

**Does EMA implementation promote green innovation? The mediation effects of
both cross-functional coopetition and co-creation**

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Does EMA implementation promote green innovation? The mediation effects of both cross-functional coopetition and supplier co-creation

Abstract

The call for green innovation necessitates the creation of an ecosystem that is friendly to the environment. Certain environmental regulations and standards are put in place to foster this type of innovation. However, there are many literature debates on the impact of guidelines and management controls on green innovation. Drawing on both the resource-based view (RBV) and dynamic capability theory (DCT), this study investigates the impact of environmental management accounting (EMA) implementation on green process and product innovation, considering the mediating effects of cross-functional coopetition and supplier co-creation. Multi-wave surveys were conducted across 799 Chinese companies. The results show that EMA implementation has a positive effect on both cross-functional coopetition and co-creation. In addition, cross-functional coopetition serves to mediate the relationship between EMA implementation and both green process and product innovation. However, it should be noted that supplier co-creation only serves to mediate the relationship between EMA implementation and green process innovation, rather than green product innovation. Overall, this research adds to the RBV literature by offering a fresh perspective on the role of cross-functional coopetition in situations where resources are shared and conflicts occur simultaneously. Furthermore, the study enhances our understanding of DCT by examining the role of supplier co-creation. This research delves into how companies balance resource availability with environmental adaptability, striking a balance between replication and renewal.

Keywords: Green innovation, Environmental management accounting, Cross-functional coopetition, Supplier co-creation, Necessary condition analysis

1. Introduction

As a solution for the management of serious environmental challenges, green innovation proposes practices, processes and products which adopt eco-design principles, green materials, environmental technology, and clean energy (Xie *et al.*, 2019; Duque-Grisales *et al.*, 2020). Green innovation calls for the establishment of an environmental-friendly ecosystem (Zhu *et al.*, 2013; Agarwal *et al.*, 2018). Thus, the effective pursuit of green innovation can enable companies to reduce their environmental impacts and achieve sustainable and economically, socially, and environmentally balanced development (Huang & Li, 2017; Singh *et al.*, 2020; Wen *et al.*, 2023). The core of green innovation is its dual objective: reducing environmental impacts while simultaneously creating new business opportunities and enhancing competitive advantages (Awan *et al.*, 2019; Awan *et al.*, 2021).

Some environmental standards and regulations are designed to promote green innovation, such as ISO14001, the European emission standard, and the EU's Restriction of Hazardous Substances (RoHS) directive. One of the most widely applied environmental management control systems is environmental management accounting (also known as the EMA, Gunarathne *et al.*, 2021). The EMA is a crucial instrument that comprehensively tracks, manages, and reports both monetary and physical aspects of environmental performance. In particular, EMA captures comprehensive financial data, including the environmental costs associated with procuring green materials, investments in eco-friendly equipment, and penalties resulting from non-compliance with regulatory standards. It also quantifies physical information, including the

consumption and disposal of resources such as water, electricity, and other materials (Burritt *et al.*, 2002; Burritt, 2004). When this instrument is implemented effectively, EMA can significantly enhance environmental sustainability. It enables organizations to develop products that are not only biodegradable and recyclable but also manufactured using clean energy, green materials, and innovative green technologies. Organizations that leverage the insights provided by EMA often lead in introducing products and services that deliver substantial environmental benefits. One of the key advantages of EMA is its ability to integrate environmental costs and performance data into the product design and development process. This integration allows companies to identify and capitalize on opportunities for innovation that meet consumer demands for sustainability. Moreover, EMA plays a pivotal role in identifying inefficiencies in production processes, optimizing energy use, and improving waste management. By adopting practices such as closed-loop systems, embracing circular economy principles, and transitioning to cleaner energy sources, companies can implement process innovations that not only enhance environmental outcomes but also reduce costs and boost operational resilience. These innovations, driven by the insights gained from EMA, are crucial for businesses aiming to achieve both economic and environmental sustainability.

However, the impact of EMA on innovation remains a contentious issue in the academic community. Some scholars argue that the stringent environmental standards often associated with EMA can escalate compliance costs, thereby constraining the financial resources that could otherwise support innovation. Evidently, both Stucki *et al.* (2018) and Valero-Gil *et al.* (2023) suggest that these increased costs and the rigidity imposed by strict compliance frameworks can reduce organizational agility, limiting the capacity for green innovation. This scenario can lead to a conservative approach

where compliance overshadows creativity, potentially stifling breakthrough innovations in green practices.

On the other hand, other researchers advocate for the positive implications of EMA on fostering innovation. Hu *et al.* (2021) and Li & Shen (2022) argue that EMA enhances transparency and accountability, encouraging companies to adopt sustainable practices that transcend mere compliance. They suggest that EMA can serve as a strategic asset—not just a regulatory requirement—stimulating companies to identify inefficiencies and innovate. This perspective views EMA as a catalyst that aligns environmental and economic goals, promoting innovations that provide competitive advantages while also enhancing environmental sustainability.

The disparate findings of prior research can be elucidated by examining the responses of companies to novel practices or management approaches, such as organizational readiness, resource allocation, external pressures, and feedback mechanisms. When a company adopts a new management approach, in addition to the long-term strategic implications (e.g., on the decision whether to engage in green innovation), the organization will also respond in immediate operational (e.g., changes in internal communication) and strategic actions (e.g., seeking external resources). EMA practices, such as environmental cost management, environmental capital budgeting, and sustainability balanced scorecards, are intended to bring about changes in control, stewardship, and decision-making practices (Gunarathne *et al.*, 2022). Thus, EMA implementation can lead to changes in various environmental areas such as energy consumption (Zhang *et al.*, 2022), carbon emissions management (Naranjo Tuesta *et al.*, 2021), and water resource management (Ferdous *et al.*, 2019). Previous studies have shown that the implementation of management control systems can lead to resource conflicts among organizational members (Darnall & Edwards, 2006;

Valero-Gil *et al.*, 2023). These conflicts often stem from differing priorities (IFAC, 2005), resistance to change, or the allocation of resources between environmental initiatives and other organizational goals (Birkinshaw & Lingblad, 2005; van der Poll, 2022). At the same time, the resource-based view (RBV) suggests that in order to operate sustainably, companies need to accumulate a variety of resources that are valuable, rare, difficult to imitate, and non-substituted (Barney, 1991). Successful implementation of EMA relies on interdepartmental collaboration to secure a range of multidisciplinary resources. For example, the research and development (R&D) department might work with the marketing department to develop new, environmentally friendly products that meet consumer preferences for sustainability. Meanwhile, the manufacturing department could work alongside the finance department to identify cost savings opportunities in energy consumption and waste management.

This kind of simultaneous cooperation and competition between departments with different functions within a company can be defined as cross-functional ‘coopetition’ (Luo, Slotegraaf, & Pan, 2006; Tsai & Hsu, 2014). In the seemingly paradoxical interplay of cross-functional coopetition, different departments are encouraged to cooperate and share valuable knowledge acquired from other departments to achieve the overall goals of the company as a whole; however, departments simultaneously compete with each other for intangible and tangible resources, strategic power, and the attention of top executives (Luo, Slotegraaf, & Pan, 2006; Bouncken & Kraus, 2013). Previous RBV literature has mainly focused on resource accumulation or consumption during the process of value creation (Carnahan *et al.*, 2010; Chen *et al.*, 2021; Furr & Eisenhardt, 2021), but there has been limited discussion of resource sharing and competition occurring simultaneously during this process.

The requirements of EMA implementation increasingly motivate companies to look outside their organization to find experience, practice, and cooperation (Singh *et al.*, 2022). Co-creation is a dynamic collaborative process that takes place in a value-creation ecosystem where stakeholders integrate with each other, learn from each other, and reconfigure their external resources to respond to turbulent external developments and complex circumstances (Teece *et al.*, 1997; Lin & Wu, 2014). Companies that implement EMA often aim to use more environmentally friendly production methods and products. This may encourage suppliers to develop and provide cleaner and more efficient materials and components. As a result, this shift in demand can motivate suppliers to innovate environmentally and jointly explore sustainable solutions. By conducting detailed environmental and cost analyses, organizations can identify key areas where collaboration with suppliers can lead to significant improvements in sustainability performance. This could include co-developing materials with a lower environmental impact, redesigning packaging to reduce waste, or implementing more efficient logistics solutions to minimize carbon emissions. Engaging in co-creation activities with suppliers can extend an organization's innovation capabilities by tapping into the specialized knowledge and expertise of suppliers. Additionally, EMA can lead to cost reductions by improving resource efficiency and minimizing waste. EMA enables a company to gain a better understanding of the environmental impact of its products and services throughout their life cycle. This transparency requires sharing environmental information with suppliers, fostering communication and collaboration across the supply chain.

According to Qiu *et al.* (2020) and Singh *et al.* (2020), dynamic capabilities play a crucial role in fostering green innovation. The successful implementation of EMA notably depends on the significant interdependence between companies and their

suppliers (van der Poll, 2022). It is crucial for companies to proactively engage in co-creative relationships with their suppliers. This collaboration provides access to clean energy, green materials, and new technologies in accordance with EMA guidelines, which not only helps reduce environmental costs and risks but also facilitates the renewal of processes and the development of green products. Despite its recognized importance, prior research has not extensively explored whether supplier co-creation directly motivates companies to pursue green innovations. This study aims to fill this gap by demonstrating that dynamic capabilities, crucial for innovation, are influenced not only by internal mechanisms but also by external factors—particularly regulatory and normative environments—which act as strategic catalysts in the innovation process. In light of these research gaps, this study proposes two research questions, rooted in the RBV and DCT, aimed at further exploring the impact of external pressures and supplier relationships on green innovation strategies:

RQ1: Does the implementation of EMA promote green processes and green product innovation?

