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Green innovation ecosystem and water performance in the food service industry: The effects of environmental management controls and digitalization

Fabricia S. Rosa[1] | Lorenzo Compagnucci[2] | Rogerio J. Lunkes[1] | Januário J. Monteiro[3]

[1]Department of Accounting, Universidade Federal de Santa Catarina, Florianópolis, Brazil
[2]Department of Law, University of Macerata, Macerata, Italy
[3]Norwich Business School, University of East Anglia, Norwich, UK

Correspondence
Fabricia S. Rosa, Department Accounting, Universidade Federal de Santa Catarina, Campus Universitário, S/N, 88040-900 Florianópolis, Brazil.
Email: fabricia.rosa@ufsc.br

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Abstract

Based on the theory of innovation ecosystems (IEs) and the literature on environmental management controls (EMCs), this study examines the effects of green innovation ecosystems (GIEs), EMCs, and digitalization on the water performance of firms in the food service industry (FSI). In this context, the moderating role of technology sensing/response (TSR) is explored. Surveying 245 managers in large Brazilian restaurants, the hypotheses are tested through partial least squares structural equation modeling. The findings reveal that the GIE positively influences digitalization and the use of both diagnostic and interactive EMCs. Additionally, the results demonstrate not only that interactive EMCs improve water performance but also that a high level of TSR increases the impact of diagnostic EMCs on water performance. This study therefore advances the literature by illustrating how cooperation between FSI firms and multiagents provides competences and resources that facilitate the implementation of digital tools and EMCs to achieve sustainability outcomes.

KEYWORDS
digitalization, environmental management controls, food service industry, green innovation ecosystems, technology sensing/response, water performance

1 | INTRODUCTION

The food service industry (FSI) comprises a broad range of operations related to procuring, storing, preparing, transporting, and selling food and beverages for immediate consumption, takeaway, or delivery (Betz et al., 2015; Rosa et al., 2021; Styles et al., 2013; Turenne, 2009). Although the spread of the COVID-19 pandemic strongly affected the global FSI balance in 2020 (Deloitte, 2022), the industry has been rapidly recovering (Bux et al., 2022). In 2019, the size of the global FSI market was approximately 2.7 trillion US dollars

Abbreviations: ABRASEL, Brazilian Association of Bars and Restaurants; AVE, Average variance extracted; CADASTUR, Registration system for natural and legal persons working in the tourism sector; CAPES, Coordination for the Improvement of Higher Education Personnel; CNPq, National Council for Scientific and Technological Development; COVID-19, Corona Virus Disease; CR, Composite reliability; DEC, Diagnostic environmental controls; DG, Digitalization; EMC, Environmental management control; EMCs, Environmental management controls; EPAGRI, Agricultural Research and Rural Extension Company of Santa Catarina; EUWD, European Union Waters Directors; FSI, Food service industry; FSIs, Food service industries; GI, Green Innovation; GIE, Green innovation ecosystem; GIEs, Green innovation ecosystems; IE, Innovation ecosystem; IEs, Innovation ecosystems; IEC, Interactive environmental controls; IoT, Internet of Things; KDS, Kitchen Display System; MNCs, Multinational corporations; MNEs, Multinational enterprises; PLS-SEM, Partial least squares structural equation modeling; POS, Point of Sale; R&D, Research and Development; SEBRAE, Brazilian Micro and Small Business Support Service; TSR, Technology sensing/response.

(Deloitte, 2020), and this figure is expected to grow to 4.1 trillion US dollars by 2026 (Research and Markets, 2023). On the one hand, such a rapid recovery (Liao & Liu, 2021) is important for creating jobs and wealth; on the other hand, the FSI exerts growing pressures on natural resources (Chou et al., 2012; Sadraei et al., 2022), especially by consuming large volumes of freshwater (Filimonau et al., 2019; Strasburg & Jahno, 2017; Warren & Becken, 2017).

In addition to mounting environmental challenges, food scandals, health protections, and consumer awareness levels (Liu et al., 2022) have progressively pushed firms to address the inadequacy of their business strategies for sustainable development (Hizarci Payne et al., 2021; Yang et al., 2021). Specifically, the FSI can seek to reduce water consumption by implementing both digitalization (Vern et al., 2022) and environmental management controls (EMCs) (European Union Waters Directors (EUWD), 2016; Rosa et al., 2021). On the one hand, digitization involves the use of digital tools to facilitate both firm–customer interactions and the incorporation of innovative practices into firms' operations (Farías & Cancino, 2021). On the other hand, diagnostic and interactive environmental controls are management practices adopted by firms to achieve environmental and financial goals (Heggen & Sridharan, 2021).

To cope with these challenges, several firms have started introducing environmental management operations into their daily activities (Doran & Ryan, 2016; Tsai & Liao, 2017a, 2017b; Warren & Becken, 2017) and have realized the necessity of improving their capability to respond to technology changes (Fernando et al., 2019) and to implement green innovation (GI)[1] (Gabriel & Mina, 2015; Liao & Liu, 2021; Tsai & Liao, 2017a). However, for GI to become a compelling factor in economic growth and environmental protection (Cui et al., 2023), joint efforts of firms and their stakeholders, such as suppliers, consumers, governments, and universities, are needed (Compagnucci et al., 2020; Günzel-Jensen & Rask, 2021; Litardi et al., 2020).

Thus, the green innovation ecosystem (GIE) functions as a lens for exploring multiagent cooperation in sustainable management in the FSI. The GIE is an innovation ecosystem (IE) that seeks to improve the conditions that support GI (Zeng et al., 2022). While several scholars have recently stressed that further attention should be given to the GIE (e.g., Fan et al., 2022; Liu et al., 2022; Liu & Stephens, 2019; Oliveira-Duarte et al., 2021; Yi & Zhang, 2022; Yin et al., 2020; Yu et al., 2022), few quantitative studies have addressed the GIE in the management literature. Specifically, there is limited empirical evidence on how and to what extent the GIE can assist firms in pursuing environmental goals, such as water performance (Zeng et al., 2022).

Accordingly, this study addresses the abovementioned research gaps by investigating the effects of the GIE on the use of EMCs, digitalization, and water performance in the FSI. Second, the moderating role of technology sensing/response (TSR) in these effects is examined. Drawing on the theoretical model of the GIE, hypotheses are developed and then tested on a dataset specifically built for this analysis. The sample includes data on 245 large Brazilian restaurants gathered through a survey. Brazil is among the top 10 countries in the global FSI market and the first-ranked in South America (Deloitte, 2022).[2] Furthermore, Brazilian restaurants are consuming a growing volume of freshwater (Rosa et al., 2021) and are likely to use both environmental management practices (Gomez-Conde et al., 2019) and digital technologies.

