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Top Management, Green Innovations, and the Mediating Effect of Customer Cooperation in Green Supply Chains

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Abstract: This study examines the mediating role of customer cooperation in green supply chain relationships. Employing 181 manufacturer–customer relationships, we test the mediating effect of customer cooperation on the process and managerial innovations. As proposed, customer cooperation positively mediates the relationship between top management commitment and process innovation. However, customer cooperation fails to mediate the relationship between top management commitment and managerial innovation. The findings suggest that the magnitude of customer cooperation increases the adoption of green innovations between supply chain partners to mitigate the negative impact on the environment. Furthermore, customer cooperation enforces a sense of mutuality between supply chain partners to diminish the impact of carbon footprint.

Keywords: customer cooperation; green innovations; top management commitment; green supply chains

1. Introduction

Reducing carbon footprint is now an integral part of supply chains. Businesses realize that when supply chains become greener, they provide them with win-win outcomes such as safeguarding the environment, improving corporate profitability, and opening new market opportunities. For such reasons, business firms adopt and implement green innovations to become greener. Green innovations are a subcategory of sustainable efforts, which firms pursue to address the ecological, social, and economic performance [1]. Current literature [2,3] supports that theory that businesses achieve competitive advantages when they adopt sustainability-driven practices and green innovations. In other words, green innovations (GIs) provide supply chain partners better control and visibility in meeting sustainability (green) objectives.

A green supply chain focuses on minimizing the environmental damage by working closely with supply chain partners that are entirely willing to practice green business practices [4,5]. In this study, we apply green or sustainable supply chains as synonymous, and green supply chain research [4] use them as interchangeable concepts. References [6,7] show that when business firms adopt green innovations and practices, it results in economic profitability, better resource utilization and a reduction in environmental degradation costs. That is why international business firms such as IBM and Xerox encourage their suppliers to improve environmental management systems and bring them by ISO 1400/14001 certifications. Likewise, automobile manufacturers Ford, General Motors and Toyota help their suppliers to fulfill the required environmental certifications to reduce ecological damage [8].

In green supply chains, customer cooperation is critical because it helps in developing a reliable sustainable compliance system [5]. Customer cooperation (CC) refers to the extent an exchange partner is willing to work and achieve sustainable outcomes [9]. When exchange partners cooperate, trust develops and increases innovations in a relationship [10]. Adoption of green practices by one of the partners enforces other partners to follow suit [11]. Such support towards sustainable practices between supply chain partners results in providing better levels of sustainable advantages [12,13]. Similarly, developing close cooperation with supply chain customers should strengthen green innovations in supply chains.

Close customer cooperation motivates supply chain partners to adopt and implement green innovations and practices. As a result, this approach would help in diminishing the adverse effect of supply chain activities on the environment. Objectively, green supply chains embrace and implement green innovations that provide superior value to their customers. For instance, green products and green business opportunities. In supply chains, better customer cooperation offers a win-win opportunity for meeting customer demands and improving sustainability efficacy. Adopting green innovations help businesses in maintaining sustainable competitiveness [14,15]. In supply chains, sustainable competitiveness act as a competitive tool that provides the needed reputation required by customers and consumers [16]. Hence, it is crucial to examine the role of customer cooperation in enhancing green innovations in green supply chain relationships.

Literature classifies green innovations as product innovations, process innovations, green technologies, managerial functions and manufacturing processes [17,18]. In this study, we employ green managerial innovation (GMI) and green process innovation (GPI). Green managerial innovation refers to measures undertaken by a firm to redesign and refine current administrative and services operations to achieve internal environmental efficiency [19]. Green managerial innovation implies undertaking various managerial measures to improve environmental awareness and environmental performance, which reduces the negative impact on the environment [20]. Furthermore, green managerial innovations underscore a radical change in a firm's managerial attitude toward environmental protection. Hence, green managerial innovation accentuates the necessary administrative modifications a firm must undertake to diminish the negative environmental impact.

Green process innovation refers to the improvements made in the existing manufacturing processes and adding new modifications to minimize the harmful effect of hazardous pollution on the environment [18]. In other words, green process innovations focus on specific improvements made in manufacturing operations to optimize resource usage. Implementing new procedures, adopting new innovative technologies to save energy, and reducing pollution during manufacturing are integral elements of green innovations [21]. For instance, using biodegradable materials in manufacturing processes.

