is highly influenced by A11 (NatPolLack) and A12 (IndustSupLack). Thus, the support of industry bodies and experts as well as government policies to enhance the implementation and effectiveness of such systems is very necessary. For example, national and regional governments need to clarify legal concerns of gathering such data as it relates to intellectual property and protection of the interest of producers in sharing information (Ahearn et al., 2016).

Lack of top-level management commitment (A1) has the second highest prominence value. As supply chain managers, top-level managers of kernel distributors need to be convinced to initiate or commit themselves to GSCR efforts. Interestingly, as shown in Table 4 and Fig. 1, A1 (L. TopMgt) is highly influenced by poor multi-tier suppliers' commitment or the low level of trust (A5). Hoejmose et al.(2012) argued that GSCM will thrive where there is top-level management support coupled with trust in suppliers. Again, as stated earlier, A11(NatPolLack)) strongly affects A1(L. TopMgt). Thus, kernel distributors commitment to GSCR and implementation of related practices should be improved through efforts to enhance trust in the supply chain and support by national and regional government policies to create the enabling environment.

The uncertainty of economic (financial and operational) benefits (A10), an operational barrier to GSCR and implementation of related practices is the third highest prominent barrier. Similar to A1(L.TopMgt), it is influenced strongly by poor multi-tier suppliers' commitment (A5). Also, it is influenced by lack of integrated management information and traceability system (A4). Therefore, kernel distributors initiatives that can improve the level of trust in the supply chain or make multi-tier suppliers be committed to the supply chain is instrumental to reduce the uncertainty of benefits for the kernel distributors as well as for other supply chain members.According to evaluators, the uncertainty of benefits especially related to RCNs trading should be minimized through the implementation of integrated management information and traceability system. Also, kernel distributors should support processors to form stronger collaboration with POs.

4.3.2. Managerial implications related to barriers that need to be addressed in both the short and long-term

As shown in Table 4 and Fig. 1, operational barriers A5 (P.SupComit) and strategic barrier A11(NatPolLack) have both high prominent and net cause-effect values. This outcome suggests that to redesign and implement GSC practices, these barriers need to be addressed by kernel distributors and policymakers in the short-term, but effort needs to be continuously made to eventually address these barriers in the long-term.

Poor multi-tier suppliers' commitment (A5) is the fourth highest prominent value and the second highest net cause-effect barrier. According to evaluators, most kernel distributors would prefer West Africa processors to have reliable groups of POs with whom they can reliably procure their RCNs and develop committed supply relationship. However, resilient producer-processor relationship is uncommon. Through the initiatives of development agencies and NGOs, leading kernel distributors support processors to enhance their collaboration with POs. Kernel distributors, NGOs and development agencies should seek to understand, through research as the next step, the resilience of PO in the West Africa cashew supply chain to know how to enhance their capacity and commitment to GSCR and implementation of related practices.

Inefficient or lack of national and regional government policies and

regulations that support the implementation of practices in GSCR (A11) is the fifth highest prominent value and the fourth highest net cause-effect. Over the past years, momentum has been gathered to enhance the policy environment of Africa cashew industry. Recently, the government ministries responsible for the cashew sector in 9 Africa countries formed the Consultative International Cashew Council (CICC), an international organization with legal capacity and financial autonomy responsible for promoting the sustainability in the cashew industry (ComCashew, 2017). This body will help harmonize policies such as RCNs trading in Africa that can increase the interest and commitment of kernel distributors in GSCR and implementation of related practices. Nevertheless, more strategic national and regional government policies and regulations need to be made and implemented to support the kernel distributors overcome the numerous barriers to GSCR and implementation of related practices (Zaal, 2017). For example, national governments should build and strengthen institutional mechanism to support and advice kernel distributors in GSCR and implementation of related practices.

4.3.3. Managerial implications related to barriers that needs attention in the long-term

Difficulties to assess environmental sustainability performance (A3), low customer and consumer demand for green cashew (A8), and inadequate support and guidance from industry bodies and development agencies (A12) have high causal-effect but low prominence values. The result suggests that it is important for kernel distributors to work towards enhancing how environmental sustainability performance is measured. However, they need to address this barrier to GSCR and implementation of related practices well, in the long-term. Also, customer and consumer demand for green cashew is essential for GSCR and implementation of related practices. Opportunities to maitain or increase demand for green cashew should be an important focus in the long-term. Again, industry bodies and developing agencies need to continuously support the industry in GSCR and implementation of related practices, but in the long-term, this barrier should be well addressed.

