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ORIGINAL ARTICLE

Sustainability of Manufacturing Companies in the Sports Industry with a Focus on Green Technology Innovation

Seyed Morteza Mortazavi[1], *Morteza Anoosheh[2], Einollah Keshavarz Turk[3], Ali Hemati Afif[4], Mohammad Anisseh[5]

1. Ph.D. Candidate in Futures Studies, Faculty of Social Sciences, Imam Khomeini International University, Qazvin, Iran
2. Assistant Professor, Department of Futures studies, Faculty of Social Sciences, Imam Khomeini International University, Qazvin, Iran
3. Associate Professor, Department of Futures studies, Faculty of Social Sciences, Imam Khomeini International University, Qazvin, Iran
4. Associate Professor, Department of Physical Education and Sports Sciences, Faculty of Social Sciences, Imam Khomeini International University, Qazvin, Iran
5. Assistant Professor, Department of Futures studies, Faculty of Social Sciences, Imam Khomeini International University, Qazvin, Iran

Correspondence:
Morteza Aoosheh
Email: Anoosheh@soc.ikiu.ac.ir

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ABSTRACT

Today, the environmental damage caused by manufacturing companies has pushed the business environment toward innovative green methods. Green technology innovation is one of the most important activities in this framework. Therefore, the current research was conducted with the aim of identifying the drivers of green technology innovation for manufacturing companies in the sports industry in Iran. This research is applied in terms of its purpose and exploratory in nature, considering the use of both qualitative and quantitative methods. Two main steps were taken to conduct this research. The first step was a systematic review of the research literature to identify the drivers of green technology innovation, and the second step was screening and confirming the drivers using the Fuzzy Delphi method. The theoretical community of the research consisted of academic experts and executive managers, and 20 people were selected to participate in the expert questionnaire through judgmental sampling. Based on the research results, 21 effective drivers were identified in the first phase. Subsequently, based on the results of Phase 2, 18 drivers were confirmed. These drivers are: environmental regulations, digital finance and fintechs, digital transformation, research and development investment, consumer awareness of the environment, capital market openness, media attention, environmental information disclosure, environmental, social, and governance ratings, government subsidies, organizational leadership style, organizational culture, organizational strategy, behavioral decision-making characteristics of the senior management team, the company's social responsibility toward the environment, green knowledge management, green intellectual capital, and green dynamic capabilities. Considering these drivers can promote green technology innovation for manufacturing companies in the sports industry, potentially improving their economic and environmental performance.

KEYWORDS

Drivers, Green Technology Innovation, Manufacturing Companies, Sports Industry, Sustainability.

آموزش محیط‌زیست و توسعه پایدار

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پایداری شرکت‌های تولیدی در صنعت ورزش با تمرکز بر نوآوری فناوری سبز

سید مرتضی مرتضوی[۱]، *مرتضی انوشه[۲]، عین‌اله کشاورز ترک[۳]، علی همتی عفیف[۴]، محمد انیسه[۵]

۱. دانشجوی دکتری آینده‌پژوهی، دانشکده علوم اجتماعی، دانشگاه بین‌المللی امام خمینی (ره)، قزوین، ایران

۲. استادیار، گروه آینده‌پژوهی، دانشکده علوم اجتماعی، دانشگاه بین‌المللی امام خمینی (ره)، قزوین، ایران

۳. دانشیار، گروه آینده‌پژوهی، دانشکده علوم اجتماعی، دانشگاه بین‌المللی امام خمینی (ره)، قزوین، ایران

۴. دانشیار، گروه تربیت‌بدنی و علوم ورزشی، دانشکده علوم اجتماعی، دانشگاه بین‌المللی امام خمینی (ره)، قزوین، ایران

۵. استادیار، گروه آینده‌پژوهی، دانشکده علوم اجتماعی، دانشگاه بین‌المللی امام خمینی (ره)، قزوین، ایران