Business firm's top management commitment towards sustainability and close cooperation with supply chain partners is vital in developing as well as strengthening green supply chains [19]. This study describes top management commitment (TMC) as the concrete support provided by a firm's top management towards sustainable operations and practices [22]. When a firm's senior management supports and implements sustainable practices with supply chains partners, it provides a supply chain the strategic strength to achieve triple bottom line (TBL) objectives [6]. Adopting and implementing sustainable practices in supply chain operations remain a challenging task. Many studies [7,9,17,22] outline the role of top management commitment, green innovations and customer cooperation in green supply chains. However, there is a limited effort to examine the effect of customer cooperation on the top management-green innovation relationships.

Recent literature [6] identifies the role of top management commitment and green innovations in achieving sustainability goals in supply chains. Nevertheless, there is a lack of evidence regarding the mediating effect of customer cooperation on the relationship between top management and green innovations in green supply chains. The goal of this research is two-dimensional. First, this research identifies the strategic role of customer cooperation as a reinforcing antecedent in

achieving sustainability objectives in supply chains. Second, the study highlights the combine roles of internal and external environment processes in pursuing challenging sustainability goals in supply chains. Overall, our research shows that an alignment of internal and external environmental processes helps achieves greener supply chains.

In the next section, we outline the conceptual model and hypotheses. Section 3 provides the data collection procedures, measurement constructs and data validity. Section 4 outlines the results. Finally, Section 5 includes discussion and conclusion.

2. Conceptual Model and Hypotheses

Internally, green supply chains demand dedicated green innovations focused on changing organizational structures and business operations. Externally, one of the essential requirements for green supply chains is to have a close collaborative relationship with collaborating customers. Top management commitment is one of the critical internal factors in achieving internal environmental management efficacy. High levels of ecological dedication and support by top management on environmental issues are fundamental for green innovations [23]. Similarly, customer cooperation, an external environmental management efficiency element, plays a critical role in adopting green innovations [24].

Adopting and implementing green innovations are directly correlated with the managerial side because it helps businesses in creating green or sustainability competitive advantages [23]. Commitment by top management plays an essential role in transforming and developing a firm's managerial and organizational structures [13], thereby providing the necessary support to undertake and achieve green practices [12]. Correspondingly, closer coordination and cooperation with customers and other supply chain partners result in the successful adoption of green innovations [25,26].

The conceptual model (see Figure 1) of this study connects top management commitment to customer cooperation and green innovations. Our research model first recognizes the role of top management commitment to building robust customer cooperation and adopting green innovations. Later, we examine how customer cooperation augments the adoption of green innovations in supply chains.

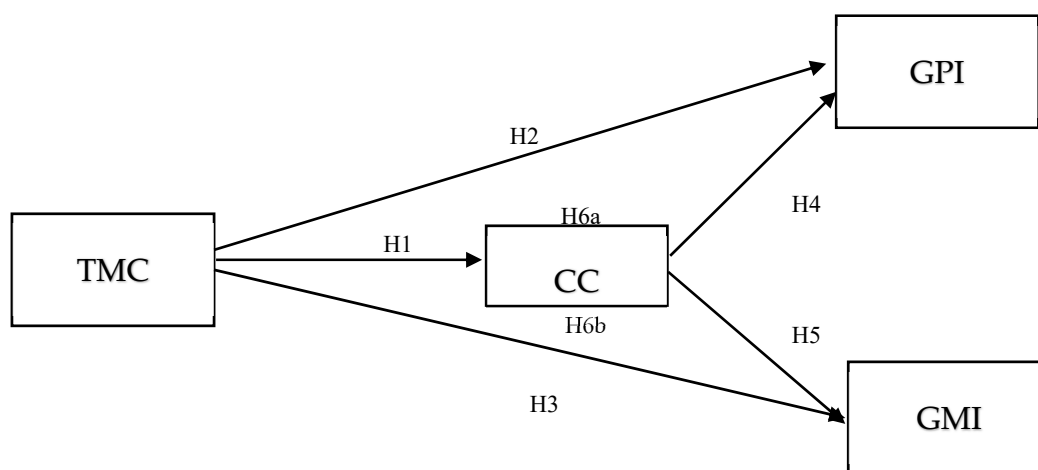


Figure 1. The Research Model.

