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RESEARCH ARTICLE

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How do green knowledge management and green technology innovation impact corporate environmental performance? Understanding the role of green knowledge acquisition

Saumyaranjan Sahoo[1] | Anil Kumar[2] | Arvind Upadhyay[3]

[1]Jaipuria Institute of Management, Jaipur, India

[2]London Metropolitan University, London, UK

[3]University of Stavanger, Stavanger, Norway

Correspondence
Anil Kumar, London Metropolitan University, London, UK.
Email: anilror@gmail.com

Abstract

Increasing regulatory obligations to adapt and execute environmentally friendly operations make it critical for businesses to pursue strategies that can strengthen their competitive edge in the market. Academics and practitioners alike have recently gravitated toward exploring how knowledge acquisition activities might improve business outcomes. To address this growing research interest, this study investigates the critical roles of green knowledge acquisition in enhancing green knowledge management and green technology innovation activities in improving corporate environmental performance, positioning resource commitment as a moderator. The research model has been assessed using structural equation modeling with survey data from 283 Indian manufacturers, demonstrating that green knowledge acquisition significantly impacts green knowledge management and green technology innovation. The statistical findings also show that green technology innovation acts catalyzes the translation of green knowledge management into improved corporate environmental performance. The results demonstrate that resource commitment moderates green knowledge acquisition's interaction with green knowledge management and green technology innovation, providing practical insights enabling managers to focus on planning, allocating, and budgeting resources for effective green practices that can contribute to improving corporate environmental performance.

KEYWORDS

business strategy, green knowledge acquisition, green knowledge management, green technology innovation, environmental performance

Abbreviations: CEP, corporate environmental performance; GKA, green knowledge acquisition; GKM, green knowledge management; GTI, green technology innovation; KBV, knowledge-based view; NRBV, natural resource-based view; RBV, resource-based view; RC, resource commitment.

1 | INTRODUCTION

Many contemporary researchers consider the conservation of natural resources among the most pressing goals for addressing global issues that contribute to environmental degradation and climate change (Singh & El-Kassar, 2019; Rehman et al., 2021; Yaoteng & Xin, 2021). Due to manufacturers wanting to balance resolving environmental issues and reaping economic benefits, sustaining a competitive advantage in the era of globalization has become a real challenge (J. Abbas, 2020; Belhadi et al., 2020). The advent of digital computing, networking, monitoring, and measuring technologies has enabled industrial processes to inundate businesses with highly heterogeneous data from any location at any moment from any machine, generating "big data" (Benzidia et al., 2021; M.-L. Song et al., 2018). A growing number of business activities across a wide range of functional verticals have recognized the usefulness of evaluating this unstructured big data to make decisions and improve business operations (Olabode et al., 2022; Waqas et al., 2021). Although this may seem simple, realizing this potential represents a next-level challenge for the organizations that must leverage big data to extract meaningful information that can contribute to wiser choices and gaining a competitive edge (Z. Khan & Vorley, 2017).

Versatile and adaptable manufacturers are attempting to develop big data analytics capabilities that can guide the knowledge management processes within their organizations (Nimmagadda et al., 2018; S. Wang & Wang, 2020) and enable them to achieve their corporate environmental performance (CEP) goals. Manufacturers have realized that their capacity to be well-informed is crucial for high-quality strategic decision-making (Nisar, Nasir, et al., 2021; Ramy et al., 2020; J. Wang et al., 2020). Acquiring, disseminating, and applying knowledge about environmental conservation can help organizations achieve their objectives of market dominance and enhanced service quality (Khurshid et al., 2019; M. Song et al., 2017). Meanwhile, scholarly evidence suggests that manufacturers have employed cutting-edge business analytics to optimize their operations to be more environmentally friendly (Benzidia et al., 2021), maximize the productivity of their supply chains (Cheng et al., 2021), and find parameters that increase their green throughput (Belhadi et al., 2020). According to this analogy, the implementation of green knowledge acquisition (GKA), propelled by the organizational capability of big data analytics, enables manufacturers to respond to abrupt market changes and continuously improve the sustainability of their operations, thereby contributing to their perceived trustworthiness and enhancing consumer and stakeholder confidence (Belhadi et al., 2020; Nisar, Nasir, et al., 2021; Rehman et al., 2021). However, research exploring GKA's contribution to CEP remains in its infancy, with research efforts in the domain often limited by the scope of investigation. For example, J. Wang et al. (2020), who employed an empirical approach to investigate the link between GKA and exploratory green innovation in the context of the Chinese manufacturing sector, suggested expanding the scope of their research by including factors such as green knowledge integration and environmental awareness.

In the contemporary corporate environment, green knowledge management (GKM) has also been recognized as pivotal to both creating and developing new sustainability-centered services and green products and performing functional processes that comply with government regulations (Benabdellah et al., 2021; Khurshid et al., 2019). For this reason, manufacturers are increasingly concerned about developing new, more effective GKM strategies that can enhance their green technology innovation (GTI) capabilities (Belhadi et al., 2020; J. Wang et al., 2020). GTI now represents a crucial strategic accelerator for achieving CEP goals (Larbi-Siaw et al., 2022) and includes all forms of technological innovation (of products and processes) designed to conserve energy, regulate emissions, and recycle waste, among other eco-purposes (Shahzad et al., 2020; Singh & El-Kassar, 2019). The increasing deployment of GTI has led many researchers to emphasize the need to identify key enablers that can facilitate such operations as a possible direction of investigation (Kraus et al., 2020; Rehman et al., 2021; Singh et al., 2020). Meanwhile, given modern manufacturers use novel ideas and assets derived from human knowledge assets to enhance environmental sustainability and financial profitability (J. Abbas & Sağsan, 2019; Shahzad et al., 2020; J. Zhou et al., 2021), GKM represents an apparent cornerstone of manufacturer ability to innovate constructively (J. Abbas & Sağsan, 2019; Pekovic & Bouziri, 2021; Shahzad et al., 2020). Elsewhere, GKA has been increasingly recognized as a GKM precursor, especially in academic research, where it is considered a potent organizational capability due to its capacity to use big data analytics to respond to and predict changes in the external environment (Nimmagadda et al., 2018; O'Connor & Kelly, 2017; S. Wang & Wang, 2020).