This study thus offers five contributions. First, it adds to previous studies on IEs (e.g., Nylund et al., 2021; Yang et al., 2021; Zou et al., 2021) by unveiling that in the GIE, FSI firms can be stimulated to establish and maintain multiagent cooperation for implementing green technologies and eco-friendly practices. Second, this research contributes to the literature on EMCs (e.g., Abdel-Maksoud et al., 2016, 2021; Demirel & Kesidou, 2018; González-Benito & González-Benito, 2006; Pondeville et al., 2013; Tsai & Liao, 2017b) by revealing that in the GIE, FSI firms are encouraged to implement both interactive and diagnostic controls. The latter contributes to reducing both the consumption and waste of water, thereby improving overall water performance. Third, different from previous studies (e.g., Fernando et al., 2019; Nayal et al., 2022), we illustrate that digitalization alone seems to have no real effect on water performance. Fourth, our study adds to the extant research on TSR (e.g., Aragón-Correa, 1998; Buzzao & Rizzi, 2021; Leonidou, Leonidou, et al., 2013; Sharma et al., 2007; Srinivasan et al., 2002) by demonstrating that in the GIE, when managers are sensitive to technology changes, the positive effect of diagnostic controls on water performance increases. Fifth, this study adopts a novel quantitative approach to address the need to advance prior qualitative research on the GIE (Yin et al., 2020) and to collect statistical evidence in relation to the FSI in emerging economies (e.g., Filimonau et al., 2019; Kasavan et al., 2019).

The study is structured as follows: Section 2 reviews the theoretical background and introduces the research hypotheses. Section 3 describes the research context, sample, data collection, and measures. Section 4 illustrates the results. Section 5 extensively discusses the findings. The final section presents the conclusions, theoretical and practical implications, limitations, and a selection of avenues for future research.

2 | THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

2.1 | GIEs and the FSI

Oliveira-Duarte et al. (2021) have argued, drawing on ecological metaphors, that the ecosystem concept was first introduced by Frosch and Gallopoulos (1989) as an analogy of industrial systems. Then, Moore (1993) coined the concept of a business ecosystem, which is "an economic community supported by a foundation of interacting organizations and individuals-the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also

[1]GI is also termed eco-innovation, sustainable innovation, or environmental innovation (Martínez-Ros & Kunapatarawong, 2019; Tsai & Liao, 2017b).

[2]In 2019, the Brazilian FSI market size was over 460 billion Brazilian reals and employed approximately 1.28 million workers. See https://www.statista.com/statistics/812751/foodservice-market-value-segment-brazil/.

include suppliers, lead producers, competitors, and other stakeholders" (p. 26). On this point, the literature has proposed several related concepts, among which the innovation ecosystem has attracted the attention of both academics and policy-makers (Adner, 2017; Jacobides et al., 2018). The IE is a framework for facilitating the development of innovation, science and technology (Aramesh, 2021).

The IE has therefore been used as a lens for examining several industries, such as the high-tech, manufacturing, financial services (Shou et al., 2022), and health care (Vlaisavljevic et al., 2020). More recently, environmental and social challenges and government pressures have paved the way toward the GIE, which aims to foster the conditions that support GI (Li & Shi, 2022), for example, the use of digital technologies and environmental management practices (Demirel & Kesidou, 2018; Tsai & Liao, 2017b). The GIE might influence a firm's willingness to establish and maintain alliances for multiagent cooperation in GI (Yang et al., 2021) by sharing knowledge, human capital, and financial resources (Cennamo & Santaló, 2019) among suppliers, governments, consumers, universities (Zeng et al., 2022), and the natural environment (Carayannis, Grigoroudis, et al., 2021). However, in a complex environment, GI can be affected by uncertainty regarding cost inputs, research and development (R&D) (Fernando & Wah, 2017), pressures from multiagent cooperation (e.g., regulatory pressures), technological knowledge levels (Liao, 2018a), and the need to align green business strategies with financial objectives (Somlai, 2022).

Few studies, however, have focused on the GIE (Li & Shi, 2022). Yang et al. (2021) have examined the evolutionary stages of a GIE by examining government–university–industry collaboration amid environmental regulations. The authors adopted game-based theory and simulation methods. Their findings show that firms and universities adopt a collaborative innovation strategy. These groups also use the betrayal alliance strategy. On the other hand, the government plays a major role in balancing the GIE by introducing environmental regulations and offering subsidies for GI to both firms and universities. Nylund et al. (2021) have developed a conceptual framework for analyzing, under a GIE, the roles and dynamics of multinational enterprises (MNEs). By investigating exemplary MNE case studies, this study reveals that MNEs are the most impactful agents within the GIE, as they play different roles, for example, secretive innovators, builders, theatre directors, platform leaders, dominators, or amplifiers.

More recently, Fan et al. (2022) have proposed a conceptual framework for GIE that includes direct and indirect value creators. This study moves from the traditional focal firm view to an ecosystem perspective. The authors review the literature on both GI and IE and use content analysis to identify the connectivities and crossovers between these two fields of knowledge. Their findings demonstrate that the two research streams overlap on the roles of the actors in multiagent cooperation.

Although the literature has stressed the importance of the GIE (Wicki & Hansen, 2019), there is limited statistical evidence on how and to what extent multiagent cooperation therein can assist firms in incorporating GI into their business strategies. Researchers therefore should address the complexity of the GIE, as it includes a combination of heterogeneous demands, technology-based solutions, direct public interventions, and incentive structures (Kibler et al., 2018; Ociepa-Kubicka & Pachura, 2017; Rosa et al., 2021). Furthermore, few empirical studies have assessed the real efforts of multiagent cooperation in pursuing GI (Günzel-Jensen & Rask, 2021; Liu et al., 2022). There is also limited evidence on how agents can be supported in improving their environmental performance, how collaborative processes affect firm outcomes, and which targets should, or at least can be, prioritized for effective cooperation (Porter & Birdi, 2018).

Multiagent cooperation for GI is also important for the FSI for a number of reasons. The FSI is increasingly attracting the attention of both managers and policy-makers because it is a rapidly growing industry (Bux et al., 2022) that also exerts a major impact on the environment by consuming high quantities of natural resources (Chou et al., 2012; Sadraei et al., 2022). Specifically, the FSI is highly dependent on freshwater supply (EUWD, 2016; Filimonau et al., 2019; Strasburg & Jahno, 2017; Warren & Becken, 2017) to procure, store, prepare, deliver, and sell food and beverages for immediate consumption, takeaway, or delivery (Betz et al., 2015; Styles et al., 2013; Turenne, 2009). For example, restaurants use, on average, 60 L of water for each meal served (Savaşan, 2022). It is also worth noting that restaurants have very different characteristics and degrees of propensity to innovate; indeed, small restaurants are usually low-tech companies that focus on incremental innovation, while restaurants affiliated with multinational corporations (MNCs) usually benefit from using patented technologies and processes for food making and delivery (Yun et al., 2020). Nevertheless, previous research has demonstrated that restaurants can implement both eco-friendly products and processes by collaborating with local stakeholders. In particular, the use of alternative sources of water can contribute to achieving economic, environmental, and social sustainability. Furthermore, on the basis of customers' profiles, restaurants can plan distinct menus and services, thus reducing waste and improving both economic and environmental performance (Rosa et al., 2021).

2.2 | GIEs, digitalization, and EMCs

The FSI is a diversified and highly competitive industry that is increasingly requiring the implementation of digital tools (Verevka, 2019). This became clear during the COVID-19 era (Amankwah-Amoah et al., 2021). In an IE, paper-based tasks are replaced by processes that rely on "computing," which facilitates communication, the adoption of organizational procedures, and the effectiveness of business models (Saarikko et al., 2020). Furthermore, digitalization might assist organizations in improving their operational tasks and providing customers with dedicated purchasing experiences (Jayawardena et al., 2023). Overall, then, in the GIE, the higher the firm cooperation with universities (Costa & Matias, 2020) and customers (Esposito et al., 2022), the higher the digitalization of the FSI will be.