RQ2: How do cross-functional cooperation and co-creation roles influence green processes and green product innovation?

This study explores the complex impact of EMA implementation on green innovation, focusing specifically on green process and product innovation through the RBV and DCT. It examines both direct and indirect relationships between EMA implementation and green innovation. The study utilizes multi-wave surveys across 799 Chinese companies to understand the interaction of these dynamics within the EMA framework. The research makes several contributions: Firstly, it expands the controversial discussion on the relationship between management standards, controls, and green innovation and provides early empirical findings on the positive effects of

EMA implementation on green innovation. Secondly, this research extends the theoretical application of RBV to simultaneous resource sharing and competition by analyzing the effects of cross-functional coopetition. It highlights that resource competition across departments is supplementary to resource sharing. Thirdly, although numerous studies focus on customer co-creation (Zhang *et al.*, 2020; Siaw & Sarpong, 2021), the role of supplier co-creation remains underexplored; this research enriches DCT by demonstrating how supplier co-creation, shaped by external institutional pressures, guides firms to green innovation.

2. Theoretical background on EMA implementation and green innovation: resource-based view and dynamic capability theory

Green innovations are novel or improved green processes, initiatives, systems, and products which achieve resource savings, improved waste disposal, eco-design, waste recycling, or other components of sustainable development philosophies (Chen *et al.*, 2006; Oltra & Saint Jean, 2009; Albort-Morant *et al.*, 2016; Wang *et al.*, 2021). Green innovation provides important competitive advantages by improving economic development, maintaining ecological sustainability, and enhancing quality of life (Dangelico & Pujari, 2010). Unlike other forms of innovation, green innovations are perceived as more specific and complicated tasks, which require the application of multidisciplinary knowledge and adequate external resources and information (De Marchi, 2012; Khan *et al.*, 2023).

EMA systems provide physical and monetary information on the use and flow of energy, water, and other materials, and monetary information on environment-related costs, earnings, and savings (Burritt *et al.*, 2002; Burritt, 2004). EMA can address the shortcomings of conventional management accounting, which overlooks the complete

costs of externalities, and pools environmental costs with general overheads (Burritt *et al.*, 2002; Gunarathne *et al.*, 2022). Based on prior literature, EMA implementation depends on three types of EMA tools: supportive EMA tools (e.g., for the identification of environmental costs and classification of environmental costs), specific use tools (e.g., carbon accounting, energy accounting and water accounting) and integrative tools (e.g., life cycle analysis, eco-control and sustainability balanced scorecard) (Gunarathne & Lee, 2021). The functional uses of EMA tools mainly apply to decision-making (e.g., long-term investment decisions, replacement, and expansion decisions) and control and stewardship (e.g., budget preparation, environmental risk management) (Gunarathne & Lee, 2021; Burritt *et al.*, 2002).

Institutional theory elucidates the impact of external norms, values, and beliefs—collectively forming the institutional environment—on organizational behavior and strategy (Agyabeng-Mensah *et al.*, 2024). In particular, it sheds light on how standardization, a manifestation of institutional pressures, influences organizational innovation strategies and behavioral by promoting conformity to widely accepted practices (Joardar *et al.*, 2021). While institutional theory emphasizes the external drivers of organizational action, it also interacts with the concept of how organizations use their internal resources and capabilities in response to these external pressures. From this perspective, research can explore how standardization not only represents a form of external constraint, but also catalyzes organizations to innovate adaptively within these constraints (Agyabeng-Mensah *et al.*, 2024). Thus, the implementation of EMA can be seen as an organizational response that leverages internal resources for innovation, while at the same time responding to external institutional pressures for sustainability. This involves the integration, assimilation, and strategic reallocation of resources to meet both the demands of institutional conformity and the pursuit of

competitive advantage through green innovation.

As the RBV explains, when companies accumulate valuable, rare, inimitable and non-substitutable (VRIN) resources, they can achieve sustainable competitive advantages that competitors may find difficult to duplicate (Barney, 1991; Acedo *et al.*, 2006). Cross-functional ‘coopetition’ – the joint combination of intra-firm cooperation and competition (Luo, Slotegraaf, & Xing, 2006) – is regarded as an effective strategy for the stimulation of innovative practices (Strese *et al.*, 2016a). When implementing EMA, an accounting department will seek to cooperate with the research and development (R&D), manufacturing, and marketing departments to understand the environmental issues faced by the organization, the physical flow of resources, and the organization’s manufacturing capability in order to implement EMA efficiently (Gunarathne *et al.*, 2022). Meanwhile, cooperation across functions inevitably feeds inter-departmental conflicts or competition due to the need to strive for limited resources (e.g., organizational capital, top management attention) and to achieve departments’ respective EMA targets. Such cross-functional coopetition characterizes companies which use multi-dimensional resources, brainstorming, and divergent creative ideas (Luo, Slotegraaf, & Xing, 2006; Nemeth *et al.*, 2004), which can further the aim of innovation. While existing RBV research has extensively explored how companies integrate and coordinate their resource endowments to secure competitive advantages (Barney, 2001; Li *et al.*, 2019; Kumar & Rodrigues, 2020), there remains a significant gap in understanding the impact of inter-departmental resource competition. This area is ripe for further investigation, as it could provide deeper insights into the complexities and potential friction points that arise from internal resource allocation practices and their effects on organizational innovation.

In contrast to RBV, which focuses more on resource accumulation (Sirmon *et al.*,

2011), dynamic capabilities enable companies to emphasize coordination, learning, and the reconfiguration of external expertise and resources to address volatile environments (Teece *et al.*, 1997; Eisenhardt & Martin, 2000). Dynamic capabilities also empower companies with a high-level capability to achieve green innovation in a dynamic business environment (Qiu *et al.*, 2020). Thus, co-creation represents the dynamic-learning-based capability to acquire, integrate, absorb, and transform external new resources, which is shared between actors linked together within an ecosystem (Lusch & Nambisan, 2015; Zhang *et al.*, 2020; Frow *et al.*, 2016). In precise terms, co-creation promotes the process of interactional creation among the different actors (e.g. customers, competitors, suppliers) forming a co-creative ecosystem; in turn, these actors realize the co-design and co-production of new products (Prahalad & Ramaswamy, 2004; Ramaswamy & Ozcan, 2018). To fulfil EMA guidelines such as the responsibility to perform carbon accounting and reduce carbon emissions, suppliers play an important role by providing green materials, environmental and technical skills, and the ability to process knowledge, all of which help to develop new green products. Thus, when implementing EMA activities, companies should engage in co-creation with allies or partners that will cooperate in searching for creative strategies to meet the multi-faceted requirements of EMA practices (Chen *et al.*, 2017). The impact of external institutional pressures is significant in this context. These pressures not only encourage firms to realign their focus towards enhancing existing operations but also contribute to broadening the scope of DCT. They provide a deeper understanding of how these pressures shape strategic innovation priorities within firms (Teece *et al.*, 1997; Eisenhardt & Martin, 2000). The intricate relationship between internal capabilities and external environments highlights the strategic importance of these pressures, not just as compliance challenges but as catalysts for innovation efforts.

The literature review highlights the significant role that environmental standards and internal resource dynamics play in shaping organizational innovation strategies. While existing research has thoroughly examined how firms accumulate and utilize resources for competitive advantages (Carnahan *et al.*, 2010; Chen *et al.*, 2021; Furr & Eisenhardt, 2021), it often overlooks the impact of simultaneous resource sharing and competition on the innovation process. This gap is particularly evident in the concept of cross-functional ‘coopetition,’ where different departments within a company cooperate and compete simultaneously (Luo, Slotegraaf, & Pan, 2006; Tsai & Hsu, 2014). In this dynamic interplay, departments are encouraged to share valuable knowledge to achieve corporate goals while also competing for tangible and intangible resources, strategic influence, and executive attention (Luo, Slotegraaf, & Pan, 2006; Bouncken & Kraus, 2013).

Another underexplored area is the role of supplier co-creation in fostering green innovations, which is becoming increasingly critical as EMA implementation motivates companies to extend their search for innovation beyond their organizational boundaries (Singh *et al.*, 2022). This study addresses these gaps by examining how cross-functional coopetition and supplier co-creation, influenced by both internal capabilities and external institutional pressures, serve as catalysts for green innovation. This research posits that dynamic capabilities, crucial for maintaining competitive advantage in rapidly changing environments, are significantly shaped not only by internal resource configurations but also by external pressures such as regulatory and normative frameworks. These frameworks not only compel firms to adopt sustainable practices but also to realign their strategic orientations towards more environmentally sustainable innovations.

This research aims to enrich the RBV and DCT by offering deeper insights into

the interplay between internal organizational dynamics and external environmental pressures, illustrating how they collectively influence the innovation agenda in contemporary business settings. Through this exploration, this study seeks to demonstrate that internal coopetition and external collaboration are not just responses to institutional demands but are strategic imperatives that drive sustainable innovation.