Previous researchers have examined big data analytics and knowledge management in studies assessing how organizations effectively use such capabilities to develop innovation activities and improve business performance, mostly as separate investigations (J. Abbas & Sağsan, 2019; Benabdellah et al., 2021; Singh & El-Kassar, 2019; Yaoteng & Xin, 2021). However, despite substantial discussion within manufacturing communities about these topics (Castellano et al., 2022; Del Río Castro et al., 2021), there has been limited research examining the relationship between GKA and GKM and considering the impact of GKA and GKM on GTI and CEP in the context of a single framework (Biscotti et al., 2018; J. Wang et al., 2020). The paucity of past studies in this domain also underscores the need for a more in-depth examination of whether or how other situational factors, such as resource commitment (RC) by senior management, affect the aforementioned interactions (Joshi & Dhar, 2020; Konadu et al., 2020). To better recognize the resources that manufacturers allocate to the development of their distinctive capabilities, empirical data usually classify organizational resources into three categories: monetary, technological, and supervisory (G.-C. Wu, 2017). Consequently, RC is described as an organization's readiness to invest resources in GKM and GTI activities to enhance overall CEP. To build strong GKM structures, manufacturers must allocate sufficient resources to harnessing their GKA capabilities and managing the competency of their human resources, such as to facilitate the strategic decision-making needed to achieve sustainable business goals (Nisar, Haider, et al., 2021; Yusliza et al., 2020). This proposition is strongly supported by the theoretical notion of the resource-based view (RBV) of firms, which underscores how the creation and retention of strategic resources over time helps businesses develop an enduring competitive advantage (Biscotti et al., 2018; Kraus et al., 2020). Academic and practitioner communities consider the strategic resources emphasized in this investigation (i.e., GKA, GKM, and GTI) unique, scarce, and difficult to replicate or substitute but also capable of providing manufacturers with a competitive edge (Singh et al., 2020; J. A. Zhang & Walton, 2017). Thus, the present study adopts the lens of RBV theory to address all of the aforementioned gaps by providing a more comprehensive understanding of the following research questions:

RQ1: What impact does big-data-analytics-enabled GKA have on GKM and GTI?

RQ2: Can GKA, backed by RC, best support the efforts of GKM and GTI to achieve an organization's CEP goals?

The rest of the article proceeds as follows: Section 2 outlines the current research's conceptual foundations, and Section 3 presents the research framework; Section 4 describes the research approach; Sections 5 and 6 summarize and discuss the statistical evidence; Section 7 concludes the paper by detailing this study's limitations and future research prospects.

2 | THEORETICAL FOUNDATIONS AND CONCEPTUAL FRAMEWORK

2.1 | Resource-based view of firms

The research literature on the implementation of green strategies by manufacturing organizations across the globe has considered various perspectives. One such perspective emphasizes a person-level approach that focuses on leadership qualities and the role of administrators in helping organizations develop broad strategies (Islam et al., 2021). A second perspective investigates the degree to which the alignment between formulated strategic plans and underlying operational processes, functional management structures, and workplace cultures explains deviations in business performance using a "strategic fit" line of reasoning (A. Wu & Li, 2020; Yasir et al., 2020). A third perspective proposes a "resource-based view" (RBV) that argues that an organization will recognize its strategically valuable capabilities and resources, which are precious, uncommon, distinctive, and non-substitutable, to achieve sustained competitiveness (Andersén, 2021; Lin et al., 2021; Shahzad et al., 2020). The RBV of a firm has been used extensively to illustrate divergent views on strategy formulation as a key driver of organizational performance by both knowledge management research (Hsieh et al., 2019; Salimath & Philip, 2020) and environmental management research (Belhadi et al., 2020; Kraus et al., 2020; Singh et al., 2020; Singh & El-Kassar, 2019).

The natural RBV (NRBV), a significant extension of the RBV, builds on the principle that a firm's competitiveness depends on its interactions with the natural environment and considers the ecological impact of organizational resources and the processes derived from this resource base (Andersén, 2021; Q. Zhang et al., 2020). Distinguishing itself from the bulk of investigations based on institutional theory, which understand GTI as a response to organizational desire for credibility and fear of regulatory punishment (C. Hu et al., 2021; J. Zhang et al., 2020), the NRBV emphasizes the firm's capacity to develop GTI (Wei & Sun, 2021; M. Zhou et al., 2020). Many research articles have linked the RBV to the theoretical emergence of the knowledge-based view (KBV), which emphasizes intellectual capital as an inimitable resource and essential engine of productive growth (Shahzad et al., 2020; Yong et al., 2019). The KBV holds that an organization's principal task is to synthesize the specialized knowledge and expertise that exists among its employees and within its network of business associates, which together comprise its unique organizational capabilities (Alonso et al., 2021; Tu & Wu, 2021). Consequently, a firm's strategic GTI capacity depends on its GKA ability to acquire and absorb specialized knowledge resources that might be able to develop GKM assets inside the organization to enhance CEP. Meanwhile, according to the NRBV, effective GTI should allow an organization to achieve a good reputation while improving its CEP, strengthening the KBV. Accordingly, the current research considers these two extensions of RBV theory to understand a diversity of firm-level green strategies and offer a research framework for the various constructs used in this study.

2.2 | Green knowledge acquisition

The currently disorganized business data management situation in several sectors has prompted recent research to examine the storage and data processing capabilities of organizations in the big data context (Benzidia et al., 2021). The term "big data" describes datasets too large for standard business database software to collect, manage, handle, and analyze (Ashrafi et al., 2019; Nimmagadda et al., 2018). There are seven aspects of big data—volume, velocity, variety, veracity, variability, volatility, and value (Belhadi et al., 2020)—and big data is often linked with business analytics or big data analytics, which use quantitative information derived from statistical techniques to contribute knowledge to strategic decision-making (Nisar, Nasir, et al., 2021). In the context of environmental big data, big data analytics refers to macro-level tools designed to identify patterns in the chaos of the explosion of environment-related information collected from various sources (e.g., process sensors, weather data, and agricultural activity) to contribute to the development of smart approaches to addressing ecological concerns. However, organizations must also obtain a wide range of solution-driven information, including green information about green technologies and ecological requirements (M.-L. Song et al., 2018). GKA, which is premised on the KBV, emphasizes acquiring green information via big data analytics to influence GKM and GTI activities within organizations (Benabdellah et al., 2021; Biscotti et al., 2018; J. Wang et al., 2020). Accordingly, a firm's GKA capacity can be understood as its ability to develop the expertise to generate green business insights from various information sources that internal employees can use for strategic decision-making. However, despite industry hype, ambiguity apparently clouds the adoption of big data analytics, with organizations flailing in their attempts to grasp what big data is and how they can extract business value from big data (O'Connor & Kelly, 2017). Through the prism of the KBV, the conceptualization of GKA capabilities broadens the perspective of big data applications to encompass all related information systems critical to harnessing the full strategic potential of green information (Z. Khan & Vorley, 2017). Thus, given the limited research regarding GKA (J. Wang et al., 2020), this study attempts to clarify and resolve residual doubt in the minds of adopters.

2.3 | Green knowledge management

According to the KBV, GKA can facilitate the creation of green knowledge and contribute to evidence-based knowledge resources capable of improving competitiveness (Shahzad et al., 2020; S. Wang & Wang, 2020). Given consumer and stakeholder expectations are always evolving, organizations must have up-to-date and novel information that can advance the technical refinement of current processes toward sustainable practices and the development of greener products (Khurshid et al., 2019; Yusliza et al., 2020). Initiating and sustaining a successful GKM strategy requires a high degree of GKA maturity, because these processes concern how organizations obtain information from external sources and utilize new knowledge gained via collaboration with other stakeholders (Ashrafi et al., 2019; S. Wang & Wang, 2020). In this context, GKM represents an organized and coordinated endeavor to use the vital information contained within the organization's social structure (Begum et al., 2022) and serves as a resource for the productive utilization of enterprise knowledge assets, which critically determine both GTI and CEP (J. Abbas & Sağsan, 2019; M. Zhou et al., 2020). This explains the RBV's conceptualization of organizations with greater GKA and GKM capabilities being more likely to develop green processes and sustainable products (Mao et al., 2016; Soto-Acosta et al., 2018; J. Wang et al., 2020).