2.1. Top Management, Customer Cooperation and Green Innovations

Concrete commitment towards sustainability by top management demonstrate that a firm will take necessary measures to develop and implement the required administrative and operational structures for implementing sustainability practices [12,27]. The absence of commitment to sustainability creates difficulties in adopting green practices and the sustainability vision in a firm [28]. Likewise, close cooperation with supply chain partners plays a critical role in adopting sustainable practices in

supply chains [26]. When business firms provide sustainable solutions to their customers, it provides them with a competitive advantage in the market [22,29].

In a supply chain context, top management commitment to sustainability exhibits a supply chain's ability to minimize carbon footprint and deliver value to its customers. Increasing environmental awareness and preference for green products by consumers further heightened the need for close customer collaboration in supply chains. When supply chain partners collaborate on sustainability issues, it facilitates them in the adoption of green innovations and practices [30]. Commitment by top management strengthens customer cooperation because it helps them in achieving sustainable objectives [13]. Hence, we propose:

Hypothesis H1. *There is a positive association between top management commitment to sustainability and customer cooperation.*

A firm's top management plays a crucial role in implementing and managing sustainability issues [31]. Similarly, an active partaking by top managers is critical in adapting and achieving green process innovation [32]. Current research shows that outstanding commitment by senior managers to adjust and improve green process innovation improve environmental sustainability goals [18]. This feature provides top managers in improving green competitive advantages and underlining which factors differentiate their businesses from competitors [33]. Recent research [6] shows top management commitment to green process innovation has a positive effect on supply chains performance. Hence, we propose:

Hypothesis H2. *There is a positive association between sustainable commitment by top management and green process innovation.*

For improving environmental performance, top management actively monitors wide-ranging ecological policy matters and then act accordingly to modify the firm's internal commitments towards green innovations. Green managerial innovation is critical for developing internal environmental management efficiency and involves changing a firm's organizational and management structures. When top management supports green managerial innovations, it develops an internal environment that is more conducive to innovative solutions that enhance the green image of a firm [22]. Supporting green administrative changes helps in reducing the negative impact of supply chain operations on the environment. By following green managerial approaches, managers achieve commercial and green performance objectives in a supply chain [17,22]. Hence, we propose,

Hypothesis H3. *There is a positive association between sustainable commitment by top management and green managerial innovation.*

2.2. Customer Cooperation and Green Innovations

In supply chains, customer cooperation is a vital element for process innovation [34]. Close customer cooperation allows businesses to improve their process innovations capabilities in key supply chain areas such as product quality, lead-time and product development [35]. Close collaboration with customers also improves market share and builds competitive advantage [36,37]. Strategically, better customer cooperation provides necessary information about new market trends and emerging market demands. Consequently, innovation processes facilitate the development of new products. For instance, when customers demand temporary solutions to their difficulties, it expedites process innovation [38]. Other studies [39,40] demonstrate that close customer cooperation improves process innovation. Hence, we propose,

Hypothesis H4. *There is a positive association between customer cooperation and green process innovation.*

Reference [41] recognizes the role of customer cooperation in motivating partners to adopt and implement innovations. For instance, business firms develop active collaboration with their customers to create and enforce managerial innovations that maximize customer value [42]. In supply chains, close integration between manufacturers and customers has a positive effect on the firm's organizational innovation levels [43]. We propose,

Hypothesis H5. *There is a positive association between customer cooperation and green managerial innovation.*

2.3. Mediation Effect

Currently, industrial customers focus on developing innovative solutions to minimize their carbon footprints. Similarly, end-consumers have become more environmentally conscious. Therefore, end-consumers are interested in understanding the ways consumer products are manufactured and disposed of via global supply chains. When consumers become sensitive to environmental issues, it becomes vital for businesses to adopt green practices to maintain their competitive advantage [44]. Empirical evidence [12] underscores the role of customers in fostering and implementing green innovations. As the demand for green products grows, supply chains face rigorous scrutiny about raw material resources, manufacturing processes, and other supply chain related issues. Hence, it is crucial for green supply chain partners to show mutual commitment towards green practices.

Reference [45] show the manufacturer-customers partnership has a vital role in adopting green innovations and achieving overall environmental performance. Studies [27,46,47] support the positive effect of other stakeholder commitment on achieving better environmental management outcomes. Better cooperation between supply chain partners on ecological issues positively affects green managerial innovations [48].

When business firms improve their relationships with customers, it strengthens green process innovation [48,49]. Integrating customers in achieving sustainability performance is vital because it provides supply chain the necessary flexibility to cater to the changing needs of customers. Cooperation with customers will improve process innovations [50] and resultantly, could reduce production waste and improve resource efficiency [51]. When environmental concerns become vital for customers, green practices such as green process innovations improve ecological performance [52].