According to prior studies, multiagent cooperation can support the adoption of new technologies (e.g., Fan et al., 2022; Rosa et al., 2021; Xin et al., 2022; Yang et al., 2021; Zeng et al., 2022). Rosa et al. (2021) demonstrate that closer relationships among FSI firms, suppliers, farmers, and the government can enable both the implementation of green processes and the development of eco-friendly products. In the GIE, multiagent cooperation can also reduce costs while increasing stakeholders' commitment to pursing GI (Zou et al., 2021). Prior studies have also suggested that multiagent cooperation can foster both the co-creation and the implementation of strategies that, in turn, might favor firm digitalization (Costa & Matias, 2020; Esposito et al., 2022; Fan et al., 2022). Nevertheless, the literature has recently stressed that there is still limited evidence regarding the impact exerted by the GIE on FSI firm operations (Zeng et al., 2022). Specifically, future research should delve deeper into how interactions among agents can foster digitalization. Accordingly, based on the above arguments, the following hypothesis is proposed:

H1a. The green innovation ecosystem positively influences digitalization.

The GIE enables the management of socioecological transitions in combination with knowledge production and innovation through the development of a systematic approach toward sustainability challenges (Carayannis, Dezi, et al., 2021; Carayannis, Grigoroudis, et al., 2021). The literature suggests that contextual contingencies, such as the environment, may affect the use of both interactive and diagnostic EMCs (Otley, 2016). Thus, we expect that the higher the involvement of FSI firms in the GIE, the greater the implementation of EMCs. Managers can benefit from using EMCs by integrating both environmental and financial information, which in turn facilitates the decision-making process (Gunarathne & Lee, 2015; Henri & Journeault, 2010).

Within the broad scope of the GIE, multiagent cooperation can promote eco-friendly behaviors in the organizational field (Yang et al., 2021) and then affect the way management controls are implemented on a daily basis. The literature argues that EMCs are commonly used to (i) shape employees' behavior, (ii) monitor firms' environmental performance, and (iii) improve financial performance (Heggen & Sridharan, 2021; Henri & Journeault, 2010; Schaltegger & Burritt, 2000). Furthermore, previous research on management control has suggested that the use of both interactive and diagnostic EMCs might lead to positive organizational results (Heggen & Sridharan, 2021).

However, there are still only a few studies that provide a guideline for FSI firms when the need for better controls based on rules and targets arises (Ahrens & Chapman, 2004, 2007). Moreover, the interactive and diagnostic approach to EMC in the FSI remains an underexplored topic, which is surprising for at least two reasons: (i) Diagnostic controls enable the monitoring of results and deviations from organizational goals while supporting the development of measures to achieve such targets, which is important for FSI strategic plans; and (ii) interactive controls encourage internal improvement through the learning process and the identification of new strategies that can be implemented to respond to perceived opportunities and threats (Journeault et al., 2016; Simons, 1995). Thus, in the GIE, we expect that the use of both diagnostic and interactive EMCs increases, as the green perspective delineates an environment where the debate about both the assumptions and monitoring of targets is critical to the decision-making process. We therefore propose the following hypotheses:

H1b. The green innovation ecosystem positively influences the use of diagnostic environmental controls.

H1c. The green innovation ecosystem positively influences the use of interactive environmental controls.

2.3 | EMCs and water performance

According to Henri and Journeault (2018), firms that are more committed to adopting environmental control practices tend to achieve higher environmental and economic performance than those that do not implement EMCs. Indeed, the successful implementation of environmental controls can contribute to reducing material costs, improving operational efficiency (Henri & Journeault, 2010), and increasing both operational and nonoperational environmental performance (Abdel-Maksoud et al., 2021). Furthermore, adopting management controls might lead to higher productivity and a better organizational reputation within the GIE. Also, when integrating environmental management issues into strategic planning processes, firms might improve both their financial and environmental performance (Judge & Douglas, 1998). These aspects seem crucial, especially for FSI firms. Indeed, previous research has demonstrated that the higher-level use of EMCs might improve eco-learning and incremental environmental innovation (Journeault, 2016).

Hence, by introducing a broad range of EMCs rather than focusing on a single measure, firms can improve their water performance. Indeed, the adoption of EMCs might enable FSI firms to reduce water waste and use water more cautiously. Specifically, restaurants can set specific targets and controls to reduce water consumption. These controls may encompass employee training, investment in low-flow taps, and the use of reward metrics based on water consumption (e.g., metrics regarding employees who comply with water reduction targets).

Although previous studies have argued that delving deeper into EMCs can contribute to a new research agenda about environmental issues related to water (Henri & Journeault, 2018), there is still little empirical evidence regarding the impact of EMCs on water performance in the FSI. To bridge this gap, we examine water management by adopting both the diagnostic and interactive controls approaches, which are expected to influence water performance by reducing the consumption and waste of water. Thus, we propose the following hypothesis:

H2. The use of environmental management controls (diagnostic and interactive) positively influences water performance.

2.4 | Digitalization and water performance

Fostering digitalization support firms in enhancing their processes, products, and services while developing new strategies and business models driven by a higher level of service customization (Fitzgerald et al., 2014; Warner & Wäger, 2019). Moreover, digitalization can enable companies to improve their environmental performance

(Fernando et al., 2019; Nayal et al., 2022). Among the most common digital tools in the FSI are iFood and Wabi, digital menus, sale order automation, voice assistants with artificial intelligence, holographic signage, interactive tables, and kitchen automation and new operating systems, such as the kitchen display system (KDS) and point of sale (POS) (Abrasel – Associação Brasileira de Bares e Restaurantes, 2022; iFood, 2021; Leal, 2021).

FSI firms can use such digital tools to increase company–customer interaction, to strengthen their brand, and to incorporate innovative practices into their organization (Farías & Cancino, 2021). In addition to improving company performance, digital technologies have become a key tool enabling the remote management of daily operations (Chadee et al., 2021). Indeed, digital devices enable organizations to be more involved in operations while fostering interactions among employees (Richardson & Benbunan-Fich, 2011). Additionally, digitalization in FSI firms affects different dimensions of food consumption, such as aesthetics, speech and language's role in eating and drinking, and ways of eating (Crumo, 2022).

Tan and Netessine (2020) have shown that restaurants that provide customers with tablets to view menu items, to reorder foods and beverages, and to pay can improve their performance. Indeed, tablets also offer entertainment, such as games and news content (tabletop technology), reduce meal length by approximately 10% and increase sales per minute by approximately 11%. More recently, Vo-Thanh et al. (2022) have demonstrated that the majority of interviewed managers recognize that digitalization allows them and their employees to perform tasks more effectively and efficiently. Furthermore, by reducing the interactions between customers and employees, digitalization contributes to enhancing the cleanliness of restaurants and to reducing the perception of health risk (Esposito et al., 2022). However, although these studies have found a positive relationship between FSI digitalization and firm performance, there is little empirical evidence for the impact of digital innovation on water performance. Thus, drawing on the reviewed literature, the following hypothesis is proposed:

> **H3.** Digitalization positively influences water performance.