2.4 | Green technology innovation

Theorists have described innovation as an organizational capacity to address ongoing issues and respond to stakeholder expectations (Ashrafi et al., 2019; Huang & Li, 2017; Shahzad et al., 2020). Building on the NRBV (Rehman et al., 2021; Singh et al., 2020), GTI is characterized by a firm's capacity to apply novel ideas in service of developing new functional processes and products and enhancing current processes or products via a greener orientation (Castellano et al., 2022). Scholars and academicians have identified GTI among the major strategic outcomes (or advantages) of effective GKM deployment because it enables organizations to discover technologies that contribute to energy conservation, emissions reduction, eco-product creation, and overall sustainable development (Benabdellah et al., 2021; Singh et al., 2022; Singh & El-Kassar, 2019; Yaoteng & Xin, 2021). Organizations with a GTI orientation not only gain an edge over its competitors but also improve the environment and the social well-being of all stakeholders (Pekovic & Bouziri, 2021; A. Wu & Li, 2020). In fact, GTI and GKM are equally valuable and unique resources for organizations wanting to enhance their CEP by developing novel concepts, products, or services, process methodologies, and administrative structures that address ecological issues (J. Abbas & Sağsan, 2019; Biscotti et al., 2018; Shahzad et al., 2020).

2.5 | Corporate environmental performance

When organizations compete on CEP, they often use techniques that allow them to maximize the efficiency of their resource consumption while safeguarding their interest in environmental sustainability by emphasizing pollution control and waste reduction (Nisar, Nasir, et al., 2021; M. Song et al., 2017; Zheng et al., 2020). Therefore, CEP can be considered the eventual outcome of an organization's environmentally conscious operational activities or, more precisely, the entirety of a firm's behaviors and attitudes geared toward achieving ecological balance (Rehman et al., 2021; M.-L. Song et al., 2018). Conceptually, the NRBV theory asserts that CEP represents an essential consideration for organizations wanting to enhance their reputation and increase profitability by fulfilling the conservational and ecological expectations of important stakeholders and, thus, gaining their trust (Aslam et al., 2021; Kraus et al., 2020; Vanalle et al., 2017). Hence, committing to environmentally sustainable action via continuous monitoring and periodic CEP benchmarking could assist organizations to not only galvanize members (or employees) to collaboratively address and mitigate environmental risks but also enhance organizational understanding of potential solutions and the technological configuration of functional processes (Khurshid et al., 2019; Singh et al., 2020; Yasir et al., 2020).

2.6 | Resource commitment

The notion of RC describes how management allocates an organization's tangible and intangible assets (or capabilities) to enable it to operate effectively and successfully while maintaining a viable business model for specific market segments (Joshi & Dhar, 2020; Konadu et al., 2020). Initiatives such as GKM and GTI depend on leadership commitments of technological, economic, and managerial resources. The RBV is particularly useful for understanding the role of RC, which involves a firm's decision to allocate resources to CEP-enhancing sustainability practices (Joshi & Dhar, 2020; G.-C. Wu, 2017). According to this theory, green-oriented organization should demonstrate congruence between the external market factors and the firm's indigenous behaviors, which, in many ways, depend on RC (J. A. Zhang & Walton, 2017).

3 | RESEARCH MODEL AND HYPOTHESES

Given the uniqueness of the proposed GKA construct—and in an attempt to validate its effect on GKM and GTI in translating CEP—the research model's development considered the fragmented evidence indicating probable relationships between these different constructs. Existing research suggests that GKA represents a possible precursor to both GKM and GTI (Tu & Wu, 2021; Wei & Sun, 2021). Meanwhile, papers emphasizing the link between GKM and GTI have hinted at the notion that GKM serves as a precursor to GTI (Singh et al., 2020; Singh & El-Kassar, 2019). Elsewhere, although researchers have also revealed an apparently indirect association between GKA and CEP (J. Wang et al., 2020), numerous studies have suggested that GKM and GTI directly influence CEP (Rehman et al., 2021; S. Wang & Wang, 2020). This argument builds on the notion that stronger GKA might stimulate GKM and GTI activities, perhaps yielding enhanced CEP (Belhadi et al., 2020; Cheng et al., 2021). Consistent with previous discussions predicated on the RBV (Hsieh et al., 2019; Lin et al., 2021), the proposed research model is relevant because it provides managers with practical insights to improve GKM and GTI activities using GKA mechanisms enabled by big data analytics. The proposed model employs RC as a moderator because previous studies have demonstrated that RC is crucial for the effectiveness of green manufacturing practices (Joshi & Dhar, 2020; J. A. Zhang & Walton, 2017). Figure 1 depicts the research framework, including the interactions examined by hypotheses that are thoroughly discussed in the following paragraphs.

3.1 | Hypotheses

According to Ackoff (1989), the DIKW (data, information, knowledge, and wisdom) Pyramid represents layers of conceptual constructs, each representing a progression toward a higher level, that is, from data via information and knowledge to arrive at wisdom (Ackoff, 1989; S. Wang & Wang, 2020). For example, GKA may serve as a knowledge generator for organizations that relates to environmental concerns via the mechanisms of big data analytics (Belhadi et al., 2020; Benzidia et al., 2021; J. Wang et al., 2020), with the KBV recognizing GKA as a source of strategic assets for an organization and proposing a comparable reciprocal relationship between GKA and GKM (Benabdellah et al., 2021; Biscotti et al., 2018; Z. Khan & Vorley, 2017). According to this analogy, GKA powered by big data analytics justifies applying proven methodologies and techniques to various data sources to obtain valuable green information (Benzidia et al., 2021; Nisar, Nasir, et al., 2021; M. Song et al., 2017). Thus, GKA-derived green information can guide green knowledge co-creation across various of an organization's functional departments, producing organizational wisdom for the development of innovative eco-products and eco-friendly processes (Singh & El-Kassar, 2019; Z. Khan & Vorley, 2017). Despite the scarcity of research investigating the relationship between GKA and GKM (J. Wang et al., 2020; Yusliza et al., 2020), various recent studies have demonstrated how valuable information generated from big data analytics is being used in strategic, tactical, and operational domains (Belhadi et al., 2020; Singh & El-Kassar, 2019; Nimmagadda et al., 2018; O'Connor & Kelly, 2017). This may be relevant to the current investigation's setting. For instance, according to these studies, augmenting GKA activities with big data analytics improves information visibility across inter-organizational processes and promotes knowledge synchronization. Consequently, evidence-based decisions become more efficient throughout an organization's functional divisions, fostering a trusting environment that reduces uncertainty and increases collaboration, which is favorable for GKM (Nisar, Nasir, et al., 2021; Wei & Sun, 2021; Yong et al., 2019; M. Zhou et al., 2020). Thus, the following hypothesis is proposed:

H1. GKA will have a positive effect on GKM.