3. Hypothesis development

3.1 EMA implementation and green innovation

Institutional theory, in particular the concept of institutional isomorphism, provides a robust framework for understanding how organizations adapt to and incorporate prevalent practices within their fields. This theory elucidates why organizations often adopt similar standards, behaviors, and practices. Organizations adopt EMA by responding to legal and regulatory forces, professional norms and standards, as well as the practices of other successful organizations. By adopting EMA, companies can gain detailed insight into the environmental costs and benefits associated with their operations. This comprehensive environmental accounting facilitates more informed decision-making and strategic planning by identifying inefficiencies and areas for improvement.

In this context, the adoption and implementation of EMA is pivotal. Based on the principles of the RBV, EMA provides organizations with the capabilities to accurately track and manage environmental costs and material flows. This meticulous management facilitates the identification of opportunities for sustainable innovation. As organizations implement EMA, they need to identify, measure, and control upfront, voluntary, and back-end environmental costs, along with the physical flow of materials

throughout the life cycle of products (Gunarathne *et al.*, 2022). This EMA information is closely related to product design, manufacturing, marketing, and disposal after use, supporting companies in exploring or substituting green materials, energy, and technology to achieve process innovation (Ferreira *et al.*, 2010; Rieckhof & Guenther, 2018). This EMA information is closely related to product design, manufacturing, marketing, and disposal after use, supporting companies in exploring or substituting green materials, energy, and technology in order to achieve process innovation (Ferreira *et al.*, 2010; Rieckhof & Guenther, 2018). Furthermore, the establishment of a balanced scorecard for sustainability allows companies to integrate environmental regulation and social environmental awareness into the management and evaluation processes, which motivates more product innovation and process improvement to maintain the balanced development of both profitability and environment (Osório de Andrade Guerra *et al.*, 2023). In addition, the environmental capital budget proposed by the EMA includes investments in clean energy, along with environmental protection equipment and technologies. Such eco-friendly investment guidelines drive companies towards achieving green processes and product innovation. Thus, it is predicted that the implementation of the EMA can contribute to green processes and product innovation; therefore, this study hypothesizes that:

Hypothesis 1: EMA implementation is positively related to green processes (a) and green product innovation (b).

3.2 EMA implementation and cross-functional coopetition

According to the resource-based view, combining cooperation and competition facilitates companies' access to complementary resources and knowledge (Ritala, 2012;

Gernsheimer *et al.*, 2021). When implementing EMA, companies are required to synthesize multidimensional knowledge and information from different departments to establish a comprehensive EMA knowledge base (Appannan *et al.*, 2022; Ul-Durar *et al.*, 2023). In addition to cross-functional cooperation, different departments are also inevitably involved in competition due to differences in their goals, orientation in terms of time, professional standards, and modes of thinking (Chen, 2021).

For instance, in the process of implementing environmental cost management (i.e., the need for the accounting department to cooperate with the R&D, manufacturing, marketing, and logistics departments, etc.), companies should rely on inter-departmental cooperation. In other words, the accounting department can systematically recognize, record, and allocate upfront costs (costs related to siting, the design of green products or processes, supplier evaluation, etc.), voluntary costs (costs related to feasibility testing, operating, manufacturing, remediation, etc.), and back-end environmental costs (costs related to decommissioning, disposal of inventory and post-closure costs). However, environmental cost management also serves as a benchmark tool for the control of resources and costs, which results in inter-departmental competition for the resources, talents, and funds needed to maximize departmental interests. Additionally, when establishing an environmental information disclosure system, various departments (i.e., the accounting department depends on the information technology, R&D, manufacturing, and marketing departments) need to understand potential environmental costs and risks throughout the life cycle of products. The manufacturing and marketing departments may conflict with the accounting department because their operational goal is to ensure the maximization of both production and sales volumes, which is sometimes achieved by producing environmental pollution and excessive waste. Thus, it is proposed that EMA

implementation can motivate cross-functional coopetition. Therefore, this study hypothesizes that:

Hypothesis 2: EMA implementation is positively related to cross-functional coopetition.

3.3 EMA implementation and supplier co-creation

Companies must co-create with external suppliers so that they can effectively accomplish EMA activities and operate well in dynamic business environments. EMA is a multifaceted system that includes environmental cost management, risk evaluation, information disclosure, etc. (Burritt, 2004; Gunaratne *et al.*, 2022). Companies which aim to implement EMA effectively are motivated to search for innovative approaches to modify operational processes and improve products in order to meet the requirements to reduce environmental costs and risks (Singh *et al.*, 2019). In the process of searching for innovation, companies should foster a dynamic capability to learn green skills and technology from external actors to enrich and update their competencies (Singh *et al.*, 2019). Co-creation is an interactive process which occurs in a dynamic network of multiple groups of entities that have diverse resources and are connected by shared institutional norms (Fang *et al.*, 2015). In the co-creation mechanism, companies can not only facilitate knowledge transfer from external stakeholders but can also combine new knowledge with their existing knowledge base, ultimately leading to the development of new strategies (Zhang *et al.*, 2020).

Because EMA implementation is closely associated with green materials, clean energy, and biodegradable packaging (Burritt, 2004), companies are motivated to co-create with suppliers. By doing so, companies can explore and obtain external new knowledge and resources, such as green technology (including degradable and

recyclable materials), which helps them renew and develop their green organizational capability to comply with EMA guidelines. Hence, EMA implementation will likely lead to co-creation with green suppliers. This study hypothesizes, therefore, that:

Hypothesis 3: EMA implementation is positively related to co-creation.

3.4 The mediating effect of cross-functional coopetition

Environmental industrial standards and norms often necessitate a unique organizational strategy known as coopetition, in which departments within the same company are required to cooperate while simultaneously competing for resources (Hoi *et al.*, 2018). These standards require various functions, such as accounting, manufacturing, and R&D, to collaborate in meeting environmental targets like reducing waste or lowering emissions. Simultaneously, these departments must compete to secure the necessary resources and prioritize their specific goals, creating a dynamic interplay that fosters both innovation and optimization of processes within the organizational framework. This coopetition, particularly when it occurs cross-functionally within companies, facilitates frequent and close collaboration between different departments, leading to synergies as well as conflicts (Strese *et al.*, 2016a). From the RBV perspective, these conflicts are not necessarily detrimental but can serve as a positive “shock” to the system, invigorating collaborative relationships. Such shocks can lead to the adoption of new perspectives, the enrichment of resources, and the acquisition of new knowledge (Soda *et al.*, 2021), thereby fostering a creative advantage (Bouncken *et al.*, 2015).

In addition, exposure to controversial perspectives encourages stakeholders to discuss and reevaluate options previously considered infeasible, thus challenging entrenched stereotypes. This process can improve the accuracy of judgements (Van de

Calseyde & Efendić, 2022) and integrate diverse perspectives into product and process innovation (Strese *et al.*, 2016a). Within the RBV framework, intra-firm coopetition is seen as a strategic capability that enables companies to gather, assimilate, and recombine multifunctional resources and knowledge (Song *et al.*, 2016). Such cross-functional coopetition encourages departments to share knowledge and information, fostering an environment where diverse opinions, controversial debates, and creative thinking are valued (Curhan *et al.*, 2020). This environment lays the groundwork for the exploration of innovative technologies, highlighting the instrumental role of intra-firm coopetition in driving organizational innovation and sustaining competitive advantage.

For example, normative EMA implementation derived from ISO14001 focuses on the use of eco-auditing to present comprehensive environmental management reports to customers and regulatory agencies (Earnhart & Mark Leonard, 2016). In order to manifest satisfactory environmental management performance, accounting departments are compelled to collaborate with manufacturing, logistics, and R&D departments. Consequently, accountants can integrate sufficient interdisciplinary knowledge and resources to record environmental costs from material input to material disposal, track the flow of resources, minimize waste, and reduce environmental risks. Subsequently, conflicts between accounting and other departments may emerge. The accounting department must underline a limited environmental capital budget, emphasizing the aversion of environmental risks and the minimization of environmental costs and wastes; this may be controversial in other departments due to the strict EMA standards mentioned above. Other departments will be more inclined to accumulate sufficient funds and talents to realize their respective departmental goals, such as high production, increasing quarterly sales performance, and high-tech

investment. Fortunately, the competitive characteristic of cross-functional coopetition is less extreme than that of inter-firm coopetition (Luo, Slotegraaf, & Pan, 2006), because the ultimate mission of each department is to achieve the common corporate goal of effectively implementing EMA. Thus, inter-departmental conflicts can evolve into a compromise that considers the importance of both individual departmental targets and EMA guidelines. In fact, compromise as a constructive conflict-handling strategy can prompt diverse departments to seek innovative and acceptable solutions by considering others' opinions and comprehensively evaluating alternatives (Song *et al.*, 2006; Wang *et al.*, 2019; Deng *et al.*, 2021). As budget and production capacity allow, manufacturing, R&D, procurement, logistics and recycling departments will seek to use appropriate green materials, update key technologies and modify processes to encourage green innovation. Such conflicts may force manufacturing staff to communicate more actively with the accounting department so that they can carefully reconsider and reexamine existing deficiencies in materials and production processes, and then continue to search for green materials and environmental technologies that can improve processes and help them develop new green products. Cross-functional coopetition, influenced by environmental industry standards and facilitated by the organizational embrace of diverse perspectives and conflict as a catalyst for innovation, exemplifies a powerful dynamic. Not only it is consistent with the RBV by broadening a company's resource and knowledge base, but it also drives companies to develop innovative solutions, ensuring that they remain adaptable and competitive in a rapidly evolving marketplace. Therefore, cross-functional coopetition is likely to mediate the association between green innovation and the institutional pressures of EMA implementation. This study hypothesizes that:

Hypothesis 4: EMA implementation is positively related to green processes (a) and

green product innovation (b) through mediation by cross-functional cooperation.