In successful green supply chains, it is essential for business firms to develop and nurture a relationship with their customers. Achieving environmental sustainability implies business firms to simultaneously adopt and implement internal and external green innovation practices. In other words, reviving overall business operations towards better ecological management. Close customer cooperation should increase the successful adoption of green innovations. Hence, we propose:

Hypothesis H6a. *Customer cooperation mediates the relationship between sustainable commitment by top management and green process innovation.*

Hypothesis H6b. *Customer cooperation mediates the relationship between sustainable commitment by top management and green managerial innovation.*

3. Empirical Setting and Measurements

To test our research model empirically, we selected ISO 14000 certified Turkish exporting firms, located in the Izmir region (Turkey). We chose all the ISO 14000 exporting firms from the Izmir region. Two hundred and fifty (250) firms agreed to participate in the survey. The unit of analysis is the relationship between the Turkish manufacturing exporters and their most important customers placed in the European continent countries. The selected firms exported textile, chemical, food, electrical,

electronics, manufacturing, and medical products. These firms have effectively adopted sustainable practices to attain environmental sustainability during their various manufacturing processes.

We applied the key informant approach [53] to collect primary data. All the respondents were working as business directors, export managers, and operations managers for more than five years in the respondent firms. They had complete knowledge about green innovations or green practices that manufacturing firms have adopted and implemented for their customers. Senior-middle managers and operational managers participated in the research. The respondents completed the survey by providing information about one strategic customer in mind. This attribute gives a better managerial perspective across a range of business firms. Out of 250 export-manufacturing firms, 181 firms completed the research survey. Lack of interest, time deficiency and other factors were cited for not completing the research questionnaire. One hundred eighty-one useable responses gave an extraordinary response rate of 72%.

To control the possibility of common method bias, we followed some vital procedures. The questionnaire asked the respondent to rank the items of the constructs comparatively and not regarding bad versus good. Next, we conducted Herman's one-factor test. No single factor accounted for the most of variance when we performed factor analysis on the items of dependent and independent variables. In our study, common method bias problem seems irrelevant.

3.1. Measurements

In this section, we provide details about the dependent, independent and control variables. Customer cooperation (CC) refers to the extent of collaboration with a supply chain partner who eagerly contributes towards green practices, procedures, packaging, and recycling in achieving sustainability objectives in green supply chains. We selected items from previous studies (e.g., [13,27]). Green process innovation (GPI) items refer to the innovations that a respondent firm performs to save energy and reduce pollution prevention processes; whereas green managerial innovation (GMI) items report about the managerial attitude a firm commences to protect the environment. We selected items from previous studies [17,22]. Top management commitment (TMC), which refers to the level of commitment provided by the respondent firms' top management in achieving sustainability objectives. We selected items from previous studies [12,34] to measure the commitment construct.

We introduced firm size and relationship duration as control variables in our research model. Firm size represents the number of permanent employees in manufacturing units. This variable captured the strategic position of a manufacturing firm regarding its relationship with a specific customer. We incorporated into our research model by taking a natural logarithm of the number of permanent employees. Relationship duration is the second control variable and identifies the number of years a manufacturer has worked with a particular customer. We integrated a natural logarithm of the number of years doing business together with important customers to account for this effect.

3.2. Validation of Constructs

First, we carried out an exploratory factor analysis (EFA) and removed items that showed low or insignificant loadings. Next, we carried confirmatory factor analysis (CFA) to measure the discriminate validity of our measurement model by using AMOS 24. The fit indices of the four-factor solution ($\chi^2 = 105.14$, $df = 59.00$, $p\text{-value} = 0.005$). The indexes $\chi^2/df = 1.782$, $GFI = 0.921$, $CFI = 0.966$, $IFI = 0.966$, $TLI = 0.955$, and $RMSEA = 0.066$ endorse an acceptable fit for our four-factor model. Table 1 illustrates the constructs' items. Table 2 shows the correlation matrix and the average variance extracted (AVE-in bold numbers) values of individual constructs, given in bold numbers.

Table 1. Individual constructs and validity measures.