Meanwhile, the business environment in which an organization operates impacts its capacity to innovate (Rehman et al., 2021). With all stakeholders putting tremendous pressure on manufacturers to adapt and embrace responsible and sustainable business practices, it is becoming more important for manufacturers to acquire green competence (Konadu et al., 2020; Pekovic & Bouziri, 2021; Tu & Wu,

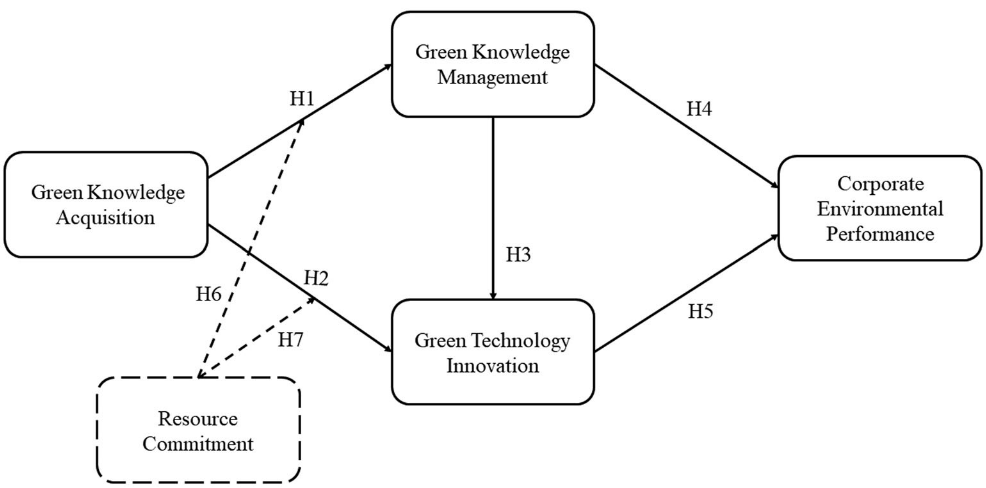

FIGURE 1 Research model

2021). The upsurge in pollution, coupled with the depletion of natural resources, has prompted government agencies in many countries and communities to advocate for GTI on a grander scale (Singh & El-Kassar, 2019). GTI synthesizes all conceivable eco-product and eco-process improvements that can reduce energy consumption, reduce emissions, and conserve resources (Huang & Li, 2017; Khurshid et al., 2019; Singh et al., 2020). However, the extant literature on different GTI accelerators features relatively few studies documenting GKA as a factor with the potential to valuably contribute to organizations developing processes and inventing products that can improve their competitiveness (Shahzad et al., 2020; Singh & El-Kassar, 2019). This calls for additional research to generalize the potential effects of GKA on GKM (J. Wang et al., 2020). Nonetheless, these studies do suggest that GKA fosters an information-driven ethos within organizations, enabling their intellectual human assets to perform environmental scanning and contribute research to achieving GTI (Begum et al., 2022; Castellano et al., 2022). For example, Shahzad et al. (2020) highlighted knowledge as a form of sustained strategic edge for organizations that are difficult to replicate and identified GKM as critical—as strategy and precursor—to an organization improving its GTI and becoming capable of finding new avenues for achieving CEP. Elsewhere, Singh and El-Kassar (2019) framed big data analytics as crucial for organizations wanting to collect green information, with systematized knowledge management of acquired information incentivizing them to be more opportunistic and experimental in pursuing innovation. These considerations are the basis for the following hypotheses:

H2. GKA will have a positive effect on GTI.

H3. GKM will have a positive effect on GTI.

Different manufacturers may have different motivations for adopting GKM and GTI (Pekovic & Bouziri, 2021; J. Zhang et al., 2020). Given both are newly emerging concepts, research is expanding, especially in the manufacturing domain, where they represent the primary method for attempting to reduce or eliminate the detrimental impact of industrial processes on the ecosystem (Kumar & Rodrigues, 2020; Vanalle et al., 2017). GKM demonstrates what employees know about their environment and their awareness of the ecosystem, allowing for collaborative responsibility for sustainable development (Riva et al., 2021). Some of the biggest GKM priorities include brainstorming and dialogue via employee engagement initiatives to facilitate the convergence of environment-related knowledge, which helps manufacturers eliminate irrelevant processes in a production set-up, decrease energy and water consumption, and reduce the release of hazardous waste into the environment (J. Abbas & Sağsan, 2019; Benabdellah et al., 2021; J. Zhang et al., 2020). The capacity for precise, comprehensive, and timely information about environmental issues serves as a propelling competency and functionality that can improve organizational performance and make manufacturers ecologically sustainable (Riva et al., 2021). GKM also ensures that an organization's unique expertise and capabilities are absorbed into strategy formulation and execution (J. Wang et al., 2020). Incorporating the interests of various stakeholders, effective GKM enables organizations to develop green products and processes (Shahzad et al., 2020). Meanwhile, considering the proposition concerning GKM's impact on GTI (J. Abbas & Sağsan, 2019; Khurshid et al., 2019), GTI represents advancement in the development of functional processes, the creation of eco-products, the deployment of eco-technologies, and the transformation of operational design with the goal of protecting the natural environment by reducing natural resource usage, waste, and pollutants (Rehman et al., 2021; Singh et al., 2020; Q. Zhang et al., 2020). Establishing pioneering GTI to enhance CEP offers firms two benefits: the commercial benefits of producing eco-friendly products and the financial rewards, which may increase competitiveness (Shahzad et al., 2020). Returning to the previous line of inquiry, existing research has highlighted the significance of studying the positive impact of GKM and GTI on CEP in the context of the manufacturing sector (J. Abbas & Sağsan, 2019; Rehman et al., 2021). However, although recently published studies have indicated a favorable connection between GTI and CEP (Abu Seman et al., 2019; Singh et al., 2022), the findings of certain older publications render this relationship ambiguous (Y.-S. Chen, 2008; Y.-S. Chen et al., 2006; Y. S. Chen & Chang, 2013). Thus, the association between GTI and CEP remains unclear, prompting the development of the following hypotheses:

H4. GKM will have a positive effect on CEP.

H5. GTI will have a positive effect on CEP.

