



## Full length article

## 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 (Küçüksayrac, 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

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