2.5 | The moderating role of TSR

The literature has shown that the external environment can exert a positive effect on environmental innovation by facilitating the acquisition of knowledge and improving processes and products (Liao, 2018b). Within this context, TSR constitutes an organization's ability to acquire knowledge and understand new technological developments, which can be driven internally or externally (Srinivasan et al., 2002). In addition to representing the ability to respond quickly to new technologies (Aragón-Correa, 1998; Leonidou, Leonidou, et al., 2013; Sharma et al., 2007), TSR comprises the ability to detect new technological developments and turn them into opportunities (Buzzao & Rizzi, 2021; Leonidou, Leonidou, et al., 2013; Srinivasan et al., 2002). Here, then, green technologies might deserve special attention, as they evolve rapidly and require considerable investments in terms of both resources and competences.

Regarding the FSI, restaurants can use green technologies to improve food storage and preparation, customer service, and energy and water conservation. That is, by introducing green technologies, FSI firms can reduce waste while increasing recycling. Moreover, their implementation of green technologies might lead firms to develop or adopt green products and services (Leonidou et al., 2015; Ngo et al., 2019; Shrivastava, 1995). Several studies have also demonstrated that by focusing on TSR, firms can improve their employees' awareness of incorporating green technologies into company processes. This, in turn, can contribute to addressing both environmental and financial issues (e.g., Ngo et al., 2019). Notably, the work of Leonidou, Katsikeas, et al. (2013) and Leonidou, Leonidou, et al. (2013) has shown a positive relationship between TSR and the development of environmentally sound marketing strategies. On the other hand, developing green products, services, and strategies requires firms to update and/or introduce new technologies, which are associated with costs (Leonidou, Katsikeas, et al., 2013). Hence, in light of the above, this study also seeks to extend the literature on TSR by exploring its role in the FSI. Thus, we propose the following hypothesis:

> **H4a.** The relationship between digitalization and water performance is reinforced by technology sensitivity/response.

Fresh water consumption is directly affected by the storage, preparation, delivery, and consumption of food (Rosa et al., 2021; Strasburg & Jahno, 2015, 2017). Recently, data have revealed that producing and delivering food demands a high volume of water: Each person consumes an average between 2000 and 5000 L of "invisible water" per day (Epagri, 2018). Nevertheless, although the rational use of water is crucial for both the economic and environmental sustainability of the FSI, few empirical studies have explored environmental outcomes in the FSI context. Specifically, there is limited knowledge regarding the impact of the daily operations of restaurants (Subramanian et al., 2021).

Thus, this study seeks to advance previous research on water performance by exploring the moderating role of TSR in the FSI. The ability to anticipate change and develop new technologies is expected to moderate the relationship between the use of EMCs and water performance. Moreover, the ability to sense, seek out, and respond to new technologies is posited to contribute to reducing water consumption and waste while improving water reuse. In addition, the rapid adoption of new eco-friendly technologies likely supports both digitalization and the introduction of EMCs, thereby exerting a positive impact on water performance. Thus, the following hypothesis is proposed:

> **H4b.** The relationship between environmental management controls (diagnostic and interactive) and water performance is reinforced by technology sensitivity/response.

3 | RESEARCH METHODOLOGY

3.1 | Sample

The target population in this study consists of FSI firms registered in the Cadastur database of the Brazilian Ministry of Tourism. Cadastur is a national registry of firms operating in the tourism sector in Brazil (Brazil, 2023). From this database, we selected firms classified as restaurants and relevant information such as their website, telephone, firm age, and city where they are located. Based on this initial information, we selected large restaurants following the classification provided by Cadastur. The final population thus comprised 2004 large Brazilian restaurants. We decided to test our hypotheses on FSI firms for a number of reasons. First, FSI firms tend to consume large volumes of fresh water in their operations, namely, food storage, preparation, cooking, and delivery, as well as their cleaning activities (Rosa et al., 2021; Savaşan, 2022). Second, large FSI firms are more likely to adopt formal EMCs (Gomez-Conde et al., 2019) and to implement new technologies and digital devices. Third, FSI is a rapidly growing and diversified sector that requires firms to implement digital technologies to cope with mounting competition over market share (Verevka, 2019).

3.2 | Data collection

Drawing on the environmental management and accounting literature, a questionnaire was prepared to collect data from Brazilian restaurants (see Appendix A). Following previous studies (e.g., Carayannis et al., 2012; Carayannis, Dezi, et al., 2021), the first part of the research instrument captured managers' perceptions regarding firm involvement with the five subsystems that form the GIE. The second section of the questionnaire captured firms' digitalization process and capability to respond to technology changes (Leonidou, Katsikeas, et al., 2013; Leonidou, Leonidou, et al., 2013; Ortas et al., 2019). The third part captured the use of EMCs with an instrument developed by Henri (2006) and Widener (2007) and adapted by Heggen and Sridharan (2021) to the environmental context. The fourth section of the questionnaire explored the use of water by evaluating the levels of both water consumption and waste reduction (Lunkes et al., 2020; Strasburg & Jahno, 2015). The last block collected the demographic characteristics of the focal restaurants, such as their firm age and the city where they operate.

The research instrument was validated by four academics with experience in topics regarding management literature in the FSI. Furthermore, a pretest was conducted with 10 restaurant managers to verify their understanding of the questions. This was necessary due to the back translation process, which required the translation of the constructs from English to Portuguese. The pretest also enabled us to define the time it would take for managers to respond to the questionnaire.

An agency specialized in surveying was in charge of data collection, (Graham et al., 2014). Whenever possible, data collection was performed following the steps proposed by Dillman et al. (2014). First, the agency contacted each restaurant manager by telephone to provide a brief explanation of the research and to invite the manager to participate in the survey. Second, the managers who agreed to participate were sent an e-mail with a cover letter describing the details of the research project and a free and informed consent form. Third, two further calls were made reminding the managers to participate in the survey. The data collection took place between January and April 2022. In total, 245 responses were obtained, representing a 12.22% response rate. Both the sample size and response rate are similar to those in previous studies that have explored similar aspects related to the management and environmental literature (e.g., Asiaei et al., 2022; Gomez-Conde et al., 2019).

3.3 | Measures and data analysis

To test our hypotheses, this study was operationalized with constructs previously tested in academic research in the management control and environmental literature. The first variable evaluates the GIE through 13 questions concerning the interactions among FSI firms and five agents, namely, university, industry, government, society, and the natural environment (Carayannis et al., 2012), toward the adoption of eco-friendly actions. To measure these items, a 7-point Likert scale was used (1 = *never* to 7 = *always*).

To assess whether firms implement interactive and diagnostic EMCs, this study relied on previous studies in management accounting that have provided consolidated instruments (Henri, 2006; Widener, 2007). Specifically, we included 12 questions based on a recent study that has explored the use of interactive and diagnostic controls through the lens of environmental action (Heggen & Sridharan, 2021). Diagnostic environmental controls were measured with five questions, while interactive environmental controls were measured with seven questions on a 7-point Likert scale from 1 (*not at all*) to 7 (*to a great extent*).