3.2 | Resource commitment as moderator

The RBV emphasizes the importance of organizational resources (Kumar & Rodrigues, 2020), stating that the effective allocation and use of these resources help organizations to develop certain competencies, including GKM and GTI (Rehman et al., 2021; Shahzad et al., 2020), which may improve CEP. Based on the theoretical foundation of the RBV, the relationship between GKA and GKM and the relationship between GKA and GTI are contingent on RC in many ways. RC refers to either or both the allocation of existing organizational resources and the arrangement of new organizational resources for strategic purposes (Joshi & Dhar, 2020; Mao et al., 2016). Extant research has shown that allocating sufficient and greater resources to green initiatives enhances an organization's performance (Konadu et al., 2020; J. A. Zhang & Walton, 2017). However, senior management RC decisions regarding green initiatives (i.e., GKA, GKM, and GTI) are determined at a tactical level because corporate strategy is usually limited by and reliant on the organization's resource portfolio (Joshi & Dhar, 2020; G.-C. Wu, 2017). Thus, given the increasing demands of many stakeholders, manufacturers with newly developed green orientations tend to concentrate on radical GTI (Zhang et al., 2020), which demands more resources and requires more time to recover investment because radical GTI features a greater degree

TABLE 1 Constructs and items

Construct and derivation	Indicator	Measures
Green knowledge acquisition Adapted from Ashrafi et al. (2019)	GKA1	Our organization anticipates and prepares for a greener future by proactively evaluating market situations or potential offsets.
	GKA2	Our organization bases its decisions on rigorous analytical methods when it comes to sustainable environmental activities (e.g., prescriptive analytics, diagnostics analytics, descriptive analytics, predictive analytics, and cyber analytics).
	GKA3	Our company processes data from diverse sources using proprietary analytical algorithms and then aggregates and spreads valuable information across all departments and other business units.
	GKA4	We stand out in the industry because of our business intelligence and analytics.
	GKA5	Improving our big data computing and analytical capabilities in order to achieve green and sustainable objectives is a key focus for our organization.
Green knowledge management Adapted from Mao et al. (2016) and Soto-Acosta et al. (2018)	GKM1	Employees and partners at our organization have easy access to information on best-in-class environmentally friendly practices.
	GKM2	Our organization has procedures in place to gain knowledge about the environmental practices of our competitors, suppliers, clients, and strategic partners.
	GKM3	Our organization has structured mechanisms in place to exchange best practices across multiple disciplines of business operations.
	GKM4	Our organization develops initiatives (such as seminars, periodic meetings, and collaborative projects) that promote green information exchange across divisions/stakeholders.
	GKM5	Our organization actively engages in processes that apply knowledge to solve new challenges across organizational departments and beyond departmental boundaries.
Green technology innovation Adapted from Singh and El-Kassar (2019) and Huang and Li (2017)	GTI1	Our organization continuously optimizes the manufacturing and operational processes by using cleaner methods or green technologies to make savings.
	GTI2	Our organization is actively involved in the redesign and improvement of products or services in order to comply with existing environmental or regulatory requirements.
	GTI3	Our organization specializes in recycling practices to ensure that end-of-life products are recovered for reuse in new product manufacturing.

(Continues)

TABLE 1 (Continued)

Construct and derivation	Indicator	Measures
	GTI4	Our organization is rigorously involved in "eco-labeling" activities to make our clients conscious of our sustainable management practices.
	GTI5	The Research & Development team at our organization ensures that the current technical advancement is included in the development of new eco-products.
Corporate environmental performance Adapted from Huang and Li (2017) and Vanalle et al. (2017)	CEP1	Reduction of air emission
	CEP2	Reduction of waste water
	CEP3	Reduction of solid wastes
	CEP4	Decrease of consumption for hazardous/ harmful/toxic materials
	CEP5	Improve[ments] in [the] companys environmental situation
Resource commitment Adapted from Konadu et al. (2020) and Wu (2017)	RC1	Top management in our organization prepares a budget each year and set aside adequate funds to be practically dedicated to environmental management programs.
	RC2	Our organization has invested sufficient financial resources to develop knowledge and information systems to effectively engage in environmental management activities.
	RC3	Our organization has invested sufficient management resources to develop knowledge and information systems to effectively engage in environmental management activities.
	RC4	As far as environmental management practices are concerned, our organization has an appropriate investment in technological infrastructure.

of novelty and unpredictability than incremental GTI (Zhang & Walton, 2017). Thus, increasing RC accelerates the rate at which manufacturers can explore new green market opportunities by leveraging their GKA competency and develop better GTI solutions by aligning their GKM outcomes with these emerging market opportunities. Furthermore, manufacturers that are more compelled to participate in ecologically conscious activities are more likely to seek strategic alliances and collaborations to overcome market uncertainties while simultaneously ensuring substantial GTI progress (Joshi & Dhar, 2020; Singh & El-Kassar, 2019). That is, increasing RC can mean that manufacturers attract strategic business partners that have similar sustainability goals and can offer complementary competencies, knowledge, and resources across their entire manufacturing value chain (Zhang & Walton, 2017). This exploration of the extant literature, especially concerning the RBV, produced the following hypotheses:

H6. RC positively moderates the relationship between GKA and GKM.

H7. RC positively moderates the relationship between GKA and GTI.

4 | RESEARCH METHODOLOGY

This research seeks to elucidate the process by which deploying GKA influences GKM and GTI and contributes to CEP in a highly dynamic environment. The proposed research model explores the linkages and interconnections between variables, with a survey of 283 Indian manufacturers enabling empirical evaluation of that model using the partial least squares (PLS) regression-based structural equation modeling (SEM) technique. The PLS method was chosen for its ability to analyze a conceptual model of simultaneous equations representing the set of connections between variables and, consequently, estimate values that quantify these interconnections (Barroso et al., 2010; Peugh et al., 2013). The next subsections detail the methodological approach used in the present research.

4.1 | Instrument development

Based on the research model, a questionnaire for the survey component was developed to capture perceptive responses corresponding to each of the variables of concern. This development process drew on several previous studies to identify items characterizing the research model's key constructs for inclusion in the survey. A five-point Likert scale—ranging from "1 = *strongly disagree*" to "5 = *strongly agree*"—was used to evaluate each respondent's position toward each survey item. As Table 1 shows, each item was framed as a reflective construct.

Using a survey approach to evaluate proposed hypotheses required a systematic approach to developing the survey instrument (Diamantopoulos et al., 1994). The questionnaire was pre-tested for content validity by five industry experts with experience in clean technologies and environmental management. This led to the clarification of some items and the resolution of certain issues. Additionally, five academics conducting research on knowledge management and innovation management were contacted to validate the substance of the questionnaire. Their recommendations were incorporated into the final version of the survey.

4.2 | Sampling and data collection

The Indian government is attempting to increase the prominence of the manufacturing sector in the national economy, as demonstrated by the "Make in India" initiative (Pulicherla et al., 2022). This policy document constitutes a strategic manufacturing plan that has established the goal of increasing the sector's contribution to the country's GDP to 25% by 2025, up from the present level of about 16% (India Brand Equity Foundation, 2022). However, although economic development is essential, environmental issues must also be addressed. For example, the manufacturing sector should utilize energy and resources more wisely, and waste production should be reduced. With India is already among the world's top polluters in terms of greenhouse gas emissions and pressure on the Indian manufacturing sector increasing, manufacturers are frantically seeking innovative, renewable, and cleaner technologies to replace outdated, polluting technologies. To the best of the author's knowledge, only a few studies have been conducted identifying various facilitators of green practices in the Indian manufacturing sector (Joshi & Dhar, 2020). This research gap prompted this study's primary goal of testing the hypotheses proposed by the research model in the context of Indian manufacturing.