3.5 The mediating effect of supplier co-creation

DCT highlights an organization's ability to adapt, integrate, build, and reconfigure both internal and external competencies in response to rapidly changing environments. Institutional pressures, including regulatory frameworks and normative standards, not only challenge firms but also strategically drive their innovation efforts. Singh *et al.* (2019) highlight how environment-related management guidelines can encourage companies to develop dynamic capabilities, particularly those that facilitate the integration and adjustment of external resources and competencies for environmental activities. This capability is crucial in contexts where co-creation, especially with suppliers, forms a dynamic learning process. In this process, knowledge and resources are not simply exchanged but are deeply integrated, assimilated, and redeployed among network actors to generate mutual value (Fang *et al.*, 2015; Alford & Duan, 2018; Awan *et al.*, 2023).

Co-creation with suppliers goes beyond traditional collaboration; it embeds suppliers in the entire innovation process, from co-ideation to co-production (Oertzen *et al.*, 2018). This deep involvement allows the focal company to access the unique resources and capabilities of suppliers, significantly enhancing its ability to innovate and respond effectively to environmental challenges. Suppliers contribute as partners in innovation, offering their expertise and capabilities, which enables companies to leverage a broader base of resources and knowledge, thereby enriching their potential for innovation and competitive advantage in a sustainable market.

For instance, early collaboration with green suppliers allows companies to integrate environmental knowledge and adopt environmentally friendly materials at the early stages of product development, promoting green innovation (Yuan & Cao, 2022). Zhang *et al.* (2016) also demonstrated that supply chain partners can actively participate in the development of green materials, reducing the environmental impact of manufacturing and packaging. In addition, co-creation enables companies to rapidly reprocess and transform waste materials into valuable products with suppliers, exemplifying effective resource utilization (Tian *et al.*, 2022).

Thus, the integration of environmental management policies or guidelines with strategic co-creation with suppliers demonstrates a profound application of DCT. It illustrates that the dynamic capabilities essential for environmental sustainability and innovation extend beyond the boundaries of the company, involving an extensive network of relationships and resources that the company can mobilize and reconfigure for sustainable competitive advantage. Given this theoretical background, the current study hypothesizes:

Hypothesis 5: EMA implementation is positively related to green processes (a) and green product innovation (b) through mediation by co-creation.

Based on the above discussion, this study develops a model to investigate whether EMA implementation can motivate green innovation through cross-functional coopetition and co-creation (Figure 1)

[Insert Figure 1 here]

4. Methodology

4.1 Sample and data collection

A three-wave online survey was conducted across different Chinese industries. China, as the largest carbon emitter in the world, has recently committed to promoting environmental policies which aim to achieve the dual goals of reaching peak carbon emissions by 2030 and achieving carbon neutrality by 2060. China is therefore a relevant and meaningful research setting for this survey. Following guidance from Wang *et al.* (2019) and Appannan *et al.* (2022), the questionnaire was distributed to a sample of manufacturing, energy, architecture and agriculture companies since these industries are major sources of noxious gases, dust, sewage, and other forms of pollution. In addition, all the sampled companies have jointly searched for new strategies and implemented environmental practices to solve environmental issues.

A pilot survey was conducted with industry practitioners and environmental management accounting professors. Two bilingual experts provided a reverse translation of the survey instrument to avoid translation bias (Brislin, 1970). The research team collaborated with a consulting company to distribute the final Chinese questionnaire using a purposive sampling technique from November 2022 to January 2023. The consulting company selected targeted enterprises from an online business directory and e-mailed questionnaires to general managers, senior executives, middle managers, junior managers, and staff. To ensure the validity of the survey, potential informants were assured of the anonymity and confidentiality of their responses. The concepts of EMA were described at the beginning of the questionnaire, and respondents confirmed the importance of EMA implementation and indicated that their companies had implemented EMA practices across various aspects of their operations.

We collected data from November 2022 because the ‘Report to the 20th National

Congress of the Communist Party of China' in October 2022 emphasized accelerating green development and improving accounting systems for carbon emissions. Although this report does not set governmental or industrial norms, it significantly affects various industries and motivates EMA implementation. In total, 799 usable questionnaire responses were included in the final analysis (a response rate of 84.5 %; see Table 1). The sample, therefore, met accepted the minimum sample size guidelines for PLS provided by Kock and Hadaya (2018).

The questionnaire was distributed in three stages. Information on EMA implementation was collected in Phase 1. One month later, in Phase 2, the questionnaire contained questions relating to cross-functional coopetition and co-creation. Information relating to green processes and green product innovation was collected in Phase 3. Each respondent provided the last four digits of their mobile number on their questionnaire responses, which enabled the research team to match data with the Phase 1 survey. The characteristics of the respondents and participating companies are provided in Table 1.

[Insert Table 1 here]

4.2 Measures

In this study, the operationalization of key constructs—Environmental Management Accounting Implementation (EMAI), Green Process Innovation (GPCI), Green Product Innovation (GPDI), Cross-functional Coopetition (CFC), and Supplier Co-creation (COCR)—employs well-validated and reliable measurement scales. These scales are carefully chosen based on their established validity and reliability in prior research, ensuring the robustness of our study's findings.

1. **Environmental Management Accounting Implementation (EMAI)** is measured through a multidimensional scale adapted from Liu *et al.* (2010) and

Wang *et al.* (2018), encapsulating coercive, normative, and mimetic aspects of institutional isomorphism. These scales have been rigorously tested in the context of environmental accounting, demonstrating strong construct validity and reliability (Xu *et al.*, 2022).

2. **Green Process Innovation (GPCI) and Green Product Innovation (GPDI)**

scales are modified from Goodhue *et al.* (2012) for GPCI and Wolff and Pett (2006) for GPDI. These modifications are crafted to align with the environmental innovation context, with the original scales showing high levels of Cronbach's alpha, indicating internal consistency and reliability.

3. **Cross-functional Coopetition (CFC)** is conceptualized as a higher-order

construct and measured through items that capture cooperative ability, cooperative intensity, and competition, based on the framework by Strese *et al.* (2016b) and Luo *et al.* (2006). This measure's construct validity is supported by its ability to capture the nuanced dynamics of intra-firm coopetition, with previous applications of the scale showing reliability and predictive validity in explaining innovation outcomes.

4. **Supplier Co-creation (COCR)** measurement is derived from the works of

Simonin (1997) and Bellini *et al.* (2019), capturing the depth and breadth of collaborative innovation efforts between companies and their suppliers. The validity and reliability of these scales have been established through their association with positive innovation performance and the ability to foster mutual value creation.

To maintain consistency and ease of interpretation, the constructs for EMA, green processes, and green product innovation are measured on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), while the measurement tool

for cross-functional coopetition and supplier co-creation utilizes a five-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). This decision is justified by the nature of the constructs and the granularity required for their effective measurement.

All questionnaire items, along with references for each construct's measurement scale, are meticulously compiled in the Appendix. This ensures transparency, facilitates replication and provides evidence of the validity and reliability of the scale in the context of this study.

4.3 Common method bias

This study applied five techniques to avoid potential common method bias (CMB) (Podsakoff *et al.*, 2003). Firstly, the anonymity and confidentiality of the survey enabled respondents to provide information as honestly as possible, without worrying about meeting demands for socially desirable or acquiescent cognition. Secondly, this questionnaire used both a five-point scale and a seven-point scale to avoid the possibility of a standardized scale format resulting in less cognitive processing. Thirdly, a temporal separation was created by introducing a one-month lag between the measurement of predictor and criterion variables, which reduced respondents' tendency to use their previous responses to answer subsequent questions. Fourthly, Harman's one-factor test suggested that the variance interpretation rate of the first common factor was below 50%. Fifthly, the highest value of the inner variance inflation factors (VIFs) was 2.804 (lower than 3.3; see Table 2) (Kock, 2015). Hence, CMB does not seriously influence the validity of the remaining research results.

5. Data analysis and results

The data were analyzed by applying partial least squares structural equation modeling (PLS-SEM). When the structure of the model comprises complex latent and

observed constructs, PLS-SEM is a suitable approach (Hair *et al.*, 2019; Yu *et al.*, 2022; Liu *et al.*, 2021; Sharma *et al.*, 2024). This study adopted necessary condition analysis (NCA) to extend the PLS-SEM findings so that the necessity logic of the proposed hypotheses could be examined.

5.1 Evaluation of the measurement model

This study assessed three aspects of the measurement model: internal consistency, indicator reliability and convergent validity (Hair *et al.*, 2019). As presented in Table 2, values for Cronbach's alpha ranged from 0.848 to 0.934 and composite reliability values ranged from 0.897 to 0.946, exceeding the threshold value of 0.70 and thus indicating internal consistency (Hair *et al.*, 2019). All the values for outer loading were greater than 0.7, suggesting sufficient reliability. Average variance extracted (AVE) values were greater than 0.5, indicating sufficient convergent validity. All values of the heterotrait–monotrait (HTMT) ratio of correlations were lower than 0.85, thus supporting discriminant validity (see Table 3; Henseler *et al.*, 2015).