Regarding the operationalization of firm capability to implement digital technologies, conceptualized as digitalization, we measured this with seven questions based on Ortas et al. (2019). The restaurant managers were asked to indicate the frequency with which digital technology is implemented in their restaurant routines on a 7-point Likert scale from 1 (*a little*) to 7 (*a lot*). Moreover, four questions about firm capability to respond to technology change, namely, TSR, were formulated according to previous empirical studies (Leonidou et al., 2015; Leonidou, Katsikeas, et al., 2013; Leonidou, Leonidou, et al., 2013; Ngo et al., 2019; Srinivasan et al., 2002). To measure TSR, managers were asked to indicate, on a 7-point Likert scale, their degree of agreement with questions that assessed firm capacity to respond quickly to technology changes (1 = *strongly disagree* to 7 = *strongly agree*).

To measure water performance, six questions were formulated to understand whether FSI firms reduce water consumption and water waste. Previous studies have stressed the importance of paying more attention to how firms use water in their operations (Gössling, 2015).

Drawing on Strasburg and Jahno (2015) and Rosa et al. (2020), we asked the managers to indicate whether their use of water seeks to reduce the waste and/or the consumption thereof in their restaurant (1 = *never* to 7 = *always*).

To control the effect of the independent variables on water performance, we considered firm maturity, the types of dishes served by the restaurant, and the city where the restaurant operates. Firm maturity was assessed through the number of years the restaurant has been active (continuous variable). Regarding the types of dishes, the managers were asked to indicate whether their restaurant serves meals *a la carte* (1), *buffet* (2), or both (3). The cities were classified into two groups, indicating whether the restaurant operates in a touristic city (1) or not (0).

Data analysis was performed via partial least squares structural equation modeling (PLS-SEM). This technique was selected due to the complex relationships explored in this study and the sample size (Hair et al., 2017). Furthermore, PLS-SEM is widely used in management studies (e.g., Lunkes et al., 2020; Monteiro et al., 2022; Rosa et al., 2021) and involves two models: The first is the measurement model that assesses the validity and readability of the constructs; the second is a structural model that examines the relationships among the variables (Hair et al., 2017). Additionally, common method and later-response biases were assessed to ensure the absence of threats to model quality. Thus, a comparison between the first 10% and the last 10% of responses revealed that there was no major concern related to nonresponse, as the difference between these groups was not significant. Furthermore, common method bias did not represent a threat to this study, as the first factor in the exploratory analysis was lower than 50%.

4 | MEASUREMENT MODEL ASSESSMENT AND HYPOTHESIS TESTING

To evaluate the consistency and validity of the constructs, we completed the evaluation procedures of the measurement model using the PLS algorithm technique. As shown in Table 1, the convergent validity of the constructs is adequate, as their average variance extracted (AVE) is above 0.50 (Hair et al., 2017). The discriminant validity criteria are also satisfied, as the constructs show autocorrelation higher than the other correlations. In terms of reliability, all the variables present a composite reliability (CR) above 0.70. This means that the constructs also satisfy the requisite for adequate measurement evaluation (Hair et al., 2017).

To test the proposed hypotheses, we used the bootstrapping technique; here, a resampling of 5000 was used following previous research on water management in the FSI (Rosa et al., 2021). These results, presented in Table 2, demonstrate that involvement in GIEs positively impacts the digitalization of FSI firms (B = 0.379; $p < 0.01$), supporting H1a. Regarding H1b, the results show that involvement in GIEs positively influences FSI firms to use diagnostic environmental controls (B = 0.391; $p < 0.01$). Furthermore, H1c is confirmed; in the

TABLE 1 Measurement model.

Constructs	CR	AVE	R^2	R^2 adjust	Q^2
1. Green innovation ecosystem	0.932	0.635	-	-	-
2. Digitalization	0.975	0.865	0.144	0.14	0.116
3. Interactive environmental controls	0.976	0.853	0.135	0.131	0.107
4. Diagnostic environmental controls	0.981	0.911	0.153	0.149	0.131
5. Technology sensing/response	0.952	0.832	-	-	-
6. Water performance	0.798	0.509	0.392	0.366	0.172
7. Maturity	-	-	-	-	-
8. Dish type	-	-	-	-	-
9. City	-	-	-	-	-

	Discriminant validity								
Constructs	1	2	3	4	5	6	7	8	9
1. Green innovation ecosystem	**0.797**								
2. Digitalization	0.379	**0.930**							
3. Interactive environmental controls	0.367	0.677	**0.923**						
4. Diagnostic environmental controls	0.391	0.74	0.916	**0.954**					
5. Technology sensing/response	0.248	0.661	0.669	0.697	**0.912**				
6. Water performance	0.192	0.36	0.526	0.516	0.563	**0.714**			
7. Maturity	0.067	−0.366	−0.227	−0.293	−0.295	−0.103	-		
8. Dish type	0.019	−0.068	−0.038	−0.058	−0.137	−0.08	0.191	-	
9. City	0.076	−0.078	−0.126	−0.11	−0.077	−0.069	0.04	−0.067	-

TABLE 2 Structural model.

Paths	B	t value	p value
Green innovation ecosystem → digitalization	0.379	12.711	0.000***
Green innovation ecosystem → interactive environmental controls	0.367	12.470	0.000***
Green innovation ecosystem → diagnostic environmental controls	0.391	12.995	0.000***
Digitalization → water performance	−0.086	0.925	0.178
Interactive environmental controls → water performance	0.257	1.485	0.069*
Diagnostic environmental controls → water performance	0.140	0.862	0.194
Technology sensing/response → water performance	0.447	5.520	0.000***
DG X TSR → water performance	0.019	0.214	0.415
IEC X TSR → water performance	−0.060	0.679	0.248
DEC X TSR → water performance	0.196	1.840	0.033**
Maturity → water performance	0.070	1.184	0.236
Dish type → water performance	−0.033	0.600	0.549
City → water performance	0.007	0.127	0.899
Green innovation ecosystem → interactive environmental controls → water performance	0.094	1.460	0.144
Green innovation ecosystem → diagnostic environmental controls → water performance	0.055	0.824	0.410

Notes: $n = 245$ observations; one-tailed for predicted relation and two-tailed otherwise.
Abbreviations: DEC, diagnostic environmental controls; DG, digitalization; IEC, interactive environmental controls; TSR, technology sensing/response.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

GIE, FSI firms are stimulated to adopt interactive environmental controls (B = 0.367; $p < 0.01$). As this research also explores the impact of management controls on organizational outcomes, the results reveal that the use of interactive environmental controls exerts a positive effect on water performance (B = 0.257; $p < 0.10$). On the other hand, diagnostic environmental controls do not impact water performance (B = 0.140; $p > 0.10$). Accordingly, H2 is only partly supported.

As the improvement in organizational routines requires firms to search for new ways to operate, our analysis suggests that digitalization might improve water performance. However, the results regarding H3 are not supported in our empirical model (−0.086; $p > 0.10$). In addition, we have explored whether and to what extent the capability of FSI firms to respond to technology change can generate organizational improvements. Our findings reveal that TSR has a positive effect on water performance (B = 0.447; $p < 0.01$) and increases the effect of diagnostic environmental controls on water performance (B = 0.196; $p < 0.05$), supporting H4b. Nevertheless, H4a, which predicts the moderating role of TSR in the effect of digitalization on water performance, is not supported (B = 0.019; $p > 0.10$).