Barrier A12 (IndustSupLack) is the highest net cause-effect barrier with low prominent value. There is the need for industry bodies to increase their support and promote GSCR and implementation of related practices. ACA as the main regional industry body should expand its activities, through partnership with institutions such as the Africa Development Bank to enhance the capacity of processors meet competitive standards which can signal to kernel distributors the potential for GSCR and implementation related practices (ACA, 2015b). Also, international development agencies projects such as ComCashew should expand their effort in building strong institutional support to promote GSCR and implementation of related practices. Their activities such as supporting rural farmers to implement green agricultural practices, advocating for favorable government policies, and developing local capacities of highly knowledgeable resource persons as trainers in cashew supply chain should be well coordinated and integrated into programs of industry bodies and government agencies.

Barrier A3 (DffAssEnvPf) is the third highest net cause-effect barrier with low prominent value. The current structure through which environmental data in West Africa cashew supply chain are conceived for decision making faces many challenges. Across Africa, it is a difficult task to collect sustainability data from farmers due to their small sized ownership of farms (Olam, 2017). Also, gathering quality environmental data such as on measuring pollution and pesticide usage may have to be accomplished by a professional. According to evaluators, in many POs and small-sized cashew processing factories located in rural areas in the region, it can be a difficult task to find the right staff member or professional to provide the necessary environmental data into a system for the kernel distributor.In the long-term, kernel distributors and industry bodies should focus on training PO leaders and processing staff members to assess and report environmental data with easy to use technologies suitable for less technical know–how use.

Low customer and consumer demand for green cashew (A8) is the fifth highest net cause-effect barrier with low prominent value. Price of green products plays a vital role in consumer choice between green cashew and standard ones since green cashew are often more expensive. The demand for standard product is reinforced with the competitive price (Brécard et al., 2009).According to evaluators, one of the major ways for green cashew from Africa to enhance its competitiveness on the global market is through food safety and quality standards as well as other social/labor standards. Therefore, many leading kernel distributors interested in GSCR are keen on how they can enhance the competitiveness of green cashew and create value for all members of the supply chain through quality and food safety standards, and fair trade certification (ACA, 2011; Etc Terra, 2015). Moreover, Kernel distributors are keen on how to increase green cashew demand beyond niche markets in developed countries.

4.3.4. Theoretical implications

A major theoretical contribution by this study is the identification of barriers to GSCR and implementation of related practices based on both the role and function of supply chain members as well as stategic forces from external stakeholders of the supply chain. Again, it shows that the framework of barriers to GSCR and implementation of related practices could be assessed to show the most important and fundamental barriers. Thus, it presents a robust method to evaluate barriers to GSCR and implementation of related practices. The results of the study as shown in Table 5 suggest that successful GSCR implementation needs increasing collaboration between kernel distributors and multi-tier suppliers, as well as the strategic support from industry bodies, NGOs and development agencies.

Earlier studies have articulated the importance of multi-tier GSC relationship (e.g., Dou et al., 2017; Mena et al., 2013; Tachizawa and Wong, 2014) and collaboration among supply chain members in GSCM (e.g., Green et al., 2012; Klassen and Vachon, 2009; Vachon and Klassen, 2006). Building on the resource–based view of the firm, Albino et al. (2012) argued that inter-organizational collaborations among internal supply chain members and external supply chain actors are beneficial for the focal enterprise overall environmental performance and the management of its environmental footprint.The various supply chain members of the firm possess resources which when integrated can lead to capabilities needed for the focal enterprise to implement GSCM (Hart, 1995). Therefore, the array of characteristics idiosyncratic to the focal enterprise ability to implement GSCR can be derived from a unique combination of internal and external capabilities that enables it overcome barriers.

Likewise as shown in Table 5, the study highlights the importance of institutional impact on supply chain internal and external resource capability to implement GSCM (Nezakati et al., 2016; Scott, 2011).The institutional lens has widely been utilized to explain organizational arrangement, arguing that enterprises are influenced by their institutional context (Carbone and Moatti, 2011; Sarkis et al., 2011). It helps to explain how the focal enterprise can address the barriers to GSCR and implementation of related practices due to potential coercive, normative, or mimetic pressures. Specifically, the strategic management of the supply chain institutional environment can effectively be shaped for an orientation towards GSCR and implementation of related practices. Therefore, different institutional conditions can yield different stakeholders influences on the focal enterprise towards GSCR and implementation of related practices (Meixell and Luoma, 2015; Sarkis et al., 2010).

In addition, the study suggests a relationship among operational and strategic barriers to GSCR and implementation of related practices.Further empirical reaserch can be conducted to understand the various internal and external roles and functions of supply chain actors and external stakeholders in GSCR implementation. For instance, how government policies influence GSCR and implementation of related practices.