Referring to Becker *et al.* (2012) and Sarstedt *et al.* (2019), this study employed a disjointed two-stage approach to evaluate cross-functional coopetition. Based on a redundancy analysis (Cheah *et al.*, 2018), the global single-item measure of cross-functional coopetition yielded a path coefficient of 0.853, providing evidence that more than 50% of the criterion construct variance could be explained by three second-order constructs. Besides, the VIF values for cross-functional cooperative ability, cross-functional cooperative intensity and cross-functional competition were less than 5, which suggested that there was no significant collinearity issue. Finally, statistical significance was indicated for three second-order constructs, with weight values of 0.267, 0.540, and 0.608 (see Table 4). Therefore, cross-functional coopetition was

reliably constructed by three dimensions.

[Insert Table 2 here]

[Insert Table 3 here]

[Insert Table 4 here]

5.2 Evaluation of the structural model

Multi-collinearity was not an issue, since the highest VIF was 2.886 (< 3.3 , Table 1). Moreover, bootstrapping was applied with 10,000 subsamples (Becker *et al.*, 2023). The results (refer to Table 5) indicate that EMA implementation significantly promoted green process and product innovation. Specifically, CEMAI ($\beta = 0.200$; $p < 0.05$), NEMAI ($\beta = 0.145$; $p < 0.05$), and MEMAI ($\beta = 0.166$; $p < 0.05$) led to green process innovation, suggesting that different facets of EMA implementation are moderately influential. Notably, the coercive aspect of EMA (CEMAI) demonstrates the strongest influence among the three, which can be attributed to the direct pressure exerted by legal and regulatory frameworks compelling companies to innovate sustainably with the support of EMA.

Similarly, for green product innovation, CEMAI ($\beta = 0.168$; $p < 0.05$), NEMAI ($\beta = 0.152$; $p < 0.05$), and MEMAI ($\beta = 0.188$; $p < 0.05$) exhibited positive effects. The effect sizes illustrate significant contributions, with MEMAI showing the most substantial effect. This indicates that mimetic processes, where companies emulate the EMA practices of their peers, are particularly effective in driving product-related green innovations, thereby supporting Hypotheses H1a and H1b.

Additionally, CEMAI ($\beta = 0.283$; $p < 0.05$), NEMAI ($\beta = 0.215$; $p < 0.05$), and MEMAI ($\beta = 0.215$; $p < 0.05$) positively influenced cross-functional coopetition. The

effect sizes for cross-functional coopetition underscore a strong positive relationship, suggesting that EMA implementation significantly impacts coopetition, and thus Hypothesis H2 was accepted. Furthermore, EMA implementation was positively associated with co-creation ($p < 0.05$), confirming Hypothesis H3.

Cross-functional coopetition significantly stimulated green process innovation ($\beta = 0.147$; $p < 0.05$) and green product innovation ($\beta = 0.083$; $p < 0.05$). However, while co-creation was associated with green process innovation ($\beta = 0.099$; $p < 0.05$), it was not related to green product innovation ($p > 0.05$).

The R^2 values were CFC (0.356), CR (0.155), GPCI (0.332) and GPDI (0.237) (R^2 values of 0.25 for weak, 0.50 for moderate and 0.75 for strong), demonstrating a moderate to a strong degree of in-sample predictive power.

[Insert Table 5 here]

5.3 *PLSPredict for model assessment*

Out-of-sample predictive power was evaluated using PLSpredict (Chin *et al.*, 2020; Shmueli *et al.*, 2019). As reported in Table 6, the Q^2 predictive statistics were above 0, and all model indicators had lower RMSE errors than the naïve LM benchmark, thus indicating strong predictive power.

[Insert Table 6 here]

5.4 *Analysis of mediating effects*

According to the results shown in Table 5, cross-functional coopetition had partial mediating effects between CEMAI ($\beta=0.042$, $p < 0.05$), NEMAI ($\beta=0.032$, $p < 0.05$), MEMAI ($\beta=0.032$, $p < 0.05$) and green process innovation. Likewise, because coercive,

normative, and mimetic EMA implementation had significant positive impacts on green product innovation via cross-functional coopetition ($p\text{-value} < 0.05$ for each), H4 (a) and H4 (b) were supported. However, co-creation only played partial mediating roles between CEMAI ($\beta=0.017$, $p < 0.05$), NEMAI ($\beta=0.014$, $p < 0.05$), MEMAI ($\beta=0.016$, $p < 0.05$) and green process innovation. Co-creation failed to mediate the relationship between EMA implementation and green product innovation ($p\text{-value} > 0.05$ for each), and thus H5 (a) and H5 (b) were partially accepted. This study also evaluated the predictive contribution of the mediator (PCM) values of cross-functional coopetition and co-creation. The PCM values of the two mediators ranged from 0.001 to 0.027, which suggested low mediating predictive power (see Table 7; Danks, 2021).

[Insert Table 7 here]

5.5 Results of necessary condition analysis (NCA)

This study also conducted NCA to examine the necessity logic of the proposed hypotheses. The NCA findings shown in Table 8 reveal that coercive, normative, and mimetic EMA implementation are necessary conditions for cross-functional coopetition ($d \geq 0.1$; $p < 0.05$).

[Insert Table 8 here]

6. Discussion and conclusions

This investigation illuminates the pathway through which the adoption of EMA propels innovation in green processes and products. By integrating both theories of RBV and DCT, this study offers a framework to explore how cross-functional coopetition and collaborative innovation influence the effectiveness of EMA in fostering eco-innovation.

First, this research significantly reinforces the pivotal role that EMA plays in guiding organizations toward adopting innovations that are not only environmentally conscious but also transformative across their operational processes and product portfolios. The insights gleaned from this study echo and build upon the findings of Huang and Chen (2022), which underscore the influential role of EMA-centric regulations, standards, and industry benchmarks in acting as strong catalysts for the initiation and acceleration of sustainable innovation initiatives. The emphasis here extends beyond mere compliance, suggesting that EMA acts as a strategic lever for organizations, compelling them to integrate environmental stewardship into their core business models and innovation strategies. This perspective highlights the multifaceted benefits of EMA - from enhancing regulatory compliance and meeting industry standards to driving competitive advantage through green innovation. By systematically incorporating environmental considerations into accounting practices, organizations are better positioned to identify, evaluate, and exploit opportunities for sustainable growth, thereby making significant contributions to the broader goals of environmental sustainability and corporate social responsibility. This dual focus on process and product innovation underlines the comprehensive impact of EMA, showcasing its capacity to not only mitigate environmental impacts but also to catalyze the development of new, sustainable business practices and offerings.

Secondly, the study sheds light on the multifaceted impact of EMA beyond merely incentivizing companies to rethink and retool their innovation strategies. It actively cultivates an organizational milieu that champions cross-functional cooperation—a hybrid of cooperation and competition among various departments within the organization. This unique cultural shift facilitates the amalgamation of wide-ranging expertise, the inclusion of diverse viewpoints, and the incubation of novel ideas,

resonating with the findings of Hafezalkotob (2017) and Hoi *et al.* (2018). Such an environment is conducive to challenging the status quo and propelling forward-thinking solutions. Furthermore, EMA emerges as a pivotal force for fostering supplier co-creation, as supported by the research of Hofman *et al.* (2020) and Tian *et al.* (2022). This dimension of EMA implementation empowers companies to collaborate closely with their suppliers in the quest for green materials and technologies, which are crucial for tackling environmental issues in a comprehensive manner. The role of EMA in promoting such strategic collaborations underscores its importance not just in driving internal innovation but also in extending its impact through the supply chain, thereby contributing significantly to the broader objectives of environmental sustainability and corporate responsibility.

Third, this study reveals that supplier co-creation emerges as a pivotal factor in enhancing green process innovation, although its influence on product innovation is comparatively subdued. This disparity can be attributed to the inherent challenges and time demands of establishing robust co-creation frameworks specifically tailored for new product development. Building such collaborative arrangements necessitates navigating complexities and dedicating substantial time to cultivate strong, effective partnerships. According to Tóth *et al.* (2018), De Vries & Verhagen (2016), and Steen *et al.* (2018), these intricate processes involve aligning organizational goals, harmonizing workflows, and managing the nuances of joint innovation efforts. The effort to synchronize diverse capabilities and resources with suppliers for product innovation often encounters obstacles, including differences in corporate culture, misaligned objectives, and the logistical hurdles of integrating new technologies or materials into existing product lines. The strength of supplier co-creation lies in its ability to foster innovation in processes—optimizing operations, reducing

environmental impact, and enhancing sustainability across the supply chain. Through co-creation, companies and their suppliers collaboratively identify and implement green solutions, leveraging shared knowledge and resources to achieve mutual sustainability goals. This collaborative approach enables a more efficient utilization of resources, leading to the development of sustainable procurement practices, waste reduction, and energy-efficient operations. Despite the challenges in extending co-creation to product innovation, its success in process innovation underscores the importance of strategic partnerships in achieving sustainability objectives. Companies seeking to maximize the benefits of co-creation should focus on building flexible, transparent relationships with suppliers, fostering a culture of open communication and mutual trust. This approach will not only facilitate an enhancement of their environmental performance but will also pave the way for more collaborative product development efforts in the future.