To better understand the potential reasons for the nonsignificant effect of diagnostic environmental controls and water performance, we tested the main effects, after splitting water performance into two groups, namely, the reduction in water waste and the reduction in water consumption. These results, presented in Table 3, show that while the use of interactive environmental controls positively influences water waste reduction (B = 0.436; $p < 0.01$), diagnostic environmental controls positively influence water consumption reduction (B = 0.260; $p < 0.10$), leading to more responsible behavior regarding the consumption of water. Moreover, these findings reveal that mature firms use water more conscientiously (B = 0.129; $p < 0.05$).

Additional analysis also revealed that TSR leads to a greater reduction in water waste and a more conscientious use of water. FSI firm managers are thus willing to invest in technology to reduce the waste of natural resources by planning menus and using sale order automation through smartphone applications (e.g., Uber eats). Furthermore, FSI firms involved in the GIE are more likely to invest in innovative practices to reduce waste and improve organizational performance.

5 | DISCUSSION

5.1 | GIEs and digitalization

Recent research (e.g., Fan et al., 2022) has found that the knowledge streams on GI and IEs overlap on the roles of agents. This means that there are numerous avenues worthy of future research applying the proposed GIE framework. Nevertheless, to date, there is limited

TABLE 3 Additional analyses.

Panel A. Prediction of water waste reduction			
Path analysis	**B**	***t* value**	***p* value**
Green innovation ecosystem → digitalization	0.381	12.424	0.000***
Green innovation ecosystem → interactive environmental controls	0.366	12.014	0.000***
Green innovation ecosystem → diagnostic environmental controls	0.389	12.520	0.000***
Interactive environmental control → water waste reduction	0.436	2.710	0.007***
Diagnostic environmental control → water waste reduction	−0.246	1.479	0.139
Technology sensing/response → water waste reduction	0.308	4.128	0.000***
Maturity → water waste reduction	0.002	0.037	0.970
Dish type → water waste reduction	−0.053	0.890	0.374
City → water waste reduction	−0.049	0.858	0.391
Panel B. Prediction of water consumption reduction			
Path analysis	**B**	***t* value**	***p* value**
Green innovation ecosystem → digitalization	0.382	12.472	0.000***
Green innovation ecosystem → interactive environmental controls	0.367	12.198	0.000***
Green innovation ecosystem → diagnostic environmental controls	0.391	12.801	0.000***
Interactive environmental controls → water consumption reduction	0.017	0.113	0.910
Diagnostic environmental controls → water consumption reduction	0.260	1.717	0.086*
Technology sensing/response → water consumption reduction	0.379	4.498	0.000***
Maturity → water consumption reduction	0.129	2.300	0.022**
Dish type → water consumption reduction	−0.013	0.220	0.826
City → water consumption reduction	0.028	0.500	0.617

Notes: $n = 245$ observations; one-tailed for predicted relation and two-tailed otherwise.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

quantitative evidence on GI activities, including digitalization. Indeed, previous research on the GIE has mainly conducted qualitative analyses (Yang et al., 2021). Except for the work of Estrada et al. (2016), which investigates the bilateral relationship between firms and universities in GI, there is limited knowledge on how and to what extent the GIE can assist FSI firms in implementing innovative digital tools for environmental sustainability. Hence, drawing on extant research (e.g., Esposito et al., 2022; Qin et al., 2022; Yi & Zhang, 2022), our analysis advances the knowledge concerning multiagent cooperation within the GIE by including the following agents: firms and their suppliers, competitors, associations, customers, universities, governments, and the natural environment. Our results show that the GIE positively affects the digitalization of firms, thus confirming H1a. By sharing their managerial, structural, and technological resources (Sun et al., 2019), firms also seem more stimulated to implement digital technologies to reduce water waste.

During the COVID-19 pandemic lockdown, several FSI firms attempted to initiate some forms of e-commerce. However, the lack of both digital competences and tools has hampered or even prevented the creation of such online business models. On the other hand, training programs such as "iFood Decola" in Brazil have proved to be important multiagent cooperation platforms for sharing knowledge and tools to foster digitalization among FSI firms. Approximately 240,000 restaurant owners and employees have participated in the iFood program to innovate their business models and procedures (iFood, 2021). Furthermore, our findings confirm extant research on the positive relationship between multiagent cooperation and the co-creation of strategies in increasing both digitalization and environmental awareness within firms (Fan et al., 2022). Similar to Xin et al. (2022), our results demonstrate that in the GIE, multiagent cooperation can contribute to promoting, either directly or indirectly, GI via resource sharing among actors operating within the innovation ecosystem.

5.2 | GIEs and EMCs

GI requires important learning efforts (Siebenhüner & Arnold, 2007; Wicki & Hansen, 2019), green corporate cultures (Melander, 2018), financial efforts (Yu et al., 2021), increased risk-taking, and long timeframes (Wicki & Hansen, 2019). Thus, it is almost impossible for a firm to implement GI alone (Kasim & Ismail, 2012; Oliver et al., 2020), including EMCs. Our results show that in the GIE, multiagent cooperation can exert a positive effect on the use of both diagnostic and interactive EMCs in the FSI. Hence, H1b and H1c are confirmed. These findings are aligned with those in previous studies (e.g., Fan et al., 2022): By sharing human, financial, and technological resources, multiagent cooperation can assist FSI firms in implementing management controls to track their progress toward both environmental and financial goals, to monitor sales and stocks, to compare results against expectations, and to analyze their performance related to food preparation and delivery. Notably, by drawing on multiagent cooperation, national support programs, such as the Brazilian Micro and Small Business Support Service (SEBRAE), have proven to be effective. Specifically, SEBRAE has played a key role in supporting FSI firms adopting management planning and control systems when measuring sales performance, monitoring inventories and productivity, assessing customer satisfaction, and performing quality inspections.

5.3 | EMCs and water performance

Our findings reveal that the use of interactive EMCs exerts a positive effect on water performance (H2). Specifically, the use of interactive controls by FSI firms needs to be performed by all employees involved in the process. In addition to committing employees to achieving environmental goals, knowledge sharing and constant dialog seem crucial in integrating EMCs toward improving water performance. The results also confirm previous research on sustainability (e.g., Derqui & Fernandez, 2017). That is, by actively engaging all collaborators and by sharing standardized controls across all levels of an organization, managers and staff seem more willing to implement effective audits and measures for reducing both the consumption and waste of water. On the other hand, regarding diagnostic EMCs, the findings show that designing and implementing top-down controls without the active participation of all employees may not generate the expected effects on water performance.

5.4 | Digitalization and water performance

FSI firms have adopted digital technologies such as contactless payment, advanced cleaning systems, digital menus, service robots, touchless elevators, and food delivery apps to implement risk-reduction strategies. Digitalization is expected to reduce in-person interactions between customers and employees and to improve the cleanliness of restaurants. This, in turn, might reduce the perception of health risk, which remains crucial for the restart of the FSI in the post pandemic era (Esposito et al., 2022; Shin & Kang, 2020). While the introduction of digital tools reduces the duration of meals, digitalization can also increase the average sales of FSI firms (Tan & Netessine, 2020). Furthermore, digitalization can make processes more efficient, as automation reduces human errors in the FSI (iFood, 2021). Additionally, by introducing digital tools, such as tabletop devices, firms are able to collect more customer data. The latter can be used to inform both the design of menu recommendations and initiatives for enhancing customer loyalty (Tan & Netessine, 2020).