Constructs	The Constructs' Items Measured on 7-Point Likert-Type Scales with Endpoints Indicating Strongly Disagree and Strongly Agree
Customer Cooperation CC: 4 items $\alpha = 0.82$, CR = 0.83	Our firm cooperates closely work with this customer for green packaging. ... this customer to achieve green handling procedures. ... this customer to evaluate green sustainable practices. ... this customer to implement green sustainable practices.
Green Process Innovation GPI: 3 items $\alpha = 0.92$, CR = 0.93	Our firm has taken measures... ...to lower the consumption of water, electricity, gas, and petrol during the production/disposal process. ...to recycle, reuse and remanufacture materials or parts. ...to achieve savings in the usage of energy, water and waste.
Green Managerial Innovation GMI: 2 items $\alpha = 0.67$, CR = 0.72	Our firm has redesigned operation and production processes to meet internal environmental efficiency. ... and improved products and services to meet new environmental criteria.
Top Management Commitment TMC: 4 items $\alpha = 0.87$, CR = 0.88	Our firm's top management strongly support efforts to develop sustainable practices. ...consider sustainable practices as a vital part of corporate strategy. ... strongly implement sustainable practices during procurement procedures. ... strongly support sustainable practices efforts.
Size of the firm Relationship duration	Size: The number of employers in the respondent firm (natural logarithm). Time: The number of years our firm is doing business with this customer (natural logarithm).

Table 2. Correlation matrix.

	TMC	CC	PI	MI	Size	Time
TMC	1.00 (0.88)					
CC	0.367	1.00 (0.55)				
GPI	0.492	0.560	1.00 (0.93)			
GMI	0.160	0.153	0.204	1.00 (0.57)		
Size	0.267	0.317	0.321	0.230	1.000	
Time	0.261	0.136	0.211	−0.029	0.305	1.000
Mean	3.6119	2.7196	2.8803	3.7459	3.8855	
S.D.	1.0499	0.9093	1.3374	1.0443	1.3807	
N	181	181	181	181	181	181

4. Results

4.1. SEM Analysis

To empirically test the hypothesized relationships between our constructs (H1–H5), we did a structural equation model (SEM) in AMOS 24. The SEM model's indices showed a satisfactory model fit ($\chi^2/df = 1.593$, GFI = 0.920, CFI = 0.967, IFI = 0.967, TLI = 0.955, and RMSEA = 0.057). Table 2 shows the correlation matrix and the average variance extracted (AVE) values of individual constructs are in bold numbers.

As predicted, the results show that top management commitment has positive and significant relationships with customer cooperation ($\beta = 0.240$, $p < 0.000$) and green process innovation ($\beta = 0.256$, $p < 0.000$), supporting hypotheses H1 and H2. Top management commitment has a moderate significant relationship with green managerial innovation ($\beta = 0.142$, $p < 0.099$) and hence hypothesis H3 is partially supported. Regarding hypotheses H4 and H5, customer cooperation has a positive and significant relationship with green process innovation ($\beta = 0.755$, $p < 0.000$) and an insignificant relationship with green managerial innovation ($\beta = 0.087$, $p > 0.494$).

4.2. The Mediation Analysis

To measure the mediation effect as formulated in hypotheses H6a and H6b, we followed the recommended bootstrapping bias-corrected confidence interval procedure [54,55] in structural equation modeling (SEM). By using AMOS 24, we applied 2000 samples to obtain the confidence

intervals. This procedure generated 95% confidence intervals and Table 3 describes the mediation effect results.

Table 3. The mediation analysis in AMOS: Using a bootstrapping procedure.

Paths	Direct Effect	Total Effect	Indirect Effect
TMC => CC => GPI	0.263 ($p < 0.001$)	0.359 ($p < 0.001$)	0.138 ($p < 0.05$)
TMC => CC => GMI	0.201 ($p > 0.149$)	0.009 ($p < 0.090$)	−0.035 ($p > 0.658$)

The mediating effect results show a significant indirect effect of top management commitment (TMC) on green process innovations (GPI) through customer cooperation (CC), supporting our predicted H6a ($\beta = 0.138$, $p < 0.05$). An insignificant indirect effect of TMC on green managerial innovation (MI) via CC shows that our predicted H6b is empirically insignificant ($\beta = -0.035$, $p > 0.05$). Hence, customer cooperation mediates the relationship between TMC and GPI, while customer cooperation fails to mediate the relationship between TMC and GMI. Our mediation results show the direct effect of TMC on customer cooperation, and customer cooperation on process innovation is positive and significant.