Fourth, cross-functional coopetition stands out as a critical intermediary that connects EMA implementation with advancements in both green process and product innovation. This mediating role, highlighted by Bouncken *et al.* (2018) and Bengtsson & Raza-Ullah (2016), illustrates how competitive cooperation across different functional areas within a company can drive the successful integration of EMA principles into innovation strategies. Cross-functional coopetition creates an environment where various departments not only collaborate but also compete, merging their distinct perspectives, expertise, and resources to challenge traditional approaches and encourage innovative solutions. In this process, departments work together to exchange, integrate, and assimilate a wide range of information and knowledge, aiming to secure the necessary resources for complex EMA activities. Simultaneously, this cooperation can lead to inter-departmental conflicts as departments contend over

limited resources and navigate differing goals. Further analysis reveals that EMA implementation lays the groundwork for cross-functional cooperation by emphasizing the importance of environmental considerations in all aspects of business operations. This not only encourages departments to work together towards shared sustainability goals but also promotes a culture of innovation where creative tensions and diverse viewpoints are valued. The dynamic interplay between cooperation and competition enables organizations to explore new avenues for green innovation, from refining processes to developing environmentally friendly products. The mediating influence of cross-functional cooperation is significant because it underscores the synergy between environmental management practices and innovative collaboration. By fostering a culture of cooperation, companies can leverage the full spectrum of their internal capabilities, enhancing their ability to respond to environmental challenges and market demands for sustainable solutions. This approach not only contributes to the company's competitive advantage but also advances the broader goals of sustainability and environmental stewardship.

6.1 Theoretical contribution

6.1.1 Contribution to research on the effects of standard implementation on innovation

This study makes the following contributions to the literature. Firstly, it supplements the mixed findings of the existing literature on the effects of EMA implementation on green innovation. There is some controversy in the existing literature about the impacts of guidelines or management controls such as EMA on innovation in the environmental field (Blind *et al.*, 2017; Valero-Gil *et al.*, 2023). Some previous studies indicate that strict guidelines may lock companies into the technological trajectory of pre-existing standards, limiting both conceptual flexibility

and the freedom of companies to innovate (Young *et al.*, 2018; Valero-Gil *et al.*, 2023). However, the results of the present study suggest that the compatibility aspect of standards promotes innovation. That is, standards can form the common foundation of advanced technological knowledge and are refined in a compatible and easily transferable form, which facilitates innovation (Young *et al.*, 2018; Valero-Gil *et al.*, 2023).

More specifically, management controls can provide complementary cost information and non-financial performance measures that help companies detect strategic uncertainties, measure deviations, and implement corrective actions, thus contributing to innovation (Henri and Wouters, 2020; Pavlatos and Kostakis, 2022). EMA guidelines are not rigid detailed standards, but rather provide a more flexible space for companies to select effective and appropriate EMA tools to evaluate their environmental costs, investments, risks, and performance. As for the diagnosis of unsatisfactory environmental issues by EMA tools, this can motivate companies to explore eco-design, green materials, and green technologies to improve product design, material usage, and manufacturing processes, thus achieving green process and product innovation.

6.1.2 Contribution to research on RBV and DCT

This study finds that innovation is not solely driven by the accumulation of resources but is also stimulated by the dynamic interplay of simultaneous resource sharing and competition. This study contributes to the literature on RBV by providing a new understanding of the role played in RBV by cross-functional coopetition in conditions of simultaneous resource sharing and conflict. Prior RBV literature has mainly studied companies' accumulation and utilization of VRIN resources to achieve sustainable

competitive advantages, largely ignoring the effects of the internal departmental conflicts that may simultaneously arise from resource sharing (Barney, 2001; Kraaijenbrink et al., 2010; Zahra, 2021; Kuypers *et al.*, 2018; Guo *et al.*, 2019). Ignoring research on resource conflicts may lead to an incomplete understanding of resource management processes, especially in new institutional environments (for example, during EMA implementation). Recent RBV-related research calls for a nuanced study on how to effectively manage resources which are shared by conflicting teams or departments (Sirmon *et al.*, 2007; Zahra, 2021). Making effective use of conflicts can generate creative opinions in brainstorming sessions, and foster opportunities to learn by acquiring more new knowledge and technology and finding innovative solutions. In addition, resource conflicts within companies can be regarded as opportunities to critically consider controversial views and reexamine the negative aspects of dominant decisions.

Despite extensive research applying DCT to explore how customer co-creation drives innovation (Zhang *et al.*, 2020; Siaw and Sarpong, 2021), there is a noticeable gap in studies examining the dynamic process of co-creation with suppliers and its effects. Suppliers are crucial for providing companies with capabilities, investments, information, and innovative ideas (Zhang *et al.*, 2016). Variations in a company's relationships with its suppliers can hinder the timely procurement of emerging materials, the absorption of product design suggestions, or the early adoption of advanced, feasible technologies. This study addresses this gap by providing empirical evidence on the role of supplier co-creation in DCT and its impact on innovative strategies.

The dynamic process of co-creating with external suppliers can foster a business ecosystem that aligns with environmental regulations and standards, promotes the co-production of eco-friendly materials and technologies, and reallocates valuable

resources to improve manufacturing processes. Co-creation with suppliers can help companies effectively implement EMA practices, leading to green process innovation. This research demonstrates that institutional pressures, such as regulatory frameworks and operational guidelines, shape firms' strategic orientations by influencing their dynamic capabilities.

The study indicates that these pressures can significantly realign a firm's focus towards enhancing and optimizing existing processes rather than immediately pursuing new product innovations. Consequently, this research broadens the scope of DCT by incorporating the impact of external institutional pressures and provides a more comprehensive understanding of how these pressures dictate strategic innovation priorities within firms. It underscores the complex interplay between internal capabilities and external environments in shaping organizational strategies and outcomes.

This enhanced understanding of dynamic capabilities under institutional pressures offers firms a clearer framework for navigating environments where regulatory, normative, and cognitive pressures are intense. It highlights the need for firms to view these pressures not just as external challenges requiring compliance but as strategic elements that can guide innovation efforts. By identifying institutional pressures as determinants steering dynamic capabilities towards process innovation, this research suggests that the factors affecting dynamic capabilities are more extensive than previously recognized. It posits that dynamic capabilities are significantly influenced by external institutional demands, introducing a nuanced perspective that these capabilities are not just internally driven but are also shaped by the external regulatory and normative environment.

6.2 Practical implications

Firstly, this research suggests that managers should be conscious of the positive influence of EMA implementation on green innovation. Managers need to actively mobilize employees to grasp EMA guidelines and implement EMA activities efficiently. For example, companies can establish joint action teams to form an understanding of EMA-related environmental regulations such as those dealing with carbon emission information disclosure, accounting systems, and environmental performance evaluation indices. It is also imperative to establish platforms or channels such as forums or field visits to gather the public's suggestions and expectations with regard to environmental information reporting and environmental performance, or to organize staff visits to leading enterprises to learn about EMA practices. Through systematically improving EMA implementation, companies can efficiently conduct eco-auditing and environmental cost and performance management, which impels companies to explore green technology, materials, and energy to renew outdated processes and products and achieve green innovation.

Secondly, this research demonstrates that simultaneous cooperation and competition across functions plays a critical role in stimulating green process and product innovation. On the one hand, managers should recognize that competition and conflicts among different departments are not always undesirable. Companies need to arrange training programs that help employees from different departments establish shared goals and recognize the convergence of individual departmental targets, thus constructing a cooperative inter-departmental atmosphere where employees cooperate with each other and handle divergent opinions constructively, with open minds. On the other hand, managers should also impose a higher degree of interest in understanding contrasting views from different departments. Specifically, companies should

decentralize their organizational structures, enabling employees in different departments to be involved in decision-making and to provide divergent views without worrying about being embarrassed, denied, neglected, or punished. For instance, companies could organize a cross-departmental group consisting of talents from different departments. The cross-functional group would increase trust among employees while providing a brainstorming atmosphere to expedite knowledge sharing and critical thinking and stimulating creative approaches to accomplishing both green process and product innovation.

Thirdly, co-creation can significantly promote green process innovation but cannot significantly motivate green product innovation. Various issues may arise during the co-creation process, such as mistrust, unfair distribution of benefits and the withholding of information (Abosag et al., 2016; Anshu et al., 2022); this can lead to inefficient communication and negotiation and difficulties in achieving product innovation within a given period of time. Hence, it is suggested that managers select well-matched collaborators, cultivate stable relationships, and associate collaborators with various departments to develop an integrated platform with clear cooperation obligations, reasonable remuneration allocation, and a standardized management system. In addition, managers should conduct regular management meetings and staff surveys to ensure that all objectives are aligned and that employees feel satisfied and trusted, which can expedite green product innovation.

6.3 Limitations and future research

Future research should continue to delve into the influence of environmental standards on corporate innovation and competitive advantage. This includes exploring a broad spectrum of innovation types—from product and process innovation to

organizational and management innovations—and understanding the specific processes by which environmental standards shape these developments. Studies could examine how different standards drive companies to adopt new technologies, alter operational processes, or reconfigure their business strategies to enhance sustainability and competitive positioning in the market.

Acknowledging the constraints inherent in this research is crucial for contextualizing its findings and guiding future inquiries. One significant limitation is the geographical focus of the sample data, which is exclusively drawn from Chinese companies. This limitation suggests a potential avenue for future research to extend the investigation into the effects of EMA implementation on green innovation by incorporating data from organizations across a diverse array of global contexts. Expanding the geographical scope would enable a broader understanding of how cultural, regulatory, and economic differences influence the adoption of EMA practices and their impact on sustainable innovation efforts.