5. Conclusions

Due to the impact on the environment, especially in regards to climate change, there has been critical pressure on focal enterprises to enhance the environmental sustainability performance in supply chains (Walker et al., 2008; Zhu and Sarkis, 2007). GSCR brings an opportunity for focal

Table 5
Recommendations for the different actors and external stakeholders of the supply chain.

Actor/Institution	Short-Term	Long-Term
Kernel Distributors	Kernel distributors need to implement integrated management information and traceability system (A4) Kernel distributors need to be convinced to initiate or commit themselves to GSCR efforts (A1) Kernel distributors initiatives in the supply chain should improve the level of trust among supply chains members to reduce the uncertainty of benefits (A3) kernel distributors need to support processors to enhance their collaboration with POs (A5) In the short-term, kernel distributors need to collaborate with national and regional governments to enhance policies and regulations for the implementation of practices in GSCR (A11)	Kernel distributors need to enhance how environmental sustainability performance is measured (A3) Kernel distributors need to support processors to enhance their collaboration with POs (A5) In the long-term, kernel distributors need to collaborate with national and regional governments to enhance policies and regulations for the implementation of practices in GSCR (A11)
Suppliers	POs need to collaborate with kernel distributors in multi-tier supplier initiatives(A5)	POs need to collaborate with kernel distributors in multi-tier supplier initiatives (A5) PO leaders and processing factory staff members need to enhance their capacity to assess and report environmental data (A3)
Customers	–	Customers and consumers need to increase demand (A8)
Competitors	–	–
Government	In the short-term, national and regional governments need to implement policies and regulations that support practices in GSCR (A11)	In the long-term, national and regional governments need to implement policies and regulations that support practices in GSCR (A11)
Industry bodies, NGOs and Development agencies	–	Industry support bodies, NGOs and development agencies need to increase their support and promote GSCR and implementation of related practices (A12)

enterprises, particularly in agrifood supply chains to address environmental sustainability concerns (Iakovou et al., 2014). However, barriers to GSCR exist in many industries. In this study, guided by two objectives highlighted in the first section, we systematically identified numerous barriers to GSCR and implementation of related practices in the West Africa cashew industry. These barriers are based on both operational and strategic perspectives of the supply chain. The operational barriers are related to the role of a kernel distributor as the focal enterprise of the cashew supply chain and the role of other internal supply chain actors. The strategic barriers are related to the role of external actors in the supply chain environment. Subsequently, based on data from two top-level managers of kernel distribution enterprises and two cashew supply chain experts, the relationships among the identified barriers were analyzed with the aid of the grey-based DEMATEL method. The results of analysis provide decision support for kernel distributors and policymakers in the cashew industry to develop effective approaches for GSCR and the implementation of related practices.

The results of the study show that the highest prominence barriers are fairly spread across the various actors of the supply chain. As such, overcoming the numerous barriers to GSCR and implementation of related practices in the West Africa cashew industry strongly rest on the role of both internal and external actors of the supply chain. Therefore, kernel distributors need to strengthen their collaboration with multi-tier suppliers in the operation of West Africa cashew supply chains. Also, the strategic support from industry bodies, NGOs and development agencies is crucial for successful GSCR implementation. In the short-term, government policies and regulations should support kernel distributors to overcome three key operational barriers which are lack of top-level management commitment, lack of integrated management information and traceability systems and the uncertainty of economic benefits for GSCR and implementation of related practices.

Our findings, which resonate with the existing literature (e.g., Dhull & Narwal, 2016; Zhu & Sarkis, 2006), contributes to the evidence that different sectors and industries have different barriers to the implementation of GSCM. Nonetheless, it is interesting to observe that many studies have highlighted barriers to GSCM (e.g. lack of government support policies and lack of top-level management support) similar to our study as of high importance. They propose a wide range of solutions to address these barriers which the West Africa cashew industry can draw lessons. For instance, in the construction industry, Balasubramanian, (2012) suggested that regional and national governments should develop policies to address external barriers to GSCM which emphasize on encouraging people and enterprises to make sustainable choices.

Despite sharing deep insights on the barriers to GSCR and implementation of related practices, this paper does not explain the impact of each barrier. Further studies can consider exploring this area. Also, the study was limited to the data for the analysis. This study used data from two top-level managers of large-sized global kernel distributors and two cashew supply chain experts, future studies, may consider a more varied sample population for the analysis. Furthermore, future studies should seek insight into the resilience of suppliers especially POs in the cashew supply chain to understand how kernel distributors can enhance their collaboration with multi-tier suppliers. Also, the various programs from industry bodies, NGOs and development agencies that can foster the potential for GSCR and implementation of related practices, need to be explored to identify strategic ways in which these interventions can support GSCR and implementations of related practices.