5. Discussions and Conclusions

This study examines the mediating role of customer cooperation in adopting green innovations in supply chains. Further, the study outlines the significant role of top management commitment in developing closer cooperative relationships with supply chain customers. Accordingly, our empirical results demonstrate that when supply chain partners collaborate in a synergic and reliable manner, sustainability objectives become achievable. Overall, the findings of this study augment the notion of establishing and maintaining close cooperation with supply chain customers result in reducing the negative impact of global supply chain operation on the environment. Furthermore, such an outcome also diminishes carbon footprint of supply chains.

When supply chains adopt green innovations, they develop sustainable competitive advantages. Green innovations are the dynamic capabilities [56] that identify and differentiate green supply chains from ordinary supply chains. In our study, the mediating role of customer cooperation in supply chains strengthens the dynamic capability towards sustainable competitive advantages. Similarly, the commitment by top management toward green innovations demonstrates the will of a firm to accomplish a specific dynamic skill towards sustainability. When each a supply chain entity strives for a particular dynamic capability to augment green supply chain sustainable objectives, close integration between suppliers, consumers, and management commitment becomes vital [56]. This demonstrates that the roles of customer cooperation and green innovations are critical in developing sustainable competitive advantage in an exchange setting [57].

Close cooperation between supply chains partners is vital for adopting green. innovations. This study identifies and provides empirical support to the logical relationship between top management commitment and customer cooperation in achieving sustainability objectives. Supply chain partners need tighter integration with key supply chain customers for strengthening environmental collaboration. For instance, exchanging manufacturing and logistics operations information, providing training to second and third tier suppliers, and coordinated cooperation for new products and the adoption of green technologies will result in realizing green supply chains.

The study finds that top management commitment (TMC) positively affect green process and green managerial innovations. In comparison to green process innovation, the impact of TMC on green managerial innovation is positive but modestly significant. A modest positive effect of TMC on GMI is explainable by the internal environmental management focus on green managerial innovation, whereas the significant positive effect of TMC on GPI demonstrates that changing an ordinary supply chain into a green supply chain demands close alignment with external supply chain

partners. This strategy is essential in strengthening the overall green competence of a supply chain in achieving ecological benefits.

Customer cooperation has a significant positive effect on green process innovation, and an insignificant impact on green managerial innovation. The results indicate that close customer cooperation could act as one of the driving components for supply chains to achieve sustainability objectives. Green process innovation has an external orientation in supply chains. It demands making supply chains holistically more environment-friendly by executing green innovations in key processes such as manufacturing, transportation, etc., that improves resource efficiency. Managerial innovations reflect an organization's assurance towards better internal environmental management system and our results show an insignificant effect of customer cooperation on green managerial innovation. Nevertheless, a green supply chain needs a credible internal environmental management system for executing a permanent external environmental collaboration. Collectively, our findings suggest that when supply chain partners move towards better environmental management, they improve environmental management at both internal and external environment levels.

The study applied customer cooperation as a mediating variable. Green process innovation outlines continuous processes with external supply chain partners to improve material efficiency, productivity, reduce costs and mitigating the negative impact on environment. Green managerial innovation shows how individual supply chain partners strategize and implement internal environment management structures. The results show a significant mediation effect on green process innovation and an insignificant effect on green managerial innovation. Strategically, green managerial innovation provides the internal flexibility required by a supply chain partner to innovate accordingly with external customer requirements, whereas green process innovation indicates the competence and commitment towards external partners in realizing green supply chain objectives.

It is substantial for supply chain managers to understand the role of green capabilities in the world's current business settings. Supply chain manager should priorities various environmental beliefs and values in promoting a firm's green credentials in developing business relationships with their primary supply chain customers. Top management should strengthen as well as motivate green managerial capabilities of their managers. This study describes the strategic relevance of close customer collaboration in green supply chains.

Like other studies, this study has some limitations. We collected data from the manufacturer side only. Collecting data about greener practices and innovations from the customer side would augment this study results. The findings of the study reflect the relevance to the export industries in Turkey. Future studies should survey multiple countries to expand the results of this study, especially those located in the developing and emerging economies. It would be interesting to integrate and measure green purchasing, green quality management, and other green supply chain measures in future studies to examine the mediating role of customer cooperation.

Overall, the study contributes to the study of green supply chains. Commitments by top management and customer cooperation are critical in adopting as well as executing green innovations. This study strengthens the notion that both internal and external sustainable commitments yield positive outcomes in mitigating environmental degradation.

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