نویسنده مسئول:
مرتضی انوشه
رایانامه: Anoosheh@soc.ikiu.ac.ir

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چکیده

امروزه آسیب‌های محیط‌زیستی شرکت‌های تولیدی موجب شده تا روند فضای کسب‌وکارها به سمت روش‌های نوآورانه سبز حرکت کند. نوآوری فناوری سبز یکی از مهم‌ترین فعالیت‌ها در این چارچوب است؛ بنابراین پژوهش حاضر با هدف شناسایی پیشران‌های شکل‌دهنده نوآوری فناوری سبز برای شرکت‌های تولیدی صنعت ورزش در ایران انجام می‌شود. پژوهش حاضر از نظر هدف، کاربردی است و با توجه به استفاده از روش‌های کیفی و کمّی از نوع آمیخته اکتشافی است؛ بنابراین برای اجرای این پژوهش ۲ گام اساسی طی شد. گام اول از مرور نظام‌مند ادبیات پژوهش برای شناسایی پیشران‌های نوآوری فناوری سبز و گام دوم از روش دلفی‌فازی برای غربال‌گری و تأیید نهایی پیشران‌ها استفاده شد. جامعه نظری پژوهش را خبرگان دانشگاهی و مدیران اجرایی تشکیل می‌دهند که ۲۰ نفر از طریق نمونه‌گیری هدفمند به‌منظور تکمیل پرسشنامه خبره‌سنجی انتخاب شدند. مطابق یافته‌های پژوهش در گام اول ۲۱ پیشران مؤثر شناسایی گردید. در ادامه مطابق یافته‌های حاصل از گام دوم ۱۸ پیشران تأیید شدند، این پیشران‌ها عبارت است از: مقررات محیط‌زیستی، امور مالی دیجیتال و فین‌تک‌ها، تحول دیجیتال، سرمایه‌گذاری تحقیق و توسعه، آگاهی مصرف‌کننده از محیط‌زیست، باز بودن بازار سرمایه، توجه رسانه‌ها، افشای اطلاعات محیط‌زیستی، رتبه‌بندی‌های محیط‌زیستی، اجتماعی و حاکمیتی، یارانه‌های دولتی، سبک رهبری سازمانی، فرهنگ‌سازمانی، استراتژی سازمانی، ویژگی‌های تصمیم‌گیری رفتاری گروه مدیریت ارشد، مسئولیت اجتماعی شرکت در قبال محیط‌زیست، مدیریت دانش سبز، سرمایه فکری سبز، قابلیت‌های پویا سبز. در نظر گرفتن این پیشران‌ها می‌تواند جلوبرنده نوآوری فناوری سبز برای شرکت‌های تولیدی در صنعت ورزش باشد و به‌طور بالقوه موجب بهبود عملکرد آنها در ابعاد اقتصادی و محیط‌زیستی شود.

واژه‌های کلیدی

پیشران، نوآوری فناوری سبز، شرکت‌های تولیدی، صنعت ورزش، پایداری.

Introduction

Environmental issues such as air pollution, rising demand for fossil fuels, and depletion of natural resources are regarded as some of the fundamental challenges in both developed and developing countries (Chang et al., 2023; Shen et al., 2020). This issue constitutes a critical subject for academic inquiry (Lestari et al., 2021), and today, a global consensus exists on conserving natural resources, enhancing energy efficiency, and fostering harmonious development between the environment and the economy to achieve sustainable development (Chen et al., 2023). Within this framework, production plays a significant role in greenhouse gas emissions and resource depletion, necessitating the adoption of sustainable practices by companies to mitigate environmental impacts and enhance competitiveness (Li et al., 2023). One of the most pivotal concepts in this regard is green innovation. Green innovation is recognized as a strategy for businesses seeking to enhance their competitive advantage while addressing environmental concerns (Niu et al., 2024; Sepahvand et al., 2023). Innovation within a company can be defined as an economic decision aimed at leveraging emerging market opportunities or mitigating potential threats (Dziura & Rojek, 2021). Failure to utilize innovation opportunities may hinder companies' ability to improve performance and develop competitive advantages (Siriram, 2022). On the other hand, companies—through their excessive consumption of natural resources and pollution generation—are among the primary contributors to environmental degradation (Fan et al., 2023) and must prioritize reducing fossil fuel consumption and accelerating the transition toward renewable energy sources (Bai & Lin, 2023). Consequently, green innovation, by establishing a balance between these two concepts, has been proposed as a win-win strategy (Liu et al., 2023).