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Appendix A

Table A1
Barriers of green supply chain redesign in the West Africa cashew industry.

Source of Barrier	Actor/Institution	Barrier	Description of Barrier
Operational (Internal) barriers of green supply chain management related to focal enterprise	Kernel Distributors (Focal enterprise)	**A1 Lack of top-level management commitment (L.TopMgt)**	Lack of commitment by top level management in GSC may reduce organizational capacity to redesign and implement related practices in GSCR. West Africa RCNs processing sector is emerging, the region is not commonly known as a source of kernel for the global market compared to India, Brazil and Vietnam. As such, top-level managers of Kernel distributors do not have much deep insights to be committed to GSCR and implementation of related practices
		A2 Financial costs and constraints (F. Costs)	Financial investments such as kernel distributors supporting many small-sized local processors to use low emission energy in processing may be very costly initiative for kernel distributors. Therefore, the financial cost of GSCR for kernel distributors is a significant barrier to GSCR and implementations of related practices.
		A3 Difficulties to assess environmental sustainability performance (DffAssEnvPf)	Measuring accurate environmental sustainability performance across supply chain operations by kernel distributor to inform GSCR may be difficult to obtain. For instance, in measuring the carbon footprint (Gestring, 2016)
		A4 Lack of integrated management information and traceability system (L.MIS &T)	Many kernel distributors of the West Africa kernel are limited in their effort to redesign and implement practices of GSC because they lack traced information from the supply chain to make good decisions for such an initiative.
Operational (Internal) barriers of green supply chain management related to other supply chain actors	Suppliers	**A5 Poor multi-tier suppliers' commitment (P.SupComit)**	Poor suppliers' commitment or low level of trust especially at the farmer level impede the implementation of practices in GSCR (Walker et al., 2008). In some cases, producers and processors do not honor each other contracts. As such, it is difficult for kernel distributors to initiate practices in GSCR which require multi-tier suppliers to be committed to the supply chain and to the green initiatives
		A6 Unwillingness to exchange information (ExchInfoSup)	Cashew supply chain members may be unwilling to exchange information on GSC for fear of exposing their weaknesses or giving other enterprises competitive advantage. This is very common when RCNs processors have to source RCNs from middlemen rather than from producers. Thus, the unwillingness to exchange information can impede kernel distributors goal for GSCR.
		A7 Lack of sustainable suppliers (L.GreenSup)	Across West Africa, not many cashew producers and processors have been able to acquire recognized certifications to qualify them as green or eco-label suppliers for the global market. Such certification by suppliers signal their potential to kernel distributors for further commitment to practices in GSCR.
	Customers	**A8 Low consumer demand for environmentally sustainable (green) cashew (LowGreenDd)**	Kernel distributors' willingness and commit to GSCR and the implementation of related practices depends on the level of demand for green cashew by customers and consumer. Therefore, low demand from places of higher demand impede the implementation of GSCR practices.
		A9 Low level of customer awareness of green cashew (LowCustAw)	Locally processed RCNs from West Africa on the global market and the associated environmental concerns in the supply chain is being marketed through industry bodies and NGOs effort. However, these recent efforts are by far limited which makes low level of awareness of green cashew a barrier to the implementations of practices in GSCR.
	Competitors	**A10 Uncertainty of economic (financial and operational) benefits (UncertEco)**	One of the common uncertainty regarding the benefit of GSC practices in West Africa cashew supply chain are related to processors and producers. Farmers may sell their high quality RCNs to competing network for much higher profit. Also processors may not honor their contract with producers. Thus, uncertainty of benefits by each member of the supply chain including the kernel distributor itself, caused by competition along the supply chain, makes it difficult for kernel distributors to commit to GSCR and implementation of related practices.

(*continued on next page*)

Table A1 (*continued*)

Source of Barrier	Actor/Institution	Barrier	Description of Barrier
Strategic (External) barriers of green supply chain management related to non-supply chain actors	Government	**A11 Inefficient/lack of national and regional government policies and regulations that support GSCR and implementation of related practices (NatPolLack)**	Lack of the necessary government regulations and policies may impede or slow down the pace of implementation. For example, in 2016, Cote d'Ivoire placed a ban on cross border RCNs trading which stifled the ability of local Ghanaian processors to stock their factories during the RCNs buying season and this favored the exportation of RCNs outside the region.
	Industry bodies and Development agencies	**A12 Inadequate support and guidance from industry bodies, NGOs and development agencies (IndustSupLack)**	Inadequate support and guidance of industry bodies, NGOs and developmental agencies resources and experts to guide multi-tier suppliers and kernel distributors may impede the implementation of practices in GSCR. For example, ComCashew, support kernel distributors and processors to work with farmers to implement green agricultural practices. Nonetheless, much of these support are still needed to expand the implementation of GSCR and implementation of related practices.