The survey's target population was manufacturing companies with ISO 14001 certificates that were listed as large firms by the Indian Ministry of Corporate Affairs. Approximately 700 large manufacturing firms in Northern and Western India were approached via various channels, and the survey was conducted using various mechanisms: in-person interviews (52 responses), telephone interviews (83 responses), mail-in questionnaires (53 responses), and online questionnaires (95 responses). The researcher approached environmental management managers working at the middle and senior levels at these firms to respond to the survey. Before proceeding with data collection, the researcher provided assurance about the confidentiality of each respondent's participation, informing them that their individual responses would not be revealed and only aggregate results would be reported. To increase the response rate, follow-up calls were made to respondents who had chosen the mail-in or online questionnaire mechanism. A total of 297 responses were received, 283 of which contained full data and were useable, indicating an effective response rate of 40.42%. Table 2 provides a comprehensive overview of the descriptive analysis of the survey participants' responses in terms of demographic factors.

4.3 | Non-response bias and common method bias

Several studies have shown that the survey approach in the domain of green practices and GKM may suffer from non-response bias (Belhadi et al., 2020; Konadu et al., 2020; Singh et al., 2020; Singh & El-Kassar, 2019). The extrapolation technique was used to determine the possibility of non-response bias and the probable disparity between early and late respondents (Armstrong & Overton, 1977). The first 120 valid responses (42.40%) received were considered early respondents, and the remaining 163 (57.60%) were classified as late respondents. Comparing the responses from the two groups (i.e., early vs. late responses) revealed no significant difference for any of the constructs, indicating that non-response bias does not represent a

TABLE 2 Demographic profile of respondents

Demographic characteristics	Frequency (%)	Demographic characteristics	Frequency (%)
Designation		***Operating sector***	
General manager	62 (21.91%)	Automotive	43 (15.19%)
Plant manager	41 (14.49%)	Electronics	79 (27.92%)
Director of operations	91 (32.16%)	Energy	34 (12.01%)
Operational-level managers	89 (31.44%)	Food and beverages	18 (6.36%)
		Petrochemical	25 (8.83%)
Ownership		Plastics	36 (12.72%)
Public	118 (41.70%)	Rubber processing	48 (16.97%)
Private	165 (58.30%)		

serious concern for the current sample. Consequently, it is reasonable to conclude that non-response bias did not impact this study's evaluation of the research model.

Meanwhile, to mitigate the possibility of common method bias (CMB), statistical techniques and remedies were adopted (Podsakoff & Organ, 1986). Harman's single-factor test, the most widely used detection technique (Islam et al., 2021; Soto-Acosta et al., 2018; J. Wang et al., 2020; J. Zhang et al., 2020; Podsakoff & Organ, 1986), was applied to all five constructs of this study's research model to detect the presence of CMB in the results. Unrotated factor solution findings using the principal axis factoring method showed that no single factor explained most of the variance and that the average variance was below 33%. Therefore, CMB was not considered a serious concern.

Exploratory factor analysis (EFA) was later conducted using principal component analysis to assess the construct reliability and validity of the research model's multiple scales (Benzidia et al., 2021; Kitsis & Chen, 2021; Zhang et al., 2020). EFA extracts the loadings of factors via varimax rotation to help researchers reveal the underlying structure of their study's construct(s) (Belhadi et al., 2020; Mao et al., 2016), with this study adopting a threshold value of 0.50 to represent the study's five latent constructs (Hair et al., 2010). The EFA results in Table 3 indicate that the factor loadings for each item of each construct (GKA, GKM, GTI, CEP, and RC) exceeded that threshold. The researcher also assessed the internal consistency (reliability) of the scales using Cronbach's α, as recommended by Hair et al. (2010). Table 3 shows that the Cronbach's α values for the five latent constructs ranged from .877 to .922, significantly exceeding the threshold value of .7 (Hair et al., 2010). The internal validity of these five latent constructs has also been established, with Kaiser–Meyer–Olkin scores ranging from 0.744 to 0.853, exceeding the threshold value of 0.6 (Hair et al., 2010). Thus, all of the research model's constructs demonstrated sufficient internal reliability and validity.

5 | RESULTS

SmartPLS software was used to perform the PLS regressions testing the research model's hypotheses. The PLS technique has many advantages. First, it is well suited to exploratory research, which is pertinent to the present study's interest in novel conceptualizations of GKA, GKM, and GTI. Consequently, the PLS technique may be a more generic model estimator than covariance-based SEM, and it is less affected by model specification inaccuracies (Barroso et al., 2010).

TABLE 3 Measurement model

Construct	Items	FL	α	KMO	CR	AVE
Green knowledge acquisition (GKA)	GKA1	0.865	.888	0.793	0.904	0.654
	GKA2	0.850				
	GKA3	0.842				
	GKA4	0.752				
	GKA5	0.728				
Green knowledge management (GKM)	GKM1	0.930	.913	0.825	0.951	0.797
	GKM2	0.908				
	GKM3	0.859				
	GKM4	0.874				
	GKM5	0.893				
Green technology innovation (GTI)	GTI1	0.891	.922	0.853	0.952	0.800
	GTI2	0.924				
	GTI3	0.899				
	GTI4	0.885				
	GTI5	0.874				
Corporate environmental performance (CEP)	CEP1	0.864	.900	0.806	0.948	0.785
	CEP2	0.897				
	CEP3	0.904				
	CEP4	0.886				
	CEP5	0.878				
Resource commitment (RC)	RC1	0.842	.877	0.744	0.918	0.736
	RC2	0.860				
	RC3	0.884				
	RC4	0.848				

Abbreviations: AVE, average variance extracted; CR, composite reliability; FL, factor loading; KMO, Kaiser–Meyer–Olkin; α, Cronbach's alpha.

Second, it is appropriate for small sample sizes, that is, samples featuring fewer than 300 cases (Hair et al., 2010). According to Carrión et al. (2017), assessing an SEM model using PLS requires fulfilling some conditions, such as identifying the nature of interactions between items and constructs, assessing construct reliability and validity, and assessing the fit of measurement and the structural model.

5.1 | Measurement model

Because the measurement scales were adapted from extant literature, confirmatory factor analysis (CFA) was used to confirm the unidimensionality of the psychometric properties of the measures (Koufteros, 1999). CFA first assesses each measure's composite reliability (CR) and convergent and discriminant validity. As Table 3 shows, CR values ranged from 0.904 to 0.952, meaning each construct's value exceeded 0.70, indicating acceptable reliability for all constructs (Barroso et al., 2010; Fornell & Larcker, 1981). Meanwhile, average variance extracted *(AVE)* ranged from 0.654 to 0.800, establishing convergent validity for all constructs based on the threshold of 0.50. Based on Fornell and Larcker (1981), discriminant validity was established because all of the of $\sqrt{AVE}$ value (diagonal values) exceeded the inter-construct correlational values (off-diagonal values) in the correlation matrix (see Table 4). Upon establishing each construct's CR and convergent and discriminant validity, CFA using the maximum likelihood estimation approach (Barroso et al., 2010) enabled linking each item to its respective construct—with freely estimated covariance—to assess the overall quality of the measurement model (Bagozzi & Yi, 1988; Barroso et al., 2010; Browne & Cudeck, 1992; L. T. Hu et al., 1992), producing the following goodness of fit indices: $CMIN/df = 2.056$, $NFI = 0.953$, $CFI = 0.978$; $GFI = 0.951$, $IFI = 0.942$, and $RMSEA = 0.033$. Thus, CFA demonstrated an acceptable model fit, allowing the subsequent development of a structural SEM model to test the study's proposed hypotheses.