Several scholars have also demonstrated that the adoption of digital tools and practices, as well as the development of digital skills among staff, can contribute to improving the environmental performance of firms (e.g., Le Thanh Ha et al., 2022; Nayal et al., 2022; Wen et al., 2021). Regarding the FSI, studies have shown that the design, implementation, and evaluation of digital technologies based on the Internet of Things (IoT) can strengthen the management of natural resources (Wen et al., 2018), thereby improving the environmental performance of firms (Savaşan, 2022). However, our findings are only partially aligned with extant research on the impact of digital tools on environmental performance. Indeed, our results reveal that digitalization does not directly affect the water performance of firms, entailing that H3 is not supported.

Hence, we argue that when implementing digital technologies, FSI firms might be more concerned with issues related to business survival (e.g., avoiding the loss of customers) and market trends (e.g., targeting market segments or capturing preferences) rather than directly addressing water waste and consumption. Although the findings reveal that digitalization improves firm daily operations, the hiring process, and consumer green behavior, these aspects are not directly related to water performance. Building on this result, future research might therefore further explore to what extent the digitalization of FSI firms is a function of economic motives or of the combination of both economic and environmental targets.

5.5 | The role of TSR

Regarding technology sensitivity/response, this study demonstrates that it is an important capability that narrows the gap between environmental changes and organizational capacities. Indeed, FSI managers require TSR capabilities to proactively identify technological opportunities and turn them into improved environmental performance (Leonidou et al., 2015; Ngo et al., 2019). Our findings reveal that the higher the sensitivity to new technologies is, the greater the positive effect of control mechanisms on water performance in relation to the reduction in freshwater consumption; the increase in the use of alternative sources of water (e.g., use of rainwater and reuse of water for gardening and external cleaning); the acknowledgment of the impact of personal consumption on society and the environment as a whole (e.g., training sessions for employees, customer awareness and process improvements); and the reduction in effluent emissions (e.g., reuse of water for cleaning and more efficient sewage collection and treatment systems). This result is particularly interesting because it shows that TSR accentuates the strict targets of diagnostic controls while exerting positive effects on water performance. In practice, then, its TSR capacity drives a firm when designing its plan, monitoring results, and, in a later stage, proposing measures for improving water management.

Finally, by distinguishing water performance in water waste reduction and water consumption reduction, we have obtained complementary results. Our findings demonstrate that interactive EMCs are important in reducing water waste; on the other hand, diagnostic environmental EMCs contribute to reducing the consumption of water. While the implementation of interactive controls requires both the awareness and proactiveness of employees, to address water waste reduction, upper management must set diagnostic controls according to a top-down approach. The latter include prior planning and the definition of targets and controls for reducing freshwater consumption. Moreover, the results show that the reduction in water consumption receives greater attention from FSI managers. This is due to its immediate economic impact (e.g., cheaper water bill). These findings also confirm recent studies (e.g., Grejo & Lunkes, 2022), as the maturity level of an FSI firm might be decisive in improving its environmental performance, especially in relation to its reduction in water consumption. That is, more mature firms might have to overcome purely economic aspects and begin to incorporate environmental sustainability in their strategy. On the other hand, both flexible controls and the active participation of employees in the environmental strategy might contribute to introducing new green practices and thus to reducing water waste.

6 | CONCLUSIONS

This research has explored how and to what extent, in the GIE, multiagent cooperation can influence FSI firms to implement environmental controls and digital tools for water performance. Drawing on the theoretical model of the GIE, the hypotheses have been tested with a sample of 245 large Brazilian restaurants. Overall, then, in the GIE, multiagent cooperation among FSI firms, suppliers, the government, consumers, and the natural environment can play a crucial role in integrating environmental controls and digital tools into firms' business strategies.

6.1 | Theoretical implications

This study offers several contributions to the literature. First, drawing upon the overlapping boundaries (Fan et al., 2022) of the research on GI and IEs (Nylund et al., 2021; Yang et al., 2021; Zou et al., 2021), we advance the knowledge regarding the role of the GIE in environmental sustainability (Zeng et al., 2022). Specifically, our analysis addresses a research gap in relation to the salient dynamics within the GIE (Fan et al., 2022; Liu et al., 2022; Liu & Stephens, 2019; Oliveira-Duarte et al., 2021; Yi & Zhang, 2022; Yin et al., 2020; Yu et al., 2022). A multiagent cooperation perspective is adopted to examine both the roles of and interactions among GIE actors. Our measurement model therefore extends previous studies (e.g., Qin et al., 2022; Yang et al., 2021; Yi & Zhang, 2022) by including the following GIE agents: FSI firms and their suppliers, competitors, governments, universities, consumers, and the natural environment. Exploring the FSI, this analysis has shown a positive relationship between GIE and both digitalization and the use of diagnostic and interactive EMCs.

Second, this study contributes to the EMC and environmental management literature (e.g., Abdel-Maksoud et al., 2016, 2021; Demirel & Kesidou, 2018; González-Benito & González-Benito, 2006; Pondeville et al., 2013; Tsai & Liao, 2017b). While previous studies have mainly investigated the effects of stakeholder pressure on the implementation of EMCs in organizations and their performance (Abdel-Maksoud et al., 2016, 2021; Pondeville et al., 2013), we propose a new framework by introducing multiagent cooperation and demonstrating that it plays an important role, as an antecedent of the use of both interactive and diagnostic EMCs. In the GIE, the implementation of EMCs thus exerts a positive effect on the water performance of firms. By designing flexible controls and by ensuring the active participation of employees, firms seem to be more committed to achieving water efficiency goals. On the other hand, the use of pre-established controls (i.e., top-down approach) through planning (diagnostic EMCs) has a greater effect on the reduction in water consumption. Previous studies have pointed out the lack of consistent results on the effects of eco-controls on environmental performance, indicating the use of generic performance measures as the main reason thereof (e.g., Abdel-Maksoud et al., 2021; Heggen & Sridharan, 2021). We have addressed this research gap by adopting specific measures related to natural resources to investigate the effect of EMCs on water performance.

Third, this study adds to the literature on TSR capability (e.g., Aragón-Correa, 1998; Buzzao & Rizzi, 2021; Leonidou et al., 2015; Leonidou, Katsikeas, et al., 2013; Leonidou, Leonidou, et al., 2013; Ngo et al., 2019; Sharma et al., 2007; Srinivasan et al., 2002) by demonstrating that TSR plays a crucial role in improving water performance. Furthermore, this analysis sheds light on the moderating role of TSR in applying controls to environmental issues; indeed, TSR plays a positive moderating role in the relationship between the use of diagnostic EMCs and the reduction in water consumption.

Fourth, this paper advances prior qualitative studies on the GIE (e.g., Yin et al., 2020) by introducing a novel quantitative approach for measuring the relevant dynamics in the FSI. Moreover, this analysis partially addresses the growing need for empirical evidence in relation to the FSI in emerging economies (e.g., Filimonau et al., 2019; Kasavan et al., 2019).