Appendix B

Table B1
The direct-relation matrix of barriers by Evaluator 1.

Barriers	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	0	3	3	4	3	2	2	4	3	4	4	3
A2	4	0	3	3	1	0	1	2	0	4	3	3
A3	4	2	0	4	1	2	2	2	4	4	3	3
A4	4	3	4	0	3	4	2	2	2	4	3	1
A5	3	3	3	4	0	3	4	3	2	4	4	3
A6	3	3	4	4	2	0	2	0	2	3	2	1
A7	3	3	3	3	3	3	0	2	3	3	4	2
A8	4	4	1	2	3	2	2	0	4	4	3	1
A9	4	1	0	2	1	2	3	4	0	4	3	2
A10	4	4	1	3	3	3	3	4	2	0	4	1
A11	3	3	3	3	3	3	4	2	3	3	0	3
A12	3	3	3	3	3	3	2	2	3	2	3	0

Note: 0 = no influence, 1 = very low influence, 2 = low influence, 3 = high influence, and 4 = very high influence.

Table B2
The direct-relation matrix of barriers by Evaluator 2.

Barriers	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	0	4	2	3	3	1	0	0	3	3	3	3
A2	3	0	3	3	0	0	1	3	0	4	3	0
A3	3	3	0	3	2	3	3	3	3	2	3	3
A4	3	3	4	0	3	4	3	3	3	4	2	2
A5	3	3	3	3	0	3	3	3	1	3	3	2
A6	4	1	4	3	3	0	3	1	1	2	3	2
A7	3	2	3	3	4	3	0	1	3	0	3	3
A8	3	4	1	3	3	1	2	0	3	3	2	2
A9	3	0	1	2	2	0	3	4	0	3	1	2
A10	3	3	0	1	3	4	3	3	3	0	2	0
A11	2	3	1	3	3	2	3	3	3	3	0	2
A12	1	3	3	3	3	2	2	3	3	2	2	0

Note: 0 = no influence, 1 = very low influence, 2 = low influence, 3 = high influence, and 4 = very high influence.

Table B3
The direct-relation matrix of barriers by Evaluator 3.

Barriers	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	0	3	3	3	4	4	4	3	3	3	3	3
A2	4	0	4	3	4	3	3	3	3	4	3	3
A3	2	2	0	4	4	4	3	3	4	4	4	4
A4	2	3	4	0	3	3	4	3	4	4	2	2
A5	1	2	4	4	0	4	3	2	1	3	1	2
A6	1	3	4	4	3	0	3	1	4	4	3	1
A7	4	1	4	4	2	1	0	1	2	2	2	2
A8	4	2	3	3	4	1	4	0	3	4	4	4
A9	4	1	4	4	4	4	4	4	0	4	4	4
A10	1	2	3	3	4	4	3	2	3	0	3	3
A11	3	3	3	4	3	2	3	3	4	4	0	3
A12	2	3	3	4	3	3	4	4	4	4	3	0

Note: 0 = no influence, 1 = very low influence, 2 = low influence, 3 = high influence, and 4 = very high influence.

Table B4
The direct-relation matrix of barriers by Evaluator 4.

Barriers	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	0	4	2	3	3	4	3	3	2	0	0	2
A2	4	0	2	3	3	4	2	3	2	2	3	2
A3	0	4	0	0	0	3	2	0	3	4	0	2
A4	4	4	3	0	3	4	0	2	3	3	2	2
A5	4	3	3	3	0	4	4	4	2	4	2	2
A6	3	4	3	3	3	0	2	2	3	3	3	3
A7	3	3	3	2	1	2	0	2	2	3	1	3
A8	3	3	0	1	2	2	2	0	4	3	3	3
A9	3	2	1	1	1	3	2	3	0	2	1	1
A10	2	3	0	3	3	3	3	3	3	0	2	3
A11	3	4	1	3	3	3	2	4	3	3	0	3
A12	3	4	3	3	3	3	2	3	3	3	3	0

Note: 0 = no influence, 1 = very low influence, 2 = low influence, 3 = high influence, and 4 = very high influence.

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