Green innovation is categorized into four main types: green management innovation, green product innovation, green process innovation, and green technological innovation (Le & Govindan, 2024). This study focuses specifically on green technological innovation. Technology plays a pivotal role in development, and the transition to a green economy necessitates innovation in related technologies (Geng et al., 2023). Green technological innovation serves as a critical strategy for the manufacturing industry, encompassing innovative activities aimed at minimizing production costs while focusing on reducing the environmental impacts of economic activities (Sharif et al., 2023; Peng et al., 2020; Ye & Cheng, 2019). This concept is a significant factor in the economic growth of developing countries (Bai et al., 2023) and has been one of the key elements of the environmental policies of countries such as China (Xu et al., 2023). Therefore, green technological innovation is of critical importance for both the public and private sectors as a vital approach to addressing environmental challenges and contributing to the achievement of sustainability goals (Zhang et al., 2023; Chang et al., 2023). The imperative of addressing this matter has been emphasized in the comprehensive environmental policies of the country (Teimornejad et al., 2022).

In this context, manufacturing companies within the sports industry play a pivotal role in the economic development of nations. However, attention must also be paid to their environmental pollution challenges alongside their growth and development (Huang & Chen, 2022). Manufacturing companies in Iran's sports industry, similar to those in other countries, require innovation to remain competitive and survive (Saeedi et al., 2020) and one of the notable domains in this regard is technological innovation (Razavi et al., 2019). On the other hand, resource challenges and environmental risks arising from industries have emerged as one of the most critical concerns (Nikpishe Kohjhari et al., 2020). Therefore, green technological innovation is imperative for manufacturing companies in the sports industry and necessitates a multidimensional examination to ensure these companies can continuously innovate, address environmental challenges, meet stakeholder expectations, and compete in the global arena.

A review of prior studies reveals that a subset of research has focused on the positive impacts of green technological innovation. In this context, the findings of the study by Dabbous & Barakat (2023) demonstrated that

green technological innovation exerts a significant positive impact on environmental sustainability. He et al. (2023) also demonstrated that green technological innovation significantly enhances employment. Furthermore, numerous studies have investigated the factors influencing the development of green technological innovation within companies to identify specific measures that facilitate such innovation. Previous researchers have predominantly focused on the impact of one or several factors on green technological innovation, such as environmental regulations (e.g., Li & Gao, 2022; Wang et al., 2022). In this context, Darvishi & Ziaei (2018) demonstrated in a study that dimensions of green intellectual capital exert a direct influence on green technological innovation. The findings of the study by Dou & Gao (2023) demonstrated that the digital transformation of companies can significantly enhance corporate green technological innovation. Sahoo et al. (2023) demonstrated in a study that green knowledge acquisition significantly influences green knowledge management and green technological innovation. The findings of the study by Zhou et al. (2023) revealed that Environmental, Social, and Governance (ESG) ratings exert an influence on the efficiency of green technological innovation, and higher ESG rankings contribute to enhancing the efficiency of corporate green technological innovation. Li & Wang (2022) demonstrated in their study that capital market openness has a significant positive impact on corporate green technological innovation. Shao & Chen (2022) demonstrated in their study that government subsidies, such as R&D subsidies, can significantly promote the advancement of green technological innovation. The findings of the study by Xue et al. (2022) demonstrated that FinTech can significantly enhance corporate green technological innovation.

Therefore, research has not comprehensively focused on the key drivers influencing green technological innovation, and there remains a gap in the current literature regarding this aspect in the pursuit of sustainability. The present study aims to fill the existing gap in the literature. Thus, the present study investigates how manufacturing companies in the sports industry fulfill their role in relation to society and the environment to achieve sustainable development. Analyzing these drivers assists policymakers and stakeholders in manufacturing industries to recognize the importance of green technological innovation for development while mitigating environmental impacts.

The main research question is formulated as follows:

What are the key drivers shaping green technological innovation in manufacturing companies within the sports industry?

Addressing this question contributes to advancing applied knowledge and discourse among researchers and managers in fostering green technological innovation and enhancing the sustainable performance of manufacturing companies in the sports industry, while providing guidance for more informed decision-making. This can lead to improved business strategies and the identification of supportive activities.

Research Methodology

The present study adopts an exploratory mixed-methods design. In terms of objective, it is exploratory due to its aim of delineating the drivers of green technological innovation in manufacturing companies within the sports industry. From the perspective of orientation, it is applied due to the utilization of its findings to better achieve environmental sustainability and economic performance. This research was conducted in two fundamental steps.

The first step utilized a systematic review of the literature to identify the drivers of green technological innovation. Therefore, in accordance with the systematic literature review process outlined by De Carvalho et al. (2017), the initial phase involved searching for the keyword “green technological innovation,” along with terms such as “drivers,” “factors,” and “manufacturing companies,” across reputable academic databases including Science Direct, Emerald, Wiley, Taylor & Francis, and Magiran. This search was conducted among published articles (quantitative, qualitative, and mixed-methods) in Persian and English, spanning the years 1393

to 1402 (2014 to 2023). Furthermore, the Critical Appraisal Skills Programme (CASP) was utilized to assess the quality of the articles, and the findings indicate that all reviewed articles met the quality criteria during the evaluation phase.

In the second step, the Fuzzy Delphi method was employed for screening and final validation of the drivers. The fuzzy Delphi method is a recognized methodology for screening factors and has been employed in various studies (e.g., Hadizadeh et al., 2024). According to Habibi et al. (2015), a minimum threshold of 0.7 is established for screening drivers in the fuzzy Delphi method. The average of expert opinions regarding the degree of influence of each driver shaping green technological innovation in manufacturing companies within the sports industry was calculated according to the following equations (Mohammadfam et al., 2022):

$$A^{(i)} = \left(a_1^i, a_2^i, a_3^i\right), \qquad i = 1,2,3,\ldots,n \tag{1}$$

$$A_m = \left(a_{m1}^i, a_{m2}^i, a_{m3}^i,\right) = \left(1/n \sum a_1^{(i)}, 1/n \sum a_2^{(i)}, 1/n \sum a_3^{(i)}\right) \tag{2}$$

Subsequently, defuzzification is performed according to the following formula (Lawnik & Banasik, 2020):

$$\text{Defuzzification} = \frac{a_1 + 2a_2 + a_3}{4}$$

The theoretical population of the study comprises academic experts and executive managers. For the selection of experts, criteria such as sufficient knowledge and experience related to the key research concepts, a minimum educational qualification of a master's degree, and at least five years of relevant work experience were considered. These criteria were intended to ensure the knowledge and expertise of individuals in this field. Thus, 20 individuals were selected through judgmental sampling.

The expert-validated questionnaire serves as the data collection instrument in the quantitative phase of the research. This questionnaire is a standard tool in the Fuzzy Delphi method, with its criteria comprising the drivers derived from the systematic literature review process. Thus, the current questionnaire comprises 21 items, each assessed on a five-point scale ranging from "very high impact," "high impact," "moderate impact," "low impact," to "very low impact." Accordingly, experts were asked to use these verbal expressions to specify the impact level of each driver. The questionnaire was validated by three experts prior to distribution.

Research Findings

In the present study, a descriptive analysis of the demographic characteristics of the sample was first conducted, as shown in Table 1. Of the participants, 90% were men and 10% were women. The participants held employment positions as executive managers and academic professors. Forty percent of the participants held a master's degree, and 60% held a doctoral degree. Among them, 50% had academic backgrounds in management, 20% in industrial engineering and industrial management, and the remainder in futures studies and environmental engineering. All participants had more than five years of professional experience.

Table 1. Demographic Characteristics of Participants

Female (10 percent) 2			Male (90 percent) 18	**Gender**
Environmental Engineering (15 percent) 3	Futures studies (15 percent) 3	Industrial Engineering (20 percent) 4	Management (Sports, Technology, Business) (50 percent) 10	**Field of study**
Ph.D (60 percent) 12			Master's degree (40 percent) 8	**Educational Level**
University lecturers (50 percent) 10	Industrial estates company managers (15 percent) 3	Managers of manufacturing companies (20 percent) 4	Organizational managers (15 percent) 3	**Employment status**
More than 15 years (20 percent) 4	10 years to 15 years (35 percent) 7		5 years to 10 years (45 percent) 9	**Job history**

Subsequently, the systematic literature review process, in accordance with Figure 1, and the final findings derived from this process are presented in Table 2.

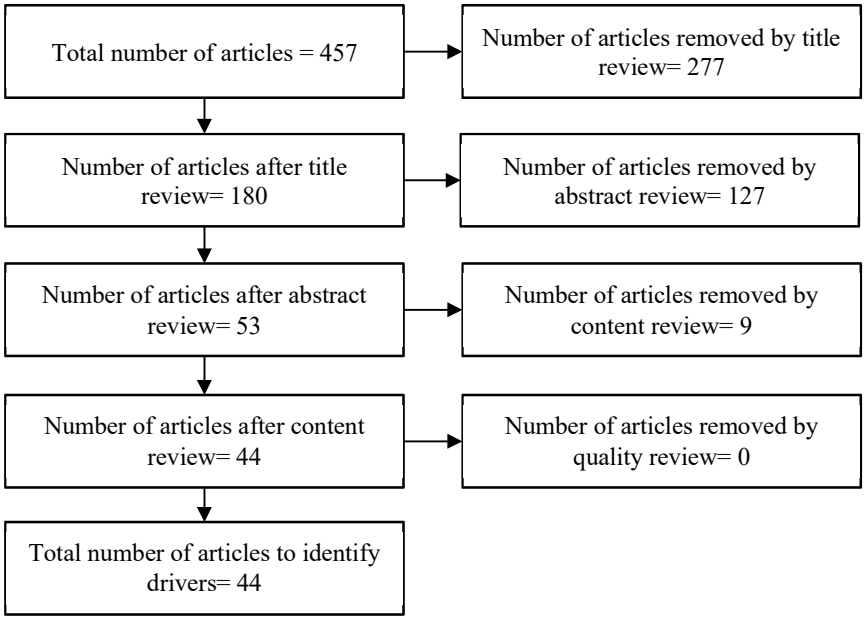

Figure 1. Final Articles Selection Process

According to Figure 1, 457 non-duplicate articles were identified from the systematic review conducted across the aforementioned academic databases. Duplicate entries were removed before the evaluation process. Of these, 277 articles were excluded following title screening. In the second phase, 127 articles were excluded from the remaining 180 after abstract screening. In the third phase, following content review, 9 more articles were excluded from the remaining 53. Ultimately, after quality evaluation and validation, 44 articles were selected to identify the drivers.

Table 2. Key Factors and Drivers Affecting Green Technology Innovation in Manufacturing Companies

Authors	Driver	Driver code
Li, Huang & Su (2023); Wang, Long & Li (2022); Li & Gao (2022); Yin, Zhang & Li (2020); Cheng & Yu (2023); Qi, Jia & Zou (2021); Wang, Li, Wang, Shi & Zhou (2023); Zhang, Shi, Gao & Feng (2023); Xiaofang & Zhuohang (2022)	Environmental regulations	D1
Ma (2023); Feng, Zhang & Li (2022); Xu, Yao & Zhou (2023); Bai & Lin (2023); Xue, Bai & Xiao (2022)	Digital finance and fintechs	D2
Xu, Yuan, Khalfaoui, Radulescu, Mallek & Zhao (2023); Zheng & Zhang (2023); Dou & Gao (2023); Sui & Yao (2023); Geng, Zheng & Ma (2023); Tian, Zhao, Li & Wang (2023); Lee, Qin & Li (2022); Yang, Li & Liu (2022); Lin & Xie (2023); Xu, Li & Guo (2023); Xu, Li, Dong & Guo (2023); Wu, Shi & Wang (2023); Li, Yang, Wang & Li (2023)	Digital transformation	D3
Yin, Zhang & Li (2020); Lee, Qin & Li (2022); Wu, Wang, Li, Zhou & Cao (2023)	Research and development investment	D4
Wang, Li, Wang, Shi & Zhou (2023)	Consumer Environmental Awareness	D5

Authors	Driver	Driver code
Wang, Li, Wang, Shi & Zhou (2023); Liu & Liang (2023); Qi, Jia & Zou (2021)	Peer competition pressure	D6
Li & Wang (2023)	Capital market openness	D7
He, Cao & Feng (2022); Li, Huang & Su (2023); Jie & Jiahui (2023)	Media attention	D8
He, Cao & Feng (2022)	Environmental information disclosure	D9
Hu, Mao, Tian, Wei, Guo & Wang (2021); Wang, Li, Wang, Shi & Zhou (2023); Guo, Hu, Fan, Mao, Tian, Wang & Wei (2023)	Environmental Non-Governmental Organizations	D10
Zhou, Huo, Bo & Chen (2023); Pan, Shen, Song & Shu (2023)	Environmental, social and governance ratings	D11
Zhang, Zhang, Chen, Wang & Zhang (2023)	Foreign direct investment	D12
Shao & Chen (2022); Liao, Hu & Xu (2023)	Government subsidies	D13
Yin, Zhang & Li (2020); Hameed, Naeem, Misra, Chotia & Malibari (2023)	Organizational leadership style	D14
Yin, Zhang & Li (2020)	Organizational culture	D15
Yin, Zhang & Li (2020)	Organizational strategy	D16
Wang, Zeng, Li (2022)	Behavioral decision-making characteristics of the senior management team	D17
Li, Wang, Mu & Li (2023)	Social responsibility of the company towards the environment	D18
Li, Yang, Wang & Li (2023); Sahoo, Kumar & Upadhyay (2023)	Green knowledge management	D19
Darvishi & Ziaei (2018)	Green intellectual capital	D20
Ismail (2023)	Green dynamic capabilities	D21

In the second step, following the identification of key factors and drivers, the Fuzzy Delphi method was employed to screen and validate them for manufacturing companies in the sports industry. The results obtained through the fuzzy Delphi method are presented in Table 3.

Table 3. Average Expert Opinions and Defuzzification Results

Results	Defuzzification	Fuzzy numbers			Driver code
		a_1	a_2	a_3	
✓	0.75	0.53	0.78	0.94	D1
✓	0.82	0.60	0.85	0.98	D2
✓	0.85	0.64	0.89	1.00	D3
✓	0.86	0.65	0.90	1.00	D4
✓	0.71	0.48	0.73	0.91	D5
×	0.68	0.44	0.69	0.90	D6
✓	0.79	0.58	0.83	0.95	D7
✓	0.74	0.51	0.76	0.93	D8
✓	0.74	0.51	0.76	0.94	D9
×	0.61	0.38	0.63	0.81	D10
✓	0.78	0.56	0.81	0.94	D11
×	0.66	0.43	0.68	0.86	D12
✓	0.79	0.58	0.83	0.95	D13

Results	Defuzzification	Fuzzy numbers			Driver code
		a_1	a_2	a_3	
✓	0.72	0.49	0.74	0.91	D14
✓	0.81	0.59	0.84	0.96	D15
✓	0.86	0.65	0.90	1.00	D16
✓	0.76	0.54	0.79	0.94	D17
✓	0.80	0.58	0.83	0.96	D18
✓	0.85	0.64	0.89	1.00	D19
✓	0.89	0.69	0.94	1.00	D20
✓	0.82	0.60	0.85	0.98	D21

Thus, according to Table 3, the systematic literature review aimed at identifying the drivers was conducted with appropriate accuracy. This is because, among the 21 identified drivers, three, peer competition pressure, environmental non-governmental organizations (NGOs), and foreign direct investment (FDI), were not approved by the experts for final validation. These three drivers were removed due to defuzzification values below the 0.7 threshold, and the remaining 18 final drivers were confirmed by the experts.

Conclusion

Environmental pollution and the resulting societal concerns have prompted this study, which aims to identify the drivers shaping green technological innovation for manufacturing companies in the sports industry. To this end, a systematic review of the literature was first conducted to identify the initial factors and drivers. The findings from this review led to the identification of 21 factors. In the subsequent step, the results from the analysis of the collected data confirmed 18 drivers, which we will proceed to explain in detail below:

Environmental Regulations: The findings of this section of the study align with the results of Li et al. (2023), Wang et al. (2023), and Li & Gao (2022). These studies have also identified environmental regulations as a key driver in motivating companies to pursue green technological innovation activities. This underscores the importance of systematically designing environmental regulations that are compatible with various industries, including the sports sector, to incentivize companies to adopt green technological innovations. It further emphasizes the necessity of integrating these regulations into the development strategies of sports industry manufacturing firms to balance economic performance with environmental sustainability.

Digital Finance and FinTechs: The findings of this section of the study align with the results of Ma et al. (2023), Xue et al. (2022), and Feng et al. (2022). These studies also demonstrate that digital finance and FinTechs significantly promote corporate green technological innovation. FinTechs, by utilizing modern technologies such as artificial intelligence and big data, can help improve financial processes and decision-making. Moreover, they also address environmental concerns. Therefore, they provide suitable opportunities for the development of green technological innovations. In this regard, it is imperative to prioritize government support for FinTechs and foster collaboration between FinTechs and manufacturing companies within the sports industry.

Digital Transformation: The findings of this section of the study align with those of Sui & Yao (2023) and Xu et al. (2023). These studies also demonstrate that digital transformation promotes corporate green technological innovation. Manufacturing companies in the sports industry must possess the necessary awareness of digital transformation trends, and leverage advanced technologies to better identify market demands and opportunities. This requires support from both companies and the government. Companies must enhance the requisite infrastructure in this domain, and the government should also increase financial support for companies cognizant of digital transformation that leverage it to improve their performance.

Research and Development Investment: The findings of this section of the study align with those of Yin et al. (2020) and Lee et al.

(2022). These studies have also shown that research and development (R&D) activities are effective in enhancing companies' willingness to adopt strategies for pursuing green technological innovation. Manufacturing companies in the sports industry should prioritize investment in research and development (R&D) activities to address environmental issues, utilize renewable energy, and gain a competitive advantage.

Consumer Environmental Awareness: The findings of this section of the study align with the results of Wang et al. (2023). This study also emphasizes the role of consumer awareness and external environmental pressure in driving green technology innovation by companies. Consumer awareness of environmental issues leads to an increased demand for green and environmentally friendly products, thereby enhancing sustainability-based initiatives. This may reflect customer pressure driving manufacturing companies in the sports industry to adopt green technological innovation.

Capital Market Openness: The findings of this section of the study align with those of Li & Wang (2023). This study also underscores the impact of capital market openness on corporate green technological innovation. The presence of foreign investors in stock markets can facilitate financing, enhance innovation, and improve companies' awareness of environmental issues. This can enhance green technological innovation for manufacturing companies in the sports industry.

Media Attention: The findings of this section of the study align with those of Jie & Jiahui (2023) and He et al. (2022). The findings of these studies also highlight media attention as a driver of green technological innovation within companies. Media concerns regarding environmental pollution issues act as an informal oversight mechanism for the performance of manufacturing companies in the sports industry. Through media reporting, these concerns can generate public attention and stakeholder pressure for sustainable corporate development, thereby incentivizing companies to enhance their environmental performance. This fosters the advancement of green technological innovation within manufacturing companies in the sports industry. Therefore, the media must strengthen their oversight role in ensuring corporate accountability for environmental protection.

Environmental Information Disclosure: The findings of this section of the study align with the results of He et al. (2022). This study also reveals that the disclosure of environmental information significantly contributes to corporate green technological innovation. Under this concept, manufacturing companies in the sports industry can disclose their environmental performance to stakeholders through various media reports and address their environmental concerns by enhancing transparency in environmental information.

Environmental, Social, and Governance (ESG) Framework: The findings of this section of the study align with those of Zhou et al. (2023) and Pan et al. (2023). These studies also indicate that higher environmental, social, and governance (ESG) rankings positively influence corporate green technological innovation. The Environmental, Social, and Governance (ESG) framework can serve as a basis for evaluating the performance of manufacturing companies in the sports industry across various domains of sustainable development and encourage them to invest in green technological innovation.

Government Subsidies: The findings of this section of the study align with the results of Shao & Chen (2022) and Liao et al. (2023). These studies also demonstrate that subsidy policies aimed at supporting green technological innovation can significantly enhance these innovations. Government subsidies can be prioritized as public sector support for manufacturing companies in the sports industry to offset some of the costs of research and development (R&D) and innovation in eco-friendly technologies.

Leadership Style: The findings of this section of the study align with the results of Hameed et al. (2023) and Yin et al. (2020). These studies also indicate that leaders play a significant role in their organizations' environmental performance. A leadership style dedicated to environmental sustainability can foster green innovation practices in sports manufacturing firms by raising awareness of environmental issues, addressing stakeholders' ecological concerns, and applying creative solutions for environmental conservation.

Organizational Culture: The findings of this section of the study align with those of Yin et al. (2020), who identify organizational culture as a key driver of green technological innovation. By institutionalizing core values within the company and encouraging employees to innovate and protect the environment, an organizational culture that supports environmental sustainability can foster green technological innovation in sports manufacturing companies.

Organizational Strategy: The findings of this section align with those of Yin et al. (2020), who identify organizational strategy as a key driver of green technological innovation. Manufacturing companies in the sports industry must adopt an effective strategy focused on sustainable initiatives and achieving improved environmental sustainability outcomes to remain competitive in today's business environment.

Behavioral Decision-Making Characteristics of Senior Management Teams: The findings of this section of the study align with those of Wang et al. (2022). This study also highlights the influence of behavioral decision-making traits in senior management teams, such as an innovative mindset and risk tolerance, on green technological innovation. The senior management team is responsible for formulating and implementing strategic decisions within the company. Characteristics such as educational level, work experience, a creative and innovative mindset, and essential environmental awareness can assist sports manufacturing companies in formulating sustainability-driven decisions.

Corporate Social Responsibility (CSR): The findings of this section align with those of Li et al. (2023), who identify CSR as a key driver of green technological innovation. Manufacturing companies in the sports industry must ensure that, when addressing stakeholders' environmental concerns and fulfilling Corporate Social Responsibility (CSR) commitments toward the environment, they do not overlook dynamic and innovative actions.in implementing corporate decisions and taking appropriate measures to improve environmental performance rapidly. Therefore, by acquiring green knowledge from the external environment and fostering creativity and innovation, companies can promote green technological innovation to advance sustainability practices.

Green Knowledge Management: The findings of this section of the study align with the results of Li et al. (2023) and Sahoo et al. (2023). These studies also indicate that the acquisition, sharing, and integration of green knowledge significantly influence green technological innovation. Manufacturing companies in the sports industry can strategically integrate knowledge management practices with environmental sustainability principles to enhance the quality of their industrial operations and secure a competitive advantage.

Green Intellectual Capital: The findings of this section of the study align with those of Darvishi and Ziaei (2018), who identify green intellectual capital as a key driver of green technological innovation. Manufacturing companies in the sports industry, by recognizing green intellectual capital as an intangible asset, can integrate factors such as learning processes, knowledge, skills, creativity, and others to enhance economic activities and improve environmental performance outcomes. This can foster green technology innovation.

Green Dynamic Capabilities: The findings of this section align with those of Ismail (2023), who posits that green dynamic capabilities significantly influence green technology innovation. As Ismail (2023) has pointed out, green dynamic capabilities can significantly enable companies to adapt to business ecosystems and foster the development of green technology innovation. Therefore, manufacturing companies in the sports industry must develop environmentally sustainable strategies within this framework.

By identifying and analyzing the key drivers influencing green technology innovation, it can be concluded that for the sustainability of manufacturing companies in the sports industry, attention must be paid to both external environmental pressures—such as regulations and consumer awareness, and internal capabilities, such as organizational culture and knowledge management.

Therefore, to support manufacturing companies in the sports industry in achieving their green technology innovation goals, the following recommendations are proposed:

- Fostering an adaptive organizational climate by cultivating an innovation mindset and risk-taking propensity to enhance green technological innovation culture, as well as ensuring employee alignment and engagement.
- Strengthening collaborative networks with universities, sports-focused knowledge-based enterprises, and startups.
- Prioritizing customer-centric collaboration to leverage their valuable experiences and insights.
- Developing and integrating digital transformation technologies and clean technologies into business processes while enhancing organizational capabilities in these domains.
- Formulating and implementing innovatively green strategies and programs at the managerial level.

It should be noted that the limited sampling confined to a specific industry and its impact on the generalizability of the findings to other manufacturing companies are among the limitations of the present study. Building on these insights, it is recommended that researchers investigate each of these drivers in a targeted manner across multiple dimensions within diverse industries. Providing new evidence in this area can assist manufacturing companies in bolstering green technology innovation and enhancing the generalizability of findings within this field.

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