Moreover, the analysis of this study did not account for the variability across different sectors, overlooking industry-specific dynamics that could significantly influence the relationship between EMA implementation and green innovation. Future studies could enrich the existing literature by conducting comparative analyses across various industries. Such research would uncover industry-specific factors that either facilitate or hinder green innovation, providing nuanced insights that could lead to more targeted and effective EMA guidelines and practices tailored to the unique needs of each sector.

Additionally, the research framework primarily focuses on product and process innovation as proxies for green innovation, potentially overlooking other critical dimensions of sustainability-driven innovation. Future research endeavors could adopt

a more holistic approach by considering the concept of innovation efficiency. This perspective would encompass not only the output of innovation activities but also the resources expended and the environmental impact mitigated through these innovations. By exploring green innovation through the lens of efficiency, future studies could uncover deeper insights into how EMA practices contribute to optimizing the balance between innovation, resource utilization, and environmental sustainability.

Addressing these limitations through subsequent research will not only broaden the understanding of EMA's role in promoting green innovation but also provide more comprehensive strategies for companies striving to integrate sustainability into their core operations. By expanding the geographical, industry-specific, and conceptual scope of research on EMA and green innovation, scholars and practitioners can develop more robust, effective, and adaptable frameworks for fostering environmental sustainability in the corporate world.

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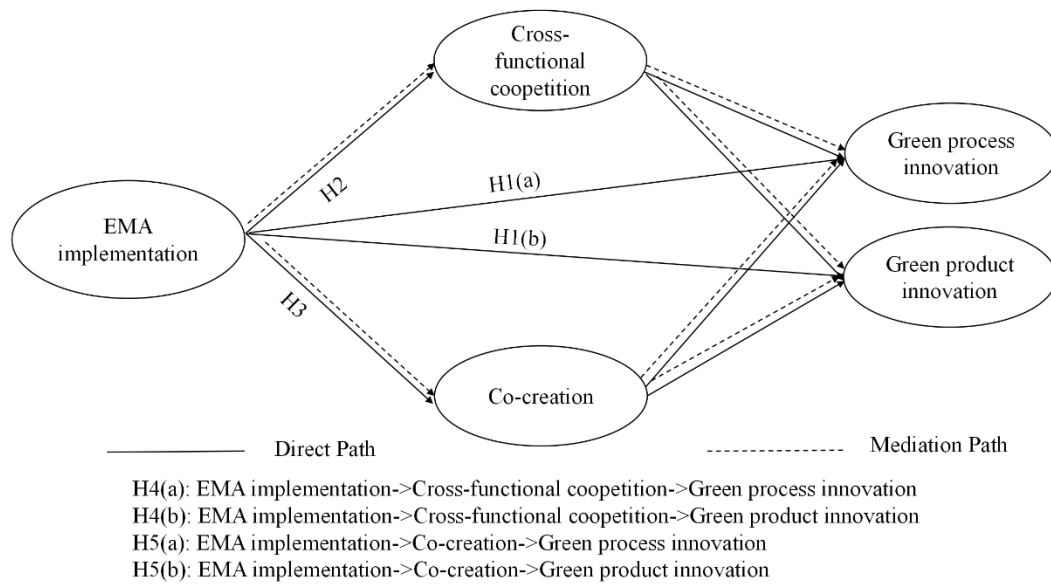


Figure 1. Note: EMA implementation (EMAI) is measured from three perspectives of institutional isomorphism, including coercive EMA implementation (CEMAI), normative EMA implementation (NEMAI) and mimetic EMA implementation (MEMAI) (Liu *et al.*, 2010; Wang *et al.*, 2018).

Table 1. Respondent and firm profile

Measure	Item	Frequency	Percentage
Industry	Food and beverage	65	8.14
	Energy	67	8.39
	Computer and Electronics	72	9.01
	Electrical products	59	7.38
	Chemical, rubber, plastic, and metal products	60	7.51
	Machinery and equipment	56	7.01
	Automobile	64	8.01
	Textile	69	8.64
	Furniture	69	8.64
	Pharmaceutical industry	74	9.26
	Architecture	80	10.01
	Agriculture	64	8.01
Firm's age	<2 years	95	11.89
	3–5 years	385	48.19
	6–10 years	294	36.80
	>10 years	25	3.13
Staff size	200–500	332	41.55
	501–1,000	249	31.16

	1,001–2,000	142	17.77
	>2,001	76	9.51
Respondent's position	General manager	19	2.38
	Senior executives	108	13.52
	Middle manager	183	22.90
	Junior manager	195	24.41
	Staff	294	36.80
Respondent's department	Research and Development	60	7.51
	Purchasing	170	21.28
	Production	35	4.38
	Quality inspection	147	18.40
	Inventory	131	16.40
	Marketing	151	18.90
	Accounting	29	3.63
	Administrative department	76	9.51
Working experiences	<2 years	73	9.14
	3–5 years	395	49.44
	6–10 years	275	34.42
	>10 years	56	7.01

Table 2. Assessment of the Measurement Model

Construct	Item	Loading	Cronbach's alpha	Composite Reliability (rho_c)	Average variance Extracted (AVE)	VIF
Coercive implementation (CEMAI)	EMA CEMAI1	0.849	0.847	0.897	0.685	2.065
	CEMAI2	0.785				1.663
	CEMAI3	0.852				2.055
	CEMAI4	0.824				1.879
Normative implementation (NEMAI)	EMA NEMAI1	0.842	0.848	0.897	0.687	1.974
	NEMAI2	0.802				1.777
	NEMAI3	0.859				2.169
	NEMAI4	0.810				1.771
Mimetic implementation (MEMAI)	EMA MEMAI1	0.856	0.868	0.910	0.717	2.104
	MEMAI2	0.849				2.149
	MEMAI3	0.850				2.129
	MEMAI4	0.832				1.975
Cross-Functional	CFCA1	0.858	0.930	0.944	0.739	2.737
Cooperative	CFCA2	0.848				2.804
Ability	CFCA3	0.870				2.752

(CFCA)	CFCA4	0.866				2.764
	CFCA5	0.857				2.539
	CFCA6	0.859				2.715
Cross-Functional Cooperative Intensity (CFCI)	CFCI1	0.771	0.900	0.923	0.668	1.853
	CFCI2	0.865				2.718
	CFCI3	0.801				2.017
	CFCI4	0.775				1.887
	CFCI5	0.835				2.291
	CFCI6	0.850				2.476
Cross-Functional Competition (CFCO)	CFCO1	0.753	0.910	0.928	0.616	1.893
	CFCO2	0.815				2.261
	CFCO3	0.804				2.215
	CFCO4	0.764				1.889
	CFCO5	0.764				1.925
	CFCO6	0.796				2.181
	CFCO7	0.736				1.830
	CFCO8	0.841				2.583
Co-creation (CR)	CR1	0.827	0.934	0.946	0.715	2.360
	CR2	0.854				2.830
	CR3	0.849				2.644

	CR4	0.836				2.445
	CR5	0.847				2.674
	CR6	0.861				2.886
	CR7	0.843				2.584
Green Process Innovation (GPCI)	GPCI1	0.846	0.927	0.942	0.731	2.533
	GPCI2	0.856				2.682
	GPCI3	0.849				2.561
	GPCI4	0.860				2.652
	GPCI5	0.863				2.748
	GPCI6	0.857				2.678
Green Product Innovation (GPDI)	GPDI1	0.872	0.916	0.937	0.748	2.750
	GPDI2	0.869				2.708
	GPDI3	0.865				2.560
	GPDI4	0.855				2.469
	GPDI5	0.863				2.537

Table 3: Heterotrait-monotrait ratio of correlations (HTMT) and Fornell-Larcker Criterion

	CFCA	CFCI	CFCO	CP	COCR	MP	NP	GPCI	GPDI
Cross-Functional Cooperative Ability (CFCA)	0.860	<i>0.041</i>	<i>0.053</i>	<i>0.167</i>	<i>0.069</i>	<i>0.156</i>	<i>0.135</i>	<i>0.164</i>	<i>0.117</i>
Cross-Functional Cooperative Intensity (CFCI)	0.028	0.817	<i>0.410</i>	<i>0.476</i>	<i>0.226</i>	<i>0.412</i>	<i>0.445</i>	<i>0.371</i>	<i>0.266</i>
Cross-Functional Competition (CFCO)	0.046	0.371	0.785	<i>0.474</i>	<i>0.255</i>	<i>0.463</i>	<i>0.457</i>	<i>0.365</i>	<i>0.327</i>
Coercive EMA implementation (CEMAI)	0.150	0.417	<i>0.417</i>	0.828	<i>0.376</i>	<i>0.631</i>	<i>0.652</i>	<i>0.541</i>	<i>0.458</i>
Co-creation (CR)	0.066	0.208	<i>0.236</i>	0.335	0.846	<i>0.364</i>	<i>0.360</i>	<i>0.330</i>	<i>0.226</i>
Mimetic EMA implementation (MEMAI)	0.143	0.365	0.413	0.542	0.329	0.847	<i>0.639</i>	<i>0.510</i>	<i>0.458</i>
Normative EMA implementation (NEMAI)	0.123	0.390	0.403	0.552	0.322	0.548	0.829	<i>0.507</i>	<i>0.448</i>
Green Process Innovation (GPCI)	0.156	0.341	0.336	0.480	0.307	0.459	0.451	0.855	<i>0.431</i>
Green Product Innovation (GPDI)	0.110	0.241	0.300	0.404	0.210	0.409	0.395	0.397	0.865