5.2 | Structural model

After examining the model fit of the measurement model, the proposed hypotheses were tested. First, the structural model's fit indices ($CMIN/df = 2.409$, $NFI = 0.944$, $CFI = 0.960$; $GFI = 0.930$, $IFI = 0.915$, and $RMSEA = 0.041$) indicated an acceptable model fit. The next stage of the analysis evaluated the strength of the relationship between the research model's constructs. The findings appear in Figure 2, with Table 5 summarizing the path coefficient and the significance of associations (*t* values) between research model constructs, indicating significant relationships between constructs. As Figure 2 shows, the path analysis results (standardized) of the SEM model use the SmartPLS software's maximum likelihood method to show the statistical

TABLE 4 Discriminant validity

Construct	GKA	GKM	GTI	CEP	RC
Green knowledge acquisition (GKA)	**(0.808)**				
Green knowledge management (GKM)	0.538	**(0.892)**			
Green technology innovation (GTI)	0.414	0.369	**(0.894)**		
Corporate environmental performance (CEP)	0.233	0.187	0.512	**(0.886)**	
Resource commitment (RC)	0.202	0.176	0.499	0.378	**(0.857)**
Mean	3.221	3.367	3.182	3.253	3.398
Standard deviation	1.134	1.255	1.021	1.227	1.211

Note: Values of $\sqrt{AVE}$ (highlighted in bold and parentheses) are on the diagonal of the correlation matrix. All correlations are significant at the 99% confidence level.

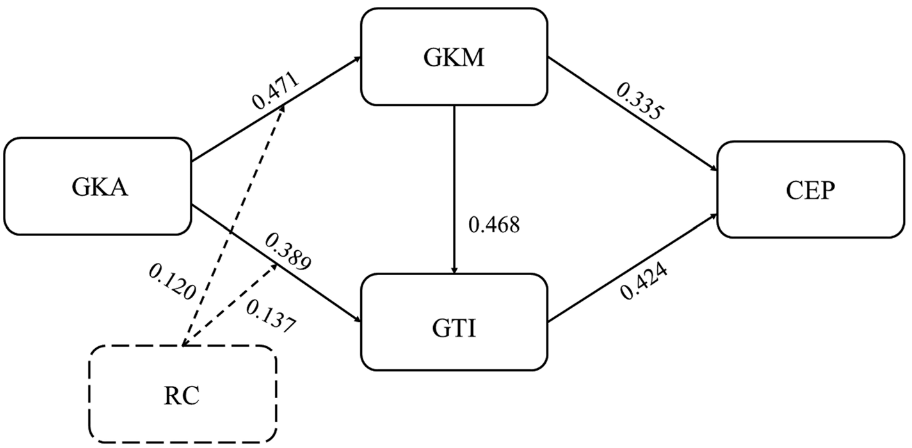

FIGURE 2 Structural estimates

significance ($p < .05$) of the direct effects of GKA on measures of GKM ($\beta = .471$, *t value* = 6.025) and GTI ($\beta = .389$, *t value* = 5.462), confirming H1 and H2. It should also be observed that GKA had a larger effect on GKM than GTI. Indeed, a manufacturing unit deploying GKA using big data analytics enhances knowledge integration across functional departments and increases green innovation potential, therefore leveraging big data analytics to enhance the decision-making processes associated with sustainability initiatives.

The findings show that GKM positively impacted GTI ($\beta = .468$, *t value* = 4.296), confirming H3 and suggesting that a manufacturer having an effective GKM process enhances its ability to innovate in terms of creating new eco-products and eco-processes. Furthermore, the direct impacts of GKM on CEP and GTI on CEP substantiate H4 and H5, with the results associated with H4 (GKM→CEP, $\beta = .335$, *t value* = 2.987) revealing that GKM efforts by manufacturers improve their CEP and the results associated with H5 (GTI→CEP, $\beta = .424$, *t value* = 5.544) showing that GTI initiatives by manufacturers similarly boost their CEP. Nonetheless, GTI apparently has a greater impact on CEP than GKM.

Additional analysis investigated whether GTI might perform a mediating role in the association between GKM and CEP. Two distinct models compared the outcomes with and without mediation (Barroso et al., 2010; Carrión et al., 2017), and examining and comparing the standardized path coefficient of the impact of GTI on CEP for the two distinct models led to the discovery of a differential effect, suggesting a partial mediating role for GTI. That is, GKM influences CEP both directly and indirectly (via GTI as mediator).

5.3 | Test of moderation

As discussed, the research model included evaluation of the moderating effect of RC on the associations between GKA and GKM and between GKA and GTI using the approach suggested by Cohen (1983) and expanded by McClelland et al. (2017). Adopting Cohen's recommendations (1983), the different measures of the independent variable (i.e., GKA) and the moderating variable (i.e., RC) were mean-centered to overcome the potential for multicollinearity (Echambadi & Hess, 2007) to impact the evaluation's outcomes (Dawson, 2014; Keith, 2014; McClelland et al., 2017). After mean-centering, the interaction (product term) was generated by multiplying each GKA factor by the RC value before conducting the moderation test in SmartPLS to confirm or reject H6 and H7. Table 5 shows the results of the moderation test, which indicate that RC significantly moderates the association between GKA and GKM (RC*GKA→GKM: $\beta = .120$, *t value* = 2.227), supporting H6. The interaction between RC and GKA similarly substantially moderates the association between GKA and GTI (RC*GKA→GTI: $\beta = .137$, *t value* = 2.091), providing statistical evidence in support of H7.

Additionally, following the methodological suggestion of Keith (2014), the effect of differential RC on the interaction between GKA and GKM and GKA and GTI activities were estimated and plotted. Figures 3 and 4 represent these using a simple slope test (Dawson, 2014) to determine whether the association (slope) between the input variable and the output variable is significant at a specific value of the control variable. Figure 3 demonstrates that the relationship between GKA and GKM is much stronger for high RC (dotted lines) than for low RC (solid line). Figure 4 similarly demonstrates the moderating effect of high and low levels of RC on the association between GKA and GTI.

6 | DISCUSSION

This research has broadened the scope of the RBV and its theoretical extensions (i.e., the KBV and the NRBV) by conceptualizing GKA and GKM to better understand decision-making in support of GTI activities. The proposed research model—premised on fragmentary evidence from previous research (J. Abbas & Sağsan, 2019; J. Wang et al., 2020)—has enabled this study to demonstrate how environmental decision-making based on big data analytics improves a firm's capacity to manage green information, enhancing the innovativeness of eco-friendly products and processes. The findings support the notion that manufacturers with technical resources and cognitive analytic capabilities can reduce the risks associated with the evolving market environment in which they operate. The conceptual inclusion of GKA, GKM, and GTI allows the research to contribute to fresh theoretical perspectives on both knowledge management and environmental management, providing useful insights for administrators and policymakers who want to promote the transformation of industrial activities away from pollution generation and toward contributing to a green economy.

TABLE 5 Path coefficient estimates

Hypotheses	Effect of (*X*)	On (*Y*)	*β* estimate	Standard error	*t* value	*p* value	Results
H1	GKA	GKM	.471	0.028	6.025	.000	Supported
H2	GKA	GTI	.389	0.019	5.462	.000	Supported
H3	GKM	GTI	.468	0.022	4.296	.000	Supported
H4	GKM	CEP	.335	0.027	2.987	.000	Supported
H5	GTI	CEP	.424	0.025	5.544	.000	Supported
H6	RC*GKA	GKM	.120	0.042	2.227	.001	Supported
H7	RC*GKA	GTI	.137	0.065	2.091	.001	Supported

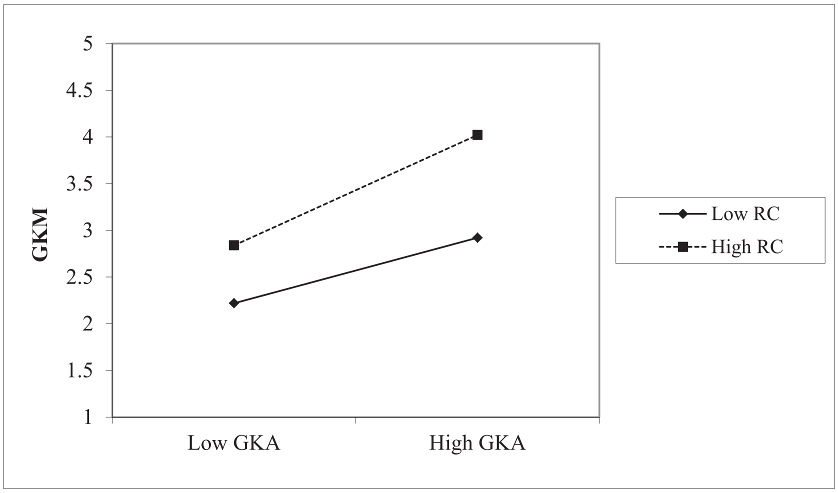

FIGURE 3 Moderating effect of resource commitment (RC) level on the relationship between green knowledge acquisition (GKA) and green knowledge management (GKM)

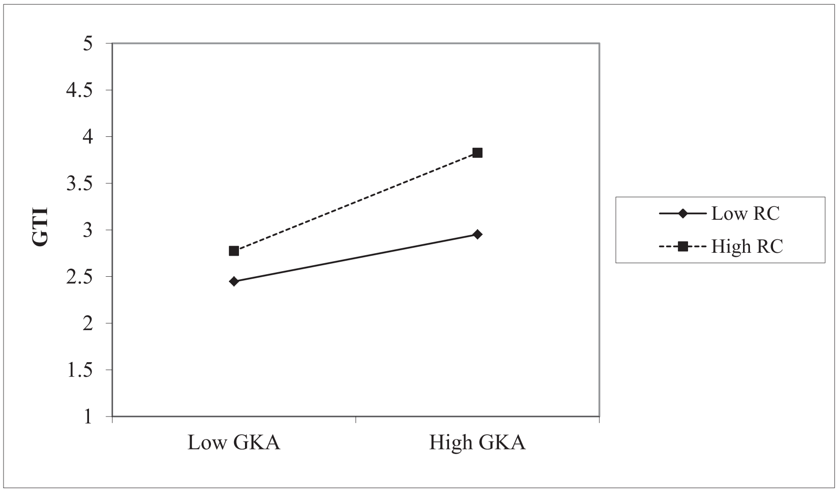

FIGURE 4 Moderating effect of resource commitment (RC) level on the relationship between green knowledge acquisition (GKA) and green technology innovation (GTI)

6.1 | Theoretical contributions

The study's findings reveal a strong positive connection between GKA and GKM (H1). These findings corroborate the assertions of many recent empirical studies, which have claimed that employing GKA enabled by big data analytics can improve collaborations between organization members with different areas of cognitive expertise to promote better decision-making (Z. Khan & Vorley, 2017; Nimmagadda et al., 2018; O'Connor & Kelly, 2017). For manufacturers to maximize the knowledge value of their environmental research, it is critical that all organization members have access to high-quality data and up-to-date information on environmental issues. This result emphasizes the potential for GKA (enabled by big data analytics) to prioritize the depth of environmental understanding that can be produced from massive volumes of data for constructive GKM via visualizing, structuring, analyzing, and modeling information that would otherwise be impossible to derive. As a corollary, the GKA-GKM strategy offers prospects for manufacturers, most of whom are ignorant about how business analytics might help them make prompt and rational decisions via the provision of valuable information and subsequent knowledge building.

Second, the study sought to investigate how analytics-enabled knowledge acquisition works to enhance a firm's innovation capability (i.e., H2), and the findings are consistent with previous research (Shahzad et al., 2020; J. Wang et al., 2020). It is clear that digital transformation has the power to disrupt conventional knowledge management frameworks and redefine GTI capabilities. GKA, via the continuous input of environmental data from linked systems, offers manufacturers constructive learning, driving change and continuous operational improvement, thereby elevating operational visibility at the CEP level. To capitalize on emerging opportunities and be successful, manufacturers should take a responsible and strategic approach to re-engineering organizational processes, fostering participatory design thinking, and integrating technology across functional units. Furthermore, a rich culture of data-driven decision-making is crucial to reap the benefits of ever-increasing intrinsic and extrinsic data sources and reshape how organizations interact with their customers, employees, and other stakeholders in the value-chain ecosystem. Therefore, GKA in a manufacturing set-up represents an intangible asset that must be developed to improve GKM capacity, reducing the environmental complexities associated with GTI activity. This notion is supported by the results associated with H3, which are consistent with the theoretical conjecture that effectively deploying GKM favorably impacts a manufacturer's GTI capabilities (J. Abbas & Sağsan, 2019; M. Zhou et al., 2020). Thus, the present investigation makes the novel contribution of considering the environmental aspects associated with the impact of GKA on GKM as a cognitive resource and a generative antecedent to the organizational synthesis of GTI.

Third, the confirmation of H4 recognizes that GKM has a substantial direct impact on CEP and a considerable indirect effect through GTI. This suggests that manufacturers with a strong GKM orientation strengthen their GTI capabilities to enhance their CEP. This finding corroborates previous findings (Shahzad et al., 2020) suggesting that GKM acts as a precursor to GTI and, consequently, a stimulator of CEP via the creation of eco-products and eco-processes. One possible explanation is that such firms have a cognitive attitude centered on self-reinforcing learning toward the development of new environmental knowledge that can readily foster GTI. The significance of progressive GTI for enhancing CEP is also demonstrated by the results associated with H5, which are also consistent with the findings of prior studies (Khurshid et al., 2019; Kraus et al., 2020; Singh et al., 2020). As a corollary, it is possible to infer that GTI operates as a stimulant for firms to invest in more sophisticated technologies, eco-friendly products, and sustainability-focused processes that