6.2 | Managerial implications

This paper also has several implications for practitioners, especially FSI managers and employees. First, this study shows the importance of stimulating multiagent cooperation in the GIE and promoting the continuous implementation of GI (Zeng et al., 2022), which includes digital tools and EMCs. However, introducing digitalization and EMCs into firms requires several resources, including knowledge and financial, structural, and human capital. On this point, multiagent cooperation assists firms in providing and sharing competences and resources. On the other hand, it is important to build connections between FSI firms and GIE agents; moreover, it is strategic to align targets among actors. This might be challenging because suppliers, governments, universities, and consumers have different interests and heterogeneous functions within the GIE.

Second, it seems that FSI managers have not yet grasped the "win–win" nature of digitalization; that is, although FSI firms have increased their use of digital tools, they seem not to have perceived the potential effects of digitalization on the environment. However, when incorporating the "green" vision into an organizational strategy, TSR has a moderating positive effect on the relationship between digitization and water performance, thus reducing both the consumption and waste of water. Furthermore, the results demonstrate that it is possible to integrate environmental goals into a firm's business strategy by aligning them with economic targets.

Third, it is important to generate a favorable environment within an organization by stimulating both the participation and the commitment of employees in achieving environmental goals. Recruiting and training talented people and ensuring their continuous training are key actions for integrating EMCs on a daily basis. At the same time, managers should strengthen their technological sensing/response capability, which means staying aware of new technological developments related to ecological issues, of the pace for adopting such technologies, of the skills needed to master them, and of how to turn them into opportunities. In particular, digitalization has become an imperative for FSI firms that seek to develop sustainable business models (iFood, 2021).

6.3 | Limitations and future research

This paper has a few limitations. First, although this study adds to the previous research that has stressed the need for more empirical evidence in relation to the GIE in the FSI, our results reflect the perceptions of managers in large Brazilian restaurants, which implies they are limited to a specific setting and that caution in generalizing should be taken. Thus, future research might further explore GIE in countries where the FSI plays an important role in economic growth and environmental performance. Second, this study has focused on water performance in response to recent calls for specific environmental metrics. However, future studies should consider exploring the consumption of energy and food in FSI firms when preparing and delivering meals. The interactions of these elements might be useful in understanding how and to what extent they reflect desirable organizational outcomes. Accordingly, investigating the nexus of food, energy, and water, a result of integrative business strategies and EMCs, might advance knowledge in the environmental and management literature and provide practical contributions to the dynamics in the FSI.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

ORCID

Fabricia S. Rosa https://orcid.org/0000-0003-4212-1065

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APPENDIX A

Green innovation ecosystem
Restaurants' engagement with universities, the economic system, regional and national government, customers, and the natural environment facilitates the adoption of a vision of environmental, social, and economic sustainability within businesses. Based on this understanding, assess the extent to which your restaurant exhibits such engagement. For your answers, use the following scale: from 1 (*never*) to 7 (*always*).
• Our restaurant collaborates with one or more universities (e.g., restaurant managers participate in events, projects, and research activities focused on sustainability and organized by universities).[a]
• I realize that a relationship between a university and a restaurant improves the knowledge of employees and managers, as it provides knowledge and expertise on sustainability.[a]
• Awareness activities developed in the education system (universities) encourage the restaurant to adopt sustainable actions (e.g., outreach activities).[a]
• The economic system (e.g., competitors, suppliers, associations, etc.) makes it possible to integrate economic and environmental aspects.
• Our restaurant uses the concept of sustainability in its processes and products.
• Economic capital (products, machines, technology) allows the restaurant to position itself in the market with sustainable initiatives.
• Our restaurant uses government support, subsidies, or other government financial incentives for sustainability.
• Political capital (government plans, policies) is important for the restaurant to implement sustainable actions.
• Our restaurant encourages the conscious consumption of ecological (organic) products.
• Our restaurant encourages a more sustainable lifestyle that can influence (inform) the media, culture, and society in relation to sustainability challenges.
• The context in which the restaurant operates, specifically in terms of traditions, values, and information, influences the way in which its services are provided, and its food is prepared.[a]
• In our restaurant, sustainability is the main focus of our business, as we understand that the consumption of "green" foods can contribute to the protection of nature and address environmental concerns.
• Society's environmental concerns (e.g., consumers, community, organizations) influence the way natural resources are used in our restaurant (water, energy, food).[a]
Technology sensing/response
Indicate the extent to which your restaurant has the capacity to respond quickly to the use of new technologies. Answer the following items using the following scale: from 1 (*strongly disagree*) to 7 (*strongly agree*).
• We are often among the first in our industry to spot technological developments that could potentially affect our green efforts.
• We actively seek information about technological changes in the environment that are likely to affect our environmental efforts.
• We generally respond very quickly to technological changes in the environment that have to do with environmental issues.
• The restaurant is ahead of others in its search for new technologies that have to do with environmental issues.
Digitalization
Rate the frequency with which digitalization are implemented in your restaurant from 1 (*a little*) to 7 (*a lot*).
• Our restaurant emphasizes the use of digital technology in its business activities.
• Our restaurant has improved some of its business processes due to a switch to digital technology.
• Our restaurant has increased the use of digital technology in its business processes.
• Our restaurant uses digital technologies to control waste.
• Our restaurant has digitized its business model.
• Our restaurant considers digital knowledge in the employee hiring process.
• Our restaurant is able to change consumer behavior through the digital technologies it uses.
Environmental management controls
Indicate the extent to which your restaurant's top management uses environmental controls for the following activities using the following scale: from 1 (*not at all*) to 7 (*to a great extent*)
Environmental diagnostic controls
• Tracking progress toward goals
• Monitoring results
• Comparing results with expectations

(Continues)

- Analyzing key performance measures
- Evaluating your performance

Environmental interactive controls

- Allow communication among superiors, subordinates and peers during meetings.
- Allow ongoing challenge and debate of data, assumptions, and action plans.
- Provide a common view of the organization.
- Unite the restaurant sectors.
- Develop a common vocabulary in the organization.
- Empower the restaurant to focus on common issues and strategic uncertainties.
- Allow the restaurant to focus on critical success factors.

Water performance

Water is the most crucial resource for both life and the economy and is used in all food production and service processes and activities. The rational use of this resource has been a challenge, and it is important to develop alternatives to preserve this natural resource. From this perspective, the questions in this questionnaire seek to identify aspects of the decision-making process on the use of water in your restaurant. For your answers, use the following scale: from 1 (*never*) to 7 (*always*).

- The restaurant has reduced its water consumption through the use of alternative sources (e.g., rainwater harvesting, the use of cisterns, reuse of water for gardening and external cleaning).
- The restaurant has reduced its water consumption through conscientious actions (e.g., employee training, customer awareness, and process improvements).
- The restaurant has reduced its water consumption through improvements in its processes and products.[a]
- The restaurant has reduced its wastewater (sewage) emissions by reducing its water consumption.[a]
- The restaurant has reduced its wastewater (sewage) emissions by reusing water (e.g., reuse of water for gardening and external cleaning).
- The restaurant has reduced its wastewater (sewage) emissions through innovation in its water collection and sewage treatment systems (e.g., use of the water source diagram method to reduce sewage).

[a] Dropped due to low factorial loading.