Note(s): The HTMT result is highlighted in italic and falls above the diagonal value while the below result belongs to Fornell–Larcker criterion

Table 4. Assessment of the higher-order construct on cross-functional coopetition

High-order Construct	Low-order Construct	Outer Weights	t-value	95% BCa CI	VIF	Convergent Validity
Cross-functional Coopetition (CFC)	Cross-Functional	0.267	5.445	[0.185; 0.348]	1.002	0.853
	Cooperative Ability					
	Cross-Functional Cooperative Intensity	0.540	10.884	[0.457; 0.619]	1.160	
	Cross-Functional Competition	0.608	12.940	[0.526; 0.682]	1.162	

Note(s): CI means 95% confidence interval bias corrected

Table 5. Assessment of the structural model

Hypothesis and relationship	Coefficient (β)	Standard deviation	p-value	t-value	95% BCa CI	VIF	f^2	Hypothesis results
Direct effects								
H1(a) _{CEMAI} : CEMAI→GPCI	0.200	0.041	0.000	4.946	[0.134; 0.267]	1.783	0.034	Significant
H1(b) _{CEMAI} : CEMAI→GPDI	0.168	0.042	0.000	4.038	[0.101; 0.236]	1.783	0.021	Significant
H1(a) _{NEMAI} : NEMAI→GPCI	0.145	0.040	0.000	3.668	[0.081; 0.211]	1.737	0.018	Significant
H1(b) _{NEMAI} : NEMAI→GPDI	0.152	0.042	0.000	3.601	[0.080; 0.221]	1.737	0.017	Significant
H1(a) _{MEMAI} : MEMAI→GPCI	0.166	0.039	0.000	4.261	[0.103; 0.231]	1.719	0.024	Significant
H1(b) _{MEMAI} : MEMAI→GPDI	0.188	0.042	0.000	4.444	[0.118; 0.258]	1.719	0.027	Significant
H2 _{CEMAI} : CEMAI→CFC	0.283	0.036	0.000	7.874	[0.224; 0.342]	1.630	0.076	Significant
H2 _{NEMAI} : NEMAI→CFC	0.215	0.040	0.000	5.390	[0.148; 0.280]	1.641	0.043	Significant
H2 _{MEMAI} : MEMAI→CFC	0.215	0.039	0.000	5.563	[0.152; 0.279]	1.621	0.044	Significant
H3 _{CEMAI} : CEMAI→CR	0.172	0.044	0.000	3.886	[0.100; 0.246]	1.630	0.022	Significant
H3 _{NEMAI} : NEMAI→CR	0.140	0.045	0.001	3.069	[0.064; 0.215]	1.646	0.014	Significant
H3 _{MEMAI} : MEMAI→CR	0.159	0.044	0.000	3.605	[0.086; 0.231]	1.621	0.018	Significant
Mediating effects								
H4(a) _{CEMAI} : CEMAI→CFC→GPCI	0.042	0.011	0.000	3.825	[0.025; 0.061]			Significant
H4(b) _{CEMAI} : CEMAI→CFC→GPDI	0.024	0.011	0.020	2.062	[0.006; 0.044]			Significant
H4(a) _{NEMAI} : NEMAI→CFC→GPCI	0.032	0.010	0.001	3.081	[0.017; 0.051]			Significant

H4(b) _{NEMAI} : NEMAI→CFC→GPDI	0.018	0.009	0.024	1.981	[0.005; 0.035]			Significant
H4(a) _{MEMAI} : MEMAI→CFC→GPCI	0.032	0.010	0.001	3.150	[0.017; 0.050]			Significant
H4(b) _{MEMAI} : MEMAI→CFC→GPDI	0.018	0.009	0.025	1.964	[0.005; 0.035]			Significant
H5(a) _{CEMAI} : CEMAI→CR→GPCI	0.017	0.007	0.009	2.370	[0.007; 0.031]			Significant
H5(b) _{CEMAI} : CEMAI→CR→GPDI	0.003	0.006	0.285	0.569	[-0.005; 0.015]			Not significant
H5(a) _{NEMAI} : NEMAI→CR→GPCI	0.014	0.006	0.017	2.129	[0.005; 0.027]			Significant
H5(b) _{NEMAI} : NEMAI→CR→GPDI	0.003	0.005	0.290	0.554	[-0.004; 0.012]			Not significant
H5(a) _{MEMAI} : MEMAI→CR→GPCI	0.016	0.007	0.011	2.305	[0.007; 0.030]			Significant
H5(b) _{MEMAI} : MEMAI→CR→GPDI	0.003	0.006	0.289	0.563	[-0.005; 0.014]			Not significant
CFC→GPCI	0.147	0.036	0.000	4.070	[0.088; 0.206]	1.558	0.021	
CFC→GPDI	0.083	0.039	0.015	2.160	[0.022; 0.148]	1.558	0.006	
CR→GPCI	0.099	0.031	0.000	3.146	[0.048; 0.150]	1.187	0.012	
CR→GPDI	0.020	0.033	0.275	0.597	[-0.034; 0.077]	1.187	0.000	
R^2								
CFC	0.356							
CR	0.155							
GPCI	0.332							
GPDI	0.237							

Note(s): Bootstrapping based on $n = 10,000$ bootstrap samples. Effects from the mediation effects and control variable are assessed by applying a two-tailed test (PCI 95%)

Table 6. PLS predict assessment on manifest variables

	Q ² predict	PLS-SEM_RMSE	LM_RMSE	PLS-SEM – LM RMSE
CR1	0.107	1.292	1.303	-0.011
CR2	0.095	1.392	1.402	-0.010
CR3	0.105	1.337	1.352	-0.015
CR4	0.119	1.312	1.319	-0.007
CR5	0.095	1.383	1.393	-0.010
CR6	0.099	1.385	1.398	-0.013
CR7	0.116	1.343	1.353	-0.010
CFCA	0.025	0.989	0.996	-0.007
CFCI	0.215	0.887	0.891	-0.004
CFCO	0.237	0.875	0.878	-0.003
GPCI1	0.201	1.667	1.679	-0.012
GPCI2	0.196	1.740	1.752	-0.012
GPCI3	0.223	1.674	1.682	-0.008
GPCI4	0.255	1.628	1.638	-0.010
GPCI5	0.235	1.66	1.667	-0.007
GPCI6	0.214	1.682	1.699	-0.017
GPD11	0.156	1.770	1.788	-0.018
GPD12	0.159	1.742	1.764	-0.022

GPDI3	0.180	1.756	1.769	-0.013
GPDI4	0.167	1.758	1.773	-0.015
GPDI5	0.181	1.763	1.783	-0.020

Note(s): (1). RMSE: Root mean squared error; PLS: Partial least squares

(2). LM: Linear regression model. k = 10 subgroups, number of repetitions = 10

Table 7.1 Predictive contribution of the mediator cross-functional cooperation (PCM)

	CEMAI	Conclusion	NEMAI	Conclusion	MEMAI	Conclusion
	PCM		PCM		PCM	
GPCI1	0.020	weak	0.026	weak	0.026	weak
GPCI2	0.015	weak	0.022	weak	0.021	weak
GPCI3	0.019	weak	0.022	weak	0.020	weak
GPCI4	0.022	weak	0.026	weak	0.027	weak
GPCI5	0.016	weak	0.024	weak	0.021	weak
GPCI6	0.022	weak	0.024	weak	0.027	weak
GPDI1	0.008	weak	0.012	weak	0.012	weak
GPDI2	0.006	weak	0.008	weak	0.008	weak
GPDI3	0.013	weak	0.013	weak	0.013	weak
GPDI4	0.011	weak	0.013	weak	0.010	weak
GPDI5	0.010	weak	0.012	weak	0.009	weak

Note(s): The approximate boundaries of 0–0.05 for small, 0.05–0.1 for moderate and greater than 0.1 for strong predictive contribution of the mediator

Table 7.2 Predictive contribution of the mediator co-creation (PCM)

	CEMAI PCM	Conclusion	NEMAI PCM	Conclusion	MEMAI PCM	Conclusion
GPCI1	0.012	weak	0.015	weak	0.014	weak
GPCI2	0.012	weak	0.014	weak	0.014	weak
GPCI3	0.010	weak	0.011	weak	0.010	weak
GPCI4	0.009	weak	0.011	weak	0.011	weak
GPCI5	0.009	weak	0.012	weak	0.010	weak
GPCI6	0.008	weak	0.009	weak	0.009	weak
GPDI1	0.002	weak	0.003	weak	0.003	weak
GPDI2	0.001	weak	0.001	weak	0.001	weak
GPDI3	0.003	weak	0.003	weak	0.003	weak
GPDI4	0.001	weak	0.002	weak	0.001	weak
GPDI5	0.002	weak	0.002	weak	0.001	weak

Note(s): The approximate boundaries of 0–0.05 for small, 0.05–0.1 for moderate and greater than 0.1 for strong predictive contribution of the mediator

Table 8. NCA effect sizes

CFC			CR	
Construct	CE-FDH	<i>p</i> -value	CE-FDH	<i>p</i> -value
CEMAI	0.136	0.000	0.044	0.081
NEMAI	0.122	0.000	0.029	0.135
MEMAI	0.139	0.000	0.035	0.215