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Nexuses among Green Supply Chain Management, Green Human Capital, Managerial Environmental Knowledge, and Firm Performance: Evidence from a Developing Country

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Abstract: The growing pressures from the government, buyers, consumers, suppliers, and the general public have recently compelled manufacturing firms to enhance their production methods by becoming more environmentally friendly and pursuing new innovative methods for producing green goods in developing countries. However, the relationship between green supply chain management (GSCM), green human capital (GHC), green innovation (GIN), managerial environmental knowledge (MEK), and firm performance (FPR) has received only a minimal amount of research focus. This study addresses this research gap by providing empirical evidence to motivate firms to implement GSCM, GHC, GIN, and MEK to enhance their FPR in developing countries substantially. A conceptual framework was developed to connect the concepts mentioned above. A questionnaire-based survey was used to collect the data. A total of 736 respondents from manufacturing firms in China were selected. Utilizing structural equation modeling (SEM), the data were analyzed. The findings indicate that neither GHC nor GSCM directly affects FPR; rather, GIN mediates the connection between GHC, GSCM, and FPR. In addition, the findings showed that MEK directly affects FPR and moderates the link between GIN and FPR. This study examined several theoretical and managerial implications and expanded research in the related fields. The results may help practitioners and managers comprehend how GSCM practices impact GIN and FPR. The outcomes of this research will benefit experts, policy makers, and stakeholders who seek to encourage FPR enhancements.

Keywords: green human capital; green supply chain management; firm performance; green innovation; managerial environmental knowledge; natural resource-based view theory

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1. Introduction

Numerous environmental challenges have come to light due to rapid economic expansion [1,2]. Manufacturing companies' activities may cause the exhaustion of natural resources, environmental degradation [3], and the emission of several ecological toxins that pollute biodiversity, water, light, oxygen, and the sound environment [4,5]. Several businesses and countries have recognized the importance of environmental sustainability to economic and social development. This issue requires a public emphasis on green and environmental concerns, such as green transformation, green supply chain management, recycling, and renewable energy sources [6]. Firms have sought to embrace sustainable green practices in response to requirements from various stakeholder groups, corporate entities, and environmental legislation [7,8]. GHC, GIN, and GSCM practices, as well as

MEK are becoming necessary for better FPR, which affects customer fulfillment, legitimacy, desire, and belief in the manufacturing firms to attain competitiveness [9,10].

The concept of GHC was developed by [11] as a full stream of intangible capacities, knowledge, and relationships related to environmental stewardship at a firm's corporate and individual levels. Furthermore, GHC is anticipated to relate strongly with GIN and FPR at the firm level. The GHC is "the sum of employees' pollution prevention or green innovation-related information, competence, expertise, intelligence, inventiveness, and dedication, etc., and is entrenched in people, not firms" [12]. GHC has been highlighted as a critical component in the implementation of green human resource management (GHRM) strategies, and it is considered among the most vital corporate science concepts. It has been argued that workers' proactive environmental skills and competencies contribute significantly to the transition of GHRM [13]. Conversely, it has been seen that employees' knowledge and abilities increase when they recognize the corporate commitment to sustainability, which directly leads to employee engagement in the company [14]. It is believed that firms that recognize the value of GHC invest in their personnel to achieve greater FPR [15]. GHC interacts with other corporate resources and competencies. We define GHC in this paper as the whole portfolio of all intangible firm resources, connections, information, and skills managed with the ultimate vision of protecting the natural environment for better FPR. This research illustrates that GHC may be focused on FPR without compromising its ability to lead GIN. In ideal circumstances, GHC should incorporate the most recent information and add to it, creating new cycles of knowledge development [16].

GIN is a concept that can reduce adverse environmental impacts and improve FPR in order to increase public trust, cost-effectiveness, productivity, and opportunities for market share [17]. GSCM, eco-friendly nature conservation, and green and sustainable product research and development are some additions needed to implement GIN. This is difficult to comprehend from the organizational and employee points of view because it discards the current work system [18]. GIN may be achieved if environmental indicators, such as an unstable climate and restricted natural resources, are considered. Consequently, firms must adjust their activities with due consideration to their ecological consequences. By incorporating GIN, FPR can be significantly changed [19], as an advancement in FPR can provide a competitive edge. The government has introduced stringent administrative procedures to encourage manufacturing firms in heavily polluting sectors to engage in environmental projects [20]. Meanwhile, the environmental consciousness of users, environmental protection groups, communities, entrepreneurs, and other stakeholders has steadily increased, putting heavy polluters under significant environmental pressure. These highly polluting manufacturing firms must focus on environmental management to limit environmental damage and lessen environmental strain. Therefore, GIN has received considerable attention [12]. GIN is the application or enhancement of green goods or processes, such as innovations in energy-saving, pollution-prevention, waste-recycling, and green-product-design technologies [21]. As the government, environmental groups, users, communities, and the media grow increasingly concerned about the environment's protection, legislators and scholars are paying greater attention to GIN due to its potential to accomplish a "win-win" scenario in the reduction of pollution and maximizing revenue [22], and firms can boost resource efficiency via GIN to offset environmental consequences [23].

The green concept has been extensively used in various sectors. Incorporating the term "green" into SCM necessitates considering the consequences and linkages between SCM and the environmental context. GSCM, with environmental stewardship, has become an essential organizational philosophy for achieving profitability and market share objectives by reducing environmental risks and consequences and enhancing the firms' and stakeholders' environmental efficiency [24,25]. GSCM reduces the ecological impact of industrial operations, improves energy usage efficiency and cooperation between business associates, and increases the firm's strength. Furthermore, FPR and the company's green image are improved while wastage is reduced [26,27]. According to [28], GSCM consists of several environmental management methods that might be advantageous for logistics. Its structure seeks to integrate environmental concerns into forward and reverse logistics [29]. Examples of GSCM initiatives include minimizing packing and trash, evaluating suppliers based on FPR, creating more ecologically friendly manufacturing, and decreasing CO_2 emissions associated with product transportation. GSCM is a concept that can handle significant concerns, including (i) the deployment of green initiatives, (ii) the motivation of stakeholders to embrace GSCM, (iii) the impediments stakeholders face during GSCM implementation, and (iv) the effects on overall FPR [30]. GSCM is a link between a firm and its partners, consumers, and vendors in which environmental preservation is a priority. By producing green products, GSCM may increase FPR profitability [31]. Hence, the number of companies utilizing GSCM to improve FPR will increase.

To date, extensive research has focused on exploring the links among the following aspects: Studies [32,33] have reported that academic interest in GSCM has expanded considerably with GHC. As per [34], manufacturers should use GSCM features to address customer demand for sustainable and environmental products and services designed and manufactured utilizing responsible environmental procedures. This method of sustainable development addresses the ethical imperative of enterprises to enhance eco-efficiency while guaranteeing compliance with applicable regulations, hence lowering the risk of penalties and closure. The study conducted by [35] found that GHC is positively connected with all aspects of performance, including economic, social, and environmental performance. However, not every aspect of business success is linked to GHC in the same way. Social performance, defined as "enhancing stakeholder satisfaction, public safety and health, employee welfare, and reduced risk to the general populace" [36], seems to be more strongly connected with GHC than with FPR. Understanding the decreased influence of GHC on FPR, as evaluated by decreases in environmental destruction and protection from the exploitation of resources, in contrast to its impact on economic and social sustainability variables, is intriguing and essential for researchers and scholars [37]. Similarly, GSCM affects the entire environment of any business participating in supply chain activities, leading to improved FPR. GSCM is a crucial issue for the majority of companies, especially in Asia and South Asia [38]. Numerous firms in this field have demonstrated their commitment to environmentally friendly growth using this method, but there remains an opportunity for enhancement and expansion. Ref. [39] suggest that GSCM features may not be connected with economic resilience. These inconsistent results concerning the relationship between GHC, GIN, GSCM, and FPR indicate that the relationships between these essential elements should be reevaluated.

Moreover, most related studies contend that MEK reduces firms' economic performance. However, more recent research has identified quantifiable benefits of eco-friendly practices. According to the research, MEK and FPR may have a complex relationship [40]. However, few studies have explored how firms convert their MEK into a competitive advantage and determine the essential resources required to expand their FPR. Intangible resources are frequently referred to as GHC and are considered essential than tangible resources [41]. Therefore, this study sought to demonstrate how GHC helps businesses to increase their FPR using GIN. Only [32,42] have researched GHC in relation to environmental issues. According to their research, the effects of GHC on FPR may be contradictory, and this remains an unresolved issue [43]. In comparison, while GHC at the company level has been the focus of substantial research, the related investigations have not clarified how GHC impacts FPR because they have not incorporated MEK and GIN into the interaction between GHC, GSCM, and the FPR [44]. This leaves other questions unexplained: the importance of moderating and mediating effects. The study conducted by [32] stressed the need to investigate how GHC supports FPR based on this logic. Thus, our study analyzes whether GIN mediates the relationship between GSCM, GHC, and FPR to further explore this particular research issue and fill a significant knowledge gap. An earlier study demonstrated that GIN is essential for guaranteeing performance results [45]. Hence, our study investigated the novel elements that may enhance FPR, which have been largely overlooked despite the enduring interest of previous researchers. These study gaps prompted us to contribute to the existing body of knowledge by examining GHC, GSCM, GIN, and MEK for the FPR.

The following are the study's contributions: First, unlike previous research, the current study addresses a gap in the literature by addressing the elements that may influence FPR. According to the authors' understanding, this is a pioneer study undertaken in a setting of a developing country, as no other research has been conducted in this context under such a novel framework. Second, this research examines the relationship between GHC, GSCM, GIN, MEK, and FPR. The natural resource-based view (RBV) theory underlines the importance of GIN as a mediating and MEK as a moderating component in understanding the FPR's continuous advancement [46]. Nonetheless, when analyzing FPR, researchers have paid little consideration to these elements. This study thus aimed to account for this oversight, the findings of which may add to and extend earlier research [38,47,48] by suggesting that neither GHC nor GSCM directly impacts FPR. We propose that GHC and GSCM indirectly impact FPR through GIN since GIN acts as a mediator. Moreover, we examined whether MEK moderates the effect of GIN on FPR. This study highlights the complex relationships between GHC, GIN, GSCM, MEK, and FPR.

The remaining sections of this study are as follows: The literature review and the formulation of hypotheses are covered in the Section 2. In Section 3, the technique and research design are described. The findings and analyses are presented in the Section 4. In Section 5, the implications of the study results for policy, the limitations, and recommendations for further research are examined.

2. Review of Literature and Development of Hypotheses

2.1. Natural Resource-Based View Theory

Ref. [46] adopted a different stance from [49] and suggested that an "internally focused" approach to the competition may be insufficient due to the problem of external interactions. In comparison, Ref. [49] acknowledges the obstacles provided by social and natural settings and suggests that a firm's competitive advantage and strategy are likely anchored in its capacity to facilitate ecologically responsible activities. The previous efforts to connect the quality of the environment with FPR were conceptually proposed by [46], in which natural RBV theory comprises three complementary approaches: (1) pollution prevention that is viewed as a naturalistically ambiguous schedule which can generate a company's key cost minimizations as its competitiveness; (2) product stewardship, which allows a company to lessen the social and economic costs associated with the product; and (3) a vision statement for environmental sustainability centered on minimizing the firm's carbon footprint and showing more significant interaction with external stakeholders in manner that can create potential prospects and continue to gain from a stabilized competency development for a sustainable competitive edge.

Based on the natural RBV theory, the resources and competencies of a firm play a crucial role in determining its competitive edge. Moreover, the natural RBV theory is an advanced form of the RBV theory that argues firms may achieve sustainable competitiveness by addressing environmental concerns. According to [46], RBV theory has many drawbacks. It eliminates, for instance, the connection between a firm's natural surroundings and the organization itself. Previously, this negligence was reasonable, but it is evident that the natural environment is necessary to obtain a competitive advantage. Natural resources and competencies boost firms' sustainable performance by lowering pollution. In addition, it is argued that pollution control strategies, environmental resources, and the firm's competencies lead to effective FPR [50]. According to the natural RBV theory, environmental awareness, including of product stewardship, pollution reduction, and environmentalism, may offer enterprises a competitive advantage [46]. In accordance with this perspective, we suggest that GHC can be regarded as an underlying organizational resource and an ever-expanding capacity. According to this perspective, businesses that increase the effect of GHC on GIN and ultimately, their FPR, may gain a competitive advantage that competitors cannot replicate by other means. Additionally, companies may continually raise their FPR by raising their MEK through GIN, GHC, and GSCM.

2.2. Green Human Capital

GHC is "the sum of employees' pollution prevention or green innovation-related information, competence, expertise, intelligence, inventiveness, and dedication, etc., and is entrenched in people, not firms" [32]. The GHC has been highlighted as a critical component in the implementation of GHRM strategies, and it is considered among the most vital corporate sciences concepts [13]. It has been argued that workers' proactive environmental skills and competencies contribute significantly to the transition of GHRM [51]. On the other hand, it has been observed that employees' knowledge and abilities increase when they recognize the corporate commitment to sustainability, which directly leads to employee engagement in the company [52]. Ref. [32] indicated that environmentalism has gained popularity in the contemporary business sector because it attempts to mitigate environmental effects and manage climate change to encourage organizations to generate green products. Moreover, heightened consumer knowledge of environmental concerns has compelled businesses to develop more effective compliance methods by incorporating environmental management to enhance their green marketing and competitiveness. Ref. [53] further stated that GHC assists organizations in adhering to stringent international environmental rules, adds value to the organization, and satisfies customers' stringent environmental needs. In addition, ref. [32] argued that for organizations to implement an environmental strategy effectively, they must have environmental information that enables them to determine the relevant opportunities for process and product modification. In this approach, GHC reduces the environmental effect and gives organizations a competitive edge by reducing expenses.

GHC is distinctive to each company and offers crucial resources and competencies for manufacturing sector competitiveness, which is difficult to replicate in other businesses. When confronted with environmental constraints, companies may identify opportunities to profit from a better environment by employing proactive measures and strategies regarding environmental concerns [54]. Thus, several researchers have analyzed the elements that impact GHC, including corporate environmental ideals and social considerations. It can speculated that having inadequate GHC is more detrimental than is having limited resources. Education, information, abilities, and training may decrease the disparity between developed and developing nations. Considering the nature of the link between GHC and economic development, it is suggested that GHC plays a crucial role in transforming the financial resilience of a country by fostering investment growth. Diversity in GHC may create diversity in regional development, which can influence the expansion. In addition, it has been emphasized that GHC helps economic progress by fostering the capacity for innovation via increased research and development (R&D) [55]. In addition, several studies have shown that GHC facilitates green growth, enhanced FPR, and the potential for economic growth [44]. Ref. [51] argued that GHC plays a crucial role in a company's value creation although research on GHC remains scarce. Ref. [37] reported that GHC improves a company's social, economic, and environmental performance, while Ref. [42] also found there to be a correlation between GHC and FPR.

2.3. Green Innovation

Several academics have voiced diverse opinions on GIN from numerous angles. GIN is defined by [56] as a transformative approach that includes innovative techniques (e.g., manufacturing, construction, procedures, and networks) that provide positive and immediate environmental benefits. Ref. [20] noted that GIN is a breakthrough technique that encompasses the energy saving, pollutant prevention, recycling and reuse, greener product development, and ecological management of a firm. The relevance of the terminologies centers on how stakeholders may adopt GIN in order to promote and achieve business goals without compromising the sustainability of the environment. GIN contributes significantly to the development of sustainable firms and has now been recognized as an essential component for effective FPR [57]. Firms that intend to stay afloat in today's highly competitive economy must adopt successful GIN approaches. With the proper regulations, businesses may advance while becoming well-known brands [58].

2.4. Green Supply Chain Management

Researchers have advocated GSCM as a feasible method for improving FPR. Whereas the original concept of GSCM may be dated back to as early as the 1990s, the surge in scholarly publications indicates that it gained prominence in 2000 [59]. According to [60], GSCM may be attributed to the environmental stewardship movement of the 1960s. Ref. [61] indicated that from the 1990s, the GSCM concept took conventional shape as a new intellectual pursuit. Over time, the concept of sustainable supply chain management has further developed. Ref. [62] examined the application of ecological ideas to the whole spectrum of the order processing cycle processes. Ref. [63] defined GSCM as combining ecological aspects into interorganizational sustainable SCM techniques, including logistical operations. The notion of GSCM is expansive, and no comprehensive explanation is available. Due to conflicting definitions in the literature, it is difficult to provide a standard explanation of GSCM [64]. Despite discrepancies in descriptions, several common terminologies have been used, such as "green logistics and environmental logistics", "green buying and procurement", "supply chain environmental management", and "sustainable supply network management" [65].

2.5. Managerial Environmental Knowledge

The ever-increasing anxieties concerning the environmental repercussions of commercial activities have rendered environmental sustainability a significant problem. Firm managers and executives may assist in preventing potential environmental issues by adhering to green business practices and standards. The opportunity for MEK may be viewed as a decision between environmental devastation and conservation based on the possible financial rewards. The intellectual framework provides executives and managers a clearer understanding of why they should embrace challenging issues [66]. Intellectual frameworks aid CEOs in sorting through all available evidence and choosing the ideal answer. Environmental management and initiatives are used to encourage GIN to enhance the FPR. Generally, businesses may utilize two core approaches (i.e., monitoring and preventive) to manage sustainability challenges [67]. For example, an organization's management may lessen or eradicate sustainability hazards by employing the entire firm's capabilities and skills to generate alternatives to ecological difficulties. In particular, the continued development of current manufacturing units, the introduction of novel manufacturing processes, and the implementation of overall quality management are contributing factors [68]. In this view, the MEK may be either moderate or high. A company with MEK is assumed to be more engaged in ecological issues (e.g., environmental rules and principles) and more creative in developing GIN operations [69]. In contrast, those with a low MEK are considered passive or reactive toward environmental problems.

2.6. Hypotheses Development

2.6.1. Green Human Capital, Firm Performance, and Green Innovation

GHC positively relates to competitiveness [11]. However, researchers believe that GHC may have varying effects on economic sustainability (ranging from strong to weak). Moreover, GHC may have minimal or no influence on the economy's perseverance. In contrast, additional studies examining the effect of GHC have revealed that GHC is positively connected with the social, environmental, and financial performance of business companies [70]. Numerous studies have examined the relationship between GIN and FPR; however, the research does not link the factors [35]. In this respect, most researchers have demonstrated a connection between GIN and FPR. These comprise empirical studies [71] indicating that an improvement in a firm's outlook on GIN corresponds to an increase in an FPR. However, a few researchers have reported there to be a negative relationship between GIN and FPR. For example, [28] hypothesized that GIN decreases business financial performance. Similarly, [72] found that the implementation of GIN raises organizational expenditures. In examining the link between GIN and FPR, [73] found that non-GIN firms have stronger FPR than do GIN firms, which did not see an increase in FPR. Given the lack of consensus in the literature regarding the exact contribution of GIN to FPR, this study sought to test the following hypotheses:

H1. *GHC is significantly associated with FPR.*

H2. *GHC is significantly related to GIN.*

2.6.2. Green Supply Chain Management, Green Innovation, and Firm Performance

The connection between GSCM and GIN includes supply chain players who may create GIN in reaction to external issues posed by authorities and regulators. The processes of GSCM and GIN are vitally linked, with GSCM exerting a significant and positive effect on GIN [38]. This concept illustrates that GSCM is a significant driver of a company's GIN. The interaction between GSCM and GIN can help companies considerably by enhancing product development, manufacturing processes, and compliance with environmental regulations [74]. To effectively implement GIN, organizations must rigorously regulate and supervise their suppliers' attempts to produce eco-friendly resources and fulfill customer demand for eco-friendly products [28].

Integrating GSCM to safeguard the environment may assist businesses in reducing raw material costs and increasing the use of recycled materials, resulting in an enhanced competitive edge and improved FPR. GSCM might promote FPR by facilitating the adoption of enhanced environmental management practices that improve FPR [75]. The study conducted by [76] suggested that GSCM has a positive and considerable impact on FPR, indicating that it can aid organizations in developing competitiveness and enhance financial performance over time. There are difference in company perspectives concerning the use of GSCM methods to improve FPR. This is because firms must comprehend GSCM's facets in order to implement the process [56] properly. Thus, we hypothesized the following:

H3. *GSCM is significantly associated with the FPR.*

H4. *GSCM has a significant relationship with GIN.*

2.6.3. Green Innovation, Managerial Environmental Knowledge, and Firm Performance

GIN is positively associated with organizational success generally. It may enhance output and compensate for rising raw material costs. First, GIN can help to improve current goods and processes for further eco-friendly manufacturing without fundamentally altering them. GIN's second benefit is to create new and innovative goods and processes [77]. Through GIN, product innovations and procedures can radically transform old systems of production, thus substantially reducing their environmental impact. It can also lead to the development of innovative products and methods that aid in the cleaning, restoration, and establishment of ecologically sustainable societies [78].

GIN and FPR are related since GIN is the technology for creating eco-friendly products that may boost marketing and sales, leading to solid FPR. Gaining market share reflects the efficacy of the FPR and GIN [79]. As per [80], firms that adopt GIN may enhance their FPR by (1) employing reusable products, which saves expenses and boosts profits, and (2) by altering the designs of environmentally friendly goods, which increases profits and revenues. FPR may be measured in financial and nonfinancial terms, with green innovators enjoying a "first-mover benefit" in price competition policy, better brand image, and increased market share perspective [81]. Thus, we developed the following hypothesis:

H5. *GIN is significantly related to the FPR.*

2.6.4. Managerial Environmental Knowledge as a Moderator

Innovative technologies must have managerial support to be successful. This justification is also acceptable for GIN in sustainable products [16]. Furthermore, [82] reported that the greater the managerial support for GIN is, the greater the ambition of prominent firms to use green technology. Ref. [83] identified MEK as one of the most significant variables in green practices. It may stimulate GIN, hence increasing the competitiveness and productivity of organizations. According to the results of the study by [40], MEK has a significant effect on the inclination to engage in environmentally friendly actions. According to [67], attitudes, beliefs, and norms influence eco-innovation acceptance. However, according to [84], a firm's MEK and specific proactive steps are intended to develop environmentally friendly and sustainable technologies that may also assist enterprises in improving their FPR. Alternately, an ineffective MEK may lead to a reactive rather than proactive MEK, raising the risk of disasters and leading to a damaged reputation [85]. According to the natural-resources-based paradigm, mitigation, enhanced producer responsibility, and environmental balance are crucial environmental measures that provide firms with a competitive advantage [46]. Considering that MEK may either increase or decrease a firm's GIN, we proposed that MEK may influence the relationship between GIN and FPR and developed the following hypotheses:

H6. *MEK significantly moderates the link between GIN and the FPR.*

H7. *MEK is significantly related to the FPR.*

2.6.5. Green Innovation as a Mediator

Based on their connection to GIN, GHC and GSCM may or may not have a positive relationship with FPR. Although some studies have shown there to be an association between GHC and a company's social, environmental, and economic performance [86], others have not [87]. These relationships may be weakened due to businesses not using GHC effectively, undermining the connection between GHC and the FPR. Only when GHC enhances GIN (and GIN creates knowledge insights that GHC can absorb) is it possible for GHC to improve FPR. Thus, GIN may serve as a mediator between GHC and FPR. Similarly to GSCM, there may or may not be a significant connection between FPR and GSCM. Numerous researchers have analyzed the impact of GSCM on FPR [88]. Furthermore, additional elements must be incorporated as a mediator to comprehend the relationship between GSCM and the FPR. In this study, GIN is treated as a mediating variable. GIN may indicate a company's capacity to seek market share, strengthen the economy, establish product links, and enhance the sociocultural environment. By using GIN, enterprises may significantly reduce the environmental impact disputed by third parties while preserving and enhancing their performance [89]. Consequently, the following hypotheses were developed:

H8. *GIN significantly mediates the relationship between GHC and the FPR.*

H9. *GIN significantly mediates the association between GSCM and the FPR.*

3. Methodology

3.1. Population and Sampling

We applied the Chinese Big Five Inventory developed by [90] to evaluate the personality traits of the targeted respondents. The questionnaire is supplied as a digital annex. On a five-point Likert scale, one indicates "strongly disagree," and five indicates "strongly agree" for all questions. Chinese cities can be divided into four groups based on their degrees of economic progress: first tier, second tier, third tier, and fourth tier. First-tier regions are the most economically, socially, and culturally advanced. Second-tier regions are provincial capitals with moderate industrialization. The 3rd tier consists mainly of somewhat developed regions in every province, while the 4th tier consists of national regions. Between January and February 2023, we conducted a comprehensive questionnaire survey in 10 Chinese regions, including Shanghai, Shenzhen, and Beijing (1st tier); Chengdu, Jinan, and Hefei (2nd tier); Xiangfan and Zhongshan (3rd tier); and Xinmin and Changshu (4th tier). These regions were chosen as they represent almost 700 cities in China [91]. A second rationale was that being the world's leading technical innovation center [92], encouraging innovative techniques in these locations would have significant policy implications for the globe.

Before conducting the research, a pilot study with a smaller sample size was undertaken to ensure that the questionnaire was valid and would collect relevant data [93]. Subsequently, we addressed responders personally [94]. The procedure consisted of two main steps. The first step included the distribution of questionnaires to 1200 participants, who were required to return their responses within one month. Participants were provided with a comprehensive explanation of each aspect of the questionnaire. Participants then completed their surveys within the allotted time frame. A total of 736 valid answers were obtained, representing 61% of the sample size. According to Westland's formula, our model necessitates a sample size of 536 [95]. Nevertheless, our final sample size (736 respondents) was much greater, indicating that the sample size was sufficient for an empirical investigation. The detailed demography of respondents is shown in Table 1.

Table 1. Respondents' demographics.

Features	Options	Frequencies	(%)
Age (Years)	18–35	290	39.4
	36–55	360	48.91
	Above 55	86	11.68
Gender	Male	394	53.53
	Female	342	46.46
Income (CNY)	2000–5000	165	22.41
	6000–10,000	290	39.4
	11,000–20,000	200	27.17
	>20,000	81	11
Education	High school	100	13.58
	College degree	234	31.79
	Graduate	402	54.61
Experience	2–5 years	195	26.49
	5–10 years	350	47.55
	More than 10 years	191	29.95

3.2. Development of the Questionnaire

We evaluated GHC using seven questions from various past studies [32]. The seven factors for GSCM practices were derived from prior empirical research [30]. Five elements were utilized to evaluate GIN [96]. MEK was assessed using five questions from [97]. Finally, the FPR was examined with four elements drawn from [98].

3.3. Data Analysis

For statistical analysis, the AMOS (version 26) and SPSS (version 26) software packages were applied. The presented hypotheses were investigated using structural equation modeling (SEM). SEM is a comprehensive strategy that provides reliable and valuable data for determining the relationship between multiple variables [99] and has three critical advantages over earlier methods: (i) an accurate estimation of measurement error, (ii) an estimation of latent constructs from observable data, and (iii) a validation of the framework used to evaluate and execute a pattern utilizing data conformity [100]. In particular, the bulk of multivariate approaches implicitly disregards computational error. However, the SEM analyzes independent and dependent variables by considering calculation errors. Owing to its dependability and sturdiness, the approach delivers accurate and distinct results [101].

SEM permits the generation of unique indicator structures for each element and delivers valid conclusions. Also assessed are the inaccuracy areas of the variables tested. Consequently, the link between variables generates trustworthy findings. Moreover, it can analyze complex relationships and several hypotheses by combining mean configurations and group assessments, something other frameworks and prototypes cannot accomplish [102]. Considering the advantages of SEM, it represents the most effective method for assessing the link between all constructs taken into consideration; hence, we employed it in our research.

4. Results

4.1. Statistical Analysis

4.1.1. Descriptive Statistics, Discriminant Validity, and Correlation Analysis

The descriptive information is displayed in Table 2 and includes the mean, standard deviation, and coefficient of variation. Using correlation analysis, the interconnections between variables were examined. The research indicated significant relationships between the factors. We examined the discriminant validity using the square root of the average variance extracted (AVE). Results validated the discriminant validity since the square root of AVE's correlation with other variables was greater than its relationship with other variables [103]. Comparing the AVE values to the MSV values for each variable is another way to establish discriminant validity. When the AVE values for a construct are larger than its MSV, discriminant validity is established [104]. The fact that the AVE values for all constructions surpassed the MSV values supported these conclusions. In addition, using AVE and item loadings, convergent validity was conducted to investigate the potential relationship between the constructs [105]. AVE values for each component were larger than 0.50, suggesting that the latent constructs maintained greater than 50% variance (see Table 3).

Table 2. Descriptive statistics of the data.

Variables	Observations	Items	Mean	Std. Dev	Coefficient of Variation (CV)
GHC	313	7	2.63	0.59	0.22
GSCM	313	7	3.692	1.597	0.43
GIN	313	5	2.34	0.576	0.25
MEK	313	5	3.686	0.571	0.15
FPR	313	4	2.854	1.328	0.47

Notes: **GHC**–green human capital; **GSCM**—green supply chain management; **GIN**—green innovation; **MEK**—managerial environmental knowledge; **FPR**—firm performance.

Table 3. Correlation and discriminant validity analysis.

Variables	GHC	GSCM	GIN	MEK	FPR	AVE	MSV
GHC	(0.795)					0.632	0.278
GSCM	0.527	(0.829)				0.687	0.278
GIN	0.269	0.362	(0.762)			0.580	0.131
MEK	0.223	0.237	0.324	(0.839)		0.703	0.121
FPR	0.168	0.314	0.334	0.348	(0.714)	0.510	0.121

Notes: Values in parentheses represent the root square of AVEs.

4.1.2. Reliability Analysis

To assess the components' reliability analysis, Cronbach's alpha was determined. Cronbach's alpha values for all variables were more than [106] the recommended threshold value of 0.70, indicating reliability. To establish the consistency of all components, a composite reliability (CR) test was carried out. According to the study results, the CR levels were above the minimum cutoff value of 0.70 [107]. The study's results are reported in Table 4.

Table 4. Results of reliability analysis and factor loadings.

Variables	Items	Standard Loadings	Cronbach-α	CR
Green human capital			0.884	0.914
	GHC 1	0.603		
	GHC 2	0.830		
	GHC 3	0.749		
	GHC 4	0.737		
	GHC 5	0.842		
	GHC 6	0.864		
	GHC 7	0.671		
Green supply chain management			0.916	0.875
	GSCM 1	0.806		
	GSCM 2	0.880		
	GSCM 3	0.906		
	GSCM 4	0.923		
	GSCM 5	0.835		
	GSCM 6	0.746		
	GSCM 7	0.679		
Green innovation			0.854	0.908
	GIN 1	0.781		
	GIN 2	0.823		
	GIN 3	0.875		
	GIN 4	0.858		
	GIN 5	0.853		
Managerial environmental knowledge			0.848	0.891
	MEK 1	0.837		
	MEK 2	0.891		
	MEK 3	0.758		
	MEK 4	0.792		
	MEK 5	0.681		
Firm performance			0.894	0.917
	FPR 1	0.715		
	FPR 2	0.752		
	FPR 3	0.686		
	FPR 4	0.702		

Notes: **Extraction method:** maximum likelihood; **Rotation method:** Promax with Kaiser normalization.

4.1.3. Multicollinearity

To develop the variance inflation factor (VIF) and tolerance values, multicollinearity was investigated using regression. [108] stated that the values of VIF and levels of tolerance must not surpass 10 and 0.1, respectively. The values of tolerance and VIF were under the allowable limits across all components, suggesting that there was no multicollinearity problem with the study's model. Table 5 summarizes the findings.

Table 5. Collinearity diagnostics.

Variables	Collinearity Statistics	
	Tolerance	VIF
GHC	0.819	1.472
GSCM	0.771	1.978
GIN	0.834	1.759
MEK	0.796	1.907

Notes: Dependent variable: FPR.

4.1.4. Factor Analysis

An EFA was performed to identify the framework of contributing design. EFA studies factor structure, as well as intervariable relationships and variable classifications based on their factor structure [8]. The results were gathered using the maximum likelihood method, which was modified using Promax Kaiser normalization to obtain more pertinent findings. Eigenvalues were critical for defining the constructs' ordering. Throughout this stage, multiple assessments of the usefulness of EFA data were conducted [109]. For example, the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity (BTS) were used to evaluate the data's suitability. KMO was determined with a value of 0.907%, suggesting that factor analysis could continue (an index of factorial simplicity). In addition, BTS was a substantial amount, at 6759.03, satisfying the EFA's standards (see Table 6). Likewise, the Table 7 communalities findings reveal that all elements with values over the minimum given standard of 0.4 were communal [110]. Promax rotation with Kaiser normalization found seven essential aspects with Eigenvalues greater than 1 and a total variance of 659.93% for the framework of this investigation (see Table 8). These findings confirm data reliability, permitting further examination [111].

Table 6. Kaiser–Meyer–Olkin (KMO) and Bartlett's tests.

KMO and Bartlett's Tests		
Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.907
Bartlett's Test of Sphericity	Approx. Chi-Square	6759.03
	Df	378
	Sig.	0.000

Notes: Df—degree of freedom; Sig—significance.

Table 7. Communalities findings.

Variables	Communalities	
	Initial	Extraction
GHC	1.000	0.601
GSCM	1.000	0.735
GIN	1.000	0.654
MEK	1.000	0.971
FPR	1.000	0.839

Notes: Extraction method: maximum likelihood.

Table 8. Eigenvalues and cumulative variance.

Variables	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.873	31.689	31.689	8.365	29.876	29.876
2	3.799	13.570	45.259	3.498	12.492	42.368
3	2.816	10.057	55.316	2.521	9.005	51.373
4	2.258	8.066	63.381	1.848	6.599	57.972
5	1.855	6.624	70.005	1.517	5.418	63.390

Notes: Rotation method: Promax with Kaiser normalization; Cumulative variance: 63.390%.

The model was then determined via a CFA. CFA validates the structure of the retrieved elements under the EFA. The initial step in constructing a paradigm is to evaluate its unidimensionality. Components with significant loadings (greater than 0.7) on the leading indicators should be preserved [112]. Based on the findings, every loading was more than 0.70. Since all elements were assembled into their appropriate structures, the measuring model's accuracy was also validated (see Figure 1). These results suggest that this investigation's data correspond well with the measurement model.

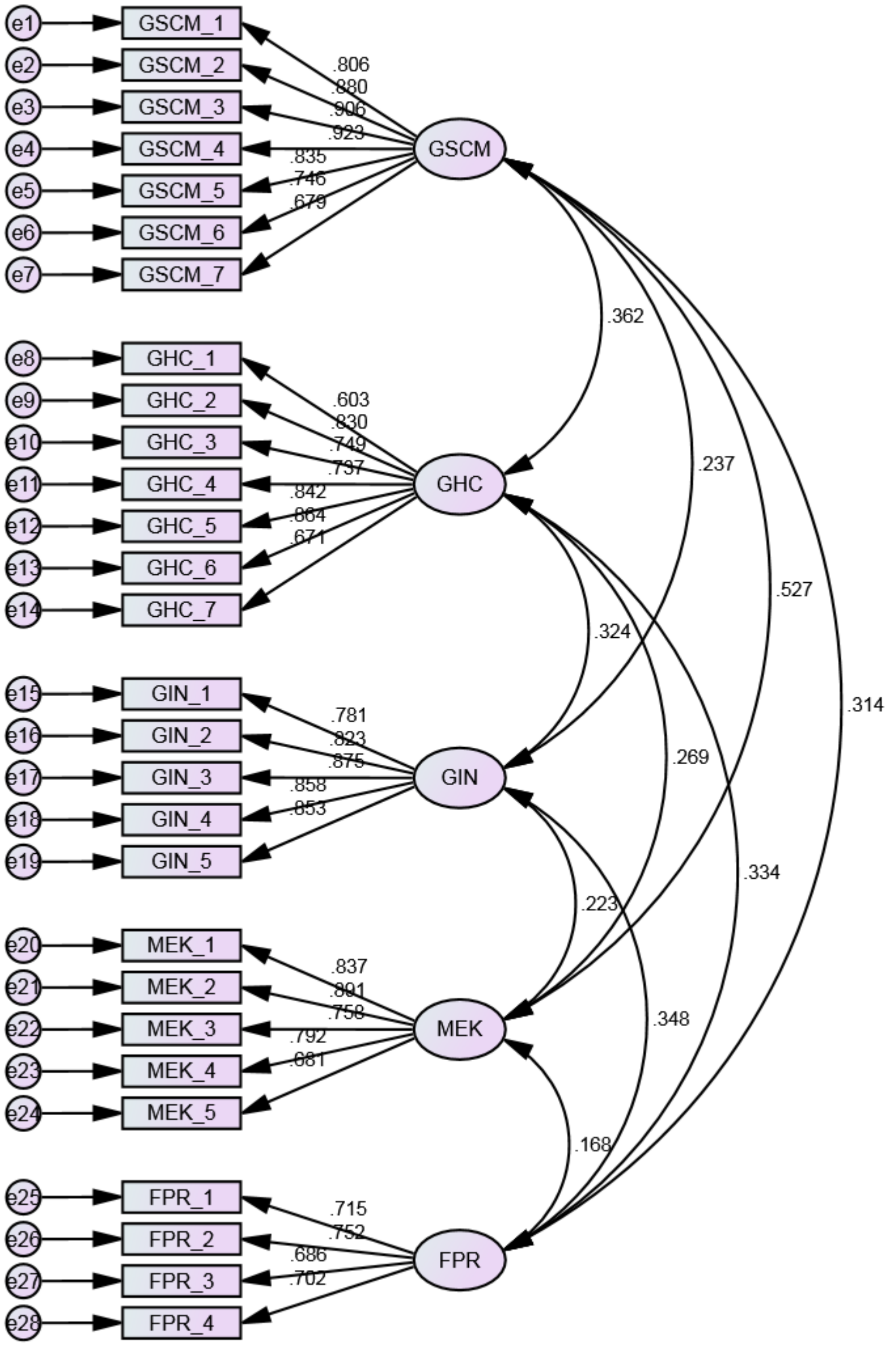

Figure 1. Confirmatory factor analysis representing the measurement model. Source: Authors' calculations.

4.1.5. Results of the Hypotheses and Structural Model

We analyzed the model's relationships by employing SEM and covariance-based curve assessment techniques. A high f-value in the research indicated that all connections were linear. Furthermore, numerous fitness tests were undertaken to ensure that the findings were consistent with the structural model. All values of fit index (i.e., CFI = 0.998, NFI = 0.953, IFI = 0.972, TLI = 0.977, GFI = 0.967, RMSEA = 0.033, X^2/df = 1.257, and SRMR = 0.033) were in the allowable threshold, suggesting that the conceptual framework sufficiently prepared for the data [113]. The schematic representation of SEM along with the structural paths is shown in Figure 2. The path coefficient of the variables GHC and GSCM did not significantly influence FPR (β = 0.458, β = 0.182). Consequently, we rejected H1 and H3. On the contrary, GHC and GSCM significantly influenced GIN (β = 0.143,

p-value = 0.05, β = 0.046, p-value = 0.1). Thus, we accepted H2 and H4. Similarly, GIN significantly influenced FPR (β = 0.073, p-value = 0.1); therefore, H5 was accepted. MEK significantly moderated the association between GIN and ENP. Thus, H6 was accepted. MEK also significantly influenced FPR, confirming H7. The mediation effect of GIN between the relationships of GHC → FPR and GSCM → FPR was also estimated. Estimations revealed full mediation (β = 0.157, p-value = 0.01) and (β = 0.036, p-value = 0.01), respectively. As a result, H8 and H9 were also accepted. Table 9 represents hypothesized paths and the hypotheses' validity.

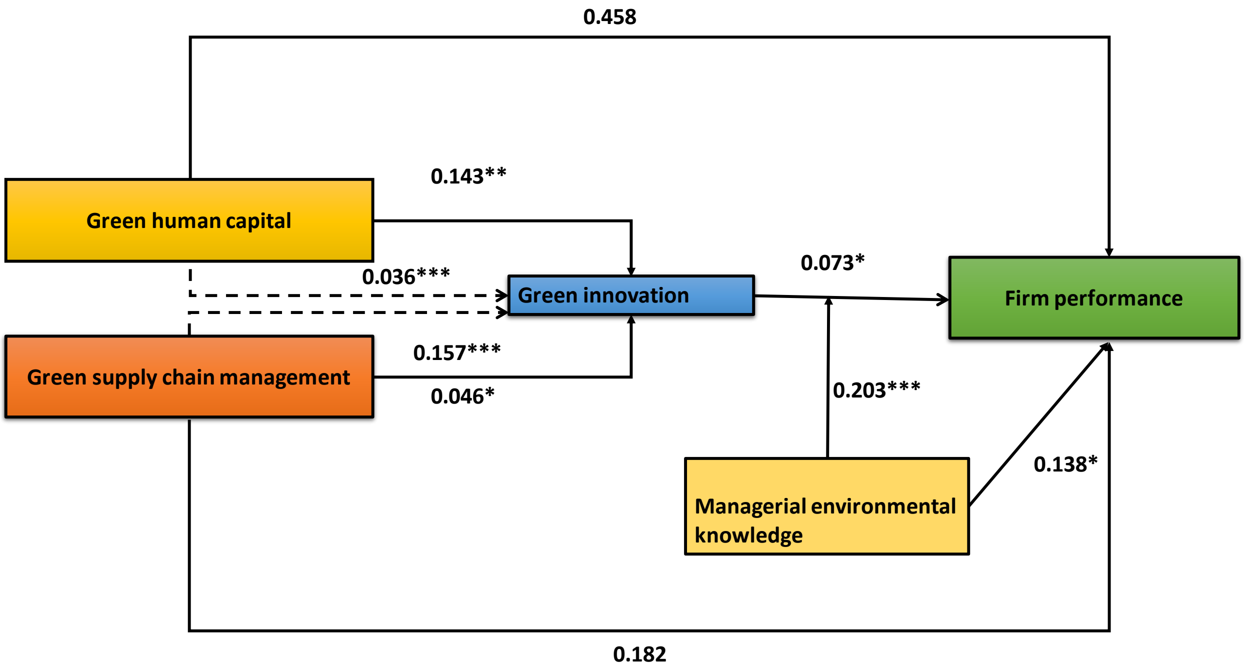

Figure 2. Path diagram of structural equation modeling. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: Authors' calculation.

Table 9. Results for the hypotheses.

Hypotheses	Structural Paths	β-Value	f-Value	Results
	Direct effects			
H1	GHC → FPR	0.458	143.1 ***	Rejected
H2	GHC → GIN	0.143 **	292.6 ***	Accepted
H3	GSCM → FPR	0.182	175.2 ***	Rejected
H4	GSCM → GIN	0.046 *	292.8 ***	Accepted
H5	GIN → FPR	0.073 *	297.3 ***	Accepted
H6	MEK * GIN → FPR	0.203 ***	140.5 ***	Accepted
H7	MEK → FPR	0.138 *	197.2 ***	Accepted
	Indirect effects			
H8	GIN → GHC → FPR	0.157 ***	155.8 ***	Full mediation
H9	GIN → GSCM → FPR	0.036 ***	142.5 ***	Full mediation

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Discussion and Conclusions

Based on the natural RBV theory, corporations must seek competitiveness through pollution reduction programs, increased manufacturer awareness, and sustainable growth [46]. To reinforce this position, we assessed the significance of MEK in supporting a company in enhancing its FPR. In addition, researchers have shown that MEK increases FPR and that the relationship between GHC, GSCM, and FPR may be modified and mediated by several variables [114]. According to prior research, MEK's impact could consist of reduced

CO_2 emission and contributing to healthy ecosystems, improving FPR [115]. This study indicates that MEK can increase an FPR while attenuating the link between GIN and FPR.

In addition, we demonstrate that GHC and GSCM are not directly tied to FPR. This finding was evaluated from the perspective of the proposed reassessment of the relationship between GHC, GSCM, and GIN. We argue that GHC and GSCM do not always directly lead to the FPR of a sustainable firm. Nonetheless, these factors impact the FPR via the GIN as a mediator. GSCM may not have a direct relationship with FPR, notwithstanding its importance. [89] stated that firms should be strongly motivated to use GSCM and GIN to enhance their reputation, efficacy, productivity, differentiation, and competitiveness, Table 10 represents the comparison studies.

Table 10. Comparison table.

Title	Findings	Reference
Analyzing the relationship between green innovation and environmental performance in large manufacturing firms	This paper argues that neither green intellectual capital nor green human resource management is directly related to environmental performance. It argues instead that green innovation mediates the relationships between green intellectual capital, green human resource management, and environmental performance. It is further concluded that environmental strategies are directly related to environmental performance and moderate the relationship between green innovation and environmental performance.	[48]
Green supply chain management and firm performance: the mediating effect of green innovation	The findings showed that green supply chain management positively affected green innovation, green innovation positively affected firm performance, and green supply chain management did not affect firm performance directly. Green innovation mediated the relationship between green supply chain management and firm performance.	[38]
Effects of green human resource management on green innovation through green human capital, environmental knowledge, and managerial environmental concern	The findings of this study revealed that green human resource management positively contributed to the green innovation of organizations. The mediating roles of green human capital and environmental knowledge were also statistically significant. Furthermore, the results revealed that the link between green human resource management and green human capital is stronger with managerial environmental concern as a moderator.	[33]
The mediating effect of green innovation on the relationship between green supply chain management and environmental performance in Malaysia manufacturing industries	The findings of this study showed that green supply chain management practices positively affect green innovation and environmental performance. Green innovation was found to affect environmental performance positively, and its role as a mediator between GSCM practices and environmental performance was confirmed. The results confirmed the complementary effect of GSCM practices on green innovation and environmental performance.	[116]

Table 10. *Cont.*

Title	Findings	Reference
An environmental policy of green intellectual capital: green innovation strategy for performance sustainability	This study showed ways in which three dimensions of GIC influence a firm's performance; that is, green human capital (GHC), green relational capital (GRC), and green structural capital (GSC). The mediating role of green innovation was used to explain the relationships. The findings indicated that the three GIC constructs positively affect economic performance, green performance, and green innovation. Further analysis found that green innovation fully mediates the linkage of GHC–economic performance and GSC–green performance and partially mediates the linkage of GRC–economic performance and GRC–green performance. Moreover, green innovation does not mediate the linkage of GSC–economic performance or of GHC–green performance.	[15]
A structural model of the impact of green intellectual capital on sustainable performance	This study investigated the connection between green intellectual capital and sustainable performance. According to their findings, green intellectual capital positively affects environmental, social, and economic performance. The significance of green intellectual capital was revealed to be an intangible resource for enterprises to achieve sustainable performance and a competitive edge for future researchers.	[42]

In addition, this research established a link between GSCM and the FPR mediated by GIN. This finding was then supported by the results of other experts, including [28]. This research analyzed the hypothesis that increasing GSCM may increase GIN and FPR. MEK has compelled companies to place a greater emphasis on GSCM, GHC, and GIN, forcing them to be environmentally responsible. Simultaneously, conscientiously buying eco-friendly components and raw materials and implementing GIN can increase FPR. Nevertheless, companies actively involved in GIN have a substantial influence on the environment. As proven throughout this study, GIN may thus serve as a mediator when examining the effect of GHC and GSCM on FPR.

5.1. Theoretical Implications

This research expands upon the concept of MEK by using GHC, GSCM, and GIN. In general, it is essential to note that GHC and GIN engage in a dynamic interplay. The only way for GHC to grow is for a company to actively commit to GIN. This dedication helps businesses to continually improve GHC. Upon GIN's incorporation into GHC, a business may become more efficient and focused. Constantly improved GHC may encourage new and inventive cycles, hence enhancing GIN's benefits. Ultimately, this continual interaction may have a substantial effect on FPR. Similarly, GSCM is abstractly related to GIN. Through the use of GIN, GSCM practices may increase their impact on FPR.

In addition, this study represents a significant theoretical development in the academic and research domains related to the natural RBV theory. This idea emphasizes the concentration and volatility of resources and skills inside organizations. They are thought to have a direct relationship with the firm's efficiency and competitive advantage [46]. The finding implies that manufacturing companies in developing countries with increased GSCM and GHC may enhance their FPR by using GIN. Successful implementation ofGSCM practices in a production line may extend the understanding of how manufacturing organizations may use GHC, GSCM, GIN, and MEK to enhance their FPR.

5.2. Practical Implications

This research has numerous practical implications, especially for legislators and firm leaders. Our study's suggested framework consists of leveraging the influence of GHC and GSCM on FPR by mediating the influence of GIN and moderating the impact of MEK. Hence, it provides a roadmap for manufacturing firms to enhance their FPR. Because of the increased attention being paid to GSCM recently, using this paradigm in developing countries' manufacturing firms may assist a firm in raising its quality and clean productivity and preserving its manufacturing competitiveness. Persistent efforts must be made by businesses to refresh and improve their GHC. When a firm's GHC yields GIN, it might gain an advantage over competitors. In this manner, GHC is a secret source and has the dynamic potential to continually evolve in response. Managers and executives of manufacturing firms must not limit themselves to GIN initiatives that improve existing sustainable and environmental products and processes. In an era of environmental concern, manufacturers should have an eco-friendly business and market structure. However, it should be kept in mind that implementing eco-friendly practices alone may not automatically increase FPR. They must encourage GIN to reduce the negative environmental impact of their activities and meet the needs of greener consumers and stakeholders.

Consequently, our research recommends that manufacturing firms should adopt GHC and GSCM and participate in GIN to enhance FPR. Environmental consequences have become a worldwide concern requiring considerable attention. In addition, this study offers a clear roadmap for manufacturing regulators and leaders to improve their FPR and environmental sustainability with several positive externalities. The manufacturing industry is a substantial contributor to environmental contamination in developing countries. The concepts and conclusions in this paper may help convince legislators and upper management of the importance of enhanced FPR via GHC, GSCM, MEK, and GIN. Therefore, when manufacturing firms embrace this strategy, the community will gain from eco-friendly products, higher resource efficiency, and enhanced life satisfaction. To retain their GHC, managers need to make a determined commitment to engage in and develop effective information systems. Managers should concurrently create proactive environmental strategies incorporating ecological security features including GSCM, GHC, MEK, and GIN. People are committed to accomplishing environmental goals when firms have excellent environmental programs.

5.3. Conclusions

This study employed the natural RBV theory to understand how GHC, GSCM, MEK, and GIN might improve FPR in the manufacturing companies of developing countries. It was shown that GIN mediates the links between GHC, GSCM, and the FPR. In particular, MEK has a moderating effect on a firm's GIN and FPR. The findings demonstrate that managers in developing economies should assign the highest weight to GHC, GSCM, MEK, and GIN. They should enhance their GHC and GSCM investments. This study further identified a mediating link between GIN, GHC, and GSCM and highlights the importance of these factors for FPR. The mediating influence of GIN and the moderating effect of MEK were validated using SEM. In particular, developing countries' manufacturing firms are less advanced and capable at applying GHC and GSCM than are their rivals in industrialized countries. Many manufacturing firms are subject to harsh environmental regulations that the government and domestic and foreign customers enforce. As a result, GHC and GSCM have been used exclusively to meet consumers' wishes, demands, and expectations because they are regarded as quick solutions to these problems.

5.4. Limitations and Future Directions

There were several limitations to this research. These findings offer valuable general information; however, the surveyed regions may restrict the generalization of the research's conclusions since the data were taken only one developing country i.e., China and many other developing countries were omitted from the survey owing to the low economic and population growth. In order to allow for greater generalization, it is necessary to incorporate other developing countries in future research. Moreover, in this study, we made no distinction between exploitative and exploratory GIN. The relationship between exploitative and exploratory GIN and FPR may be unique. Therefore, future research should differentiate between the two types of GIN. Furthermore, the study was cross-sectional as opposed to longitudinal. Cross-sectional examinations of a sequence of dynamical notions (e.g., GHC, GSCM, GIN, and MEK) include an assessment at a single point in time instead of the overall behavior throughout a period. Thus, the cause–effect relationships could not be identified. In future research, the significance of green culture, green organizational commitment, and green organizational strategy may be examined as moderators of the relationship between GSCM, GHC, and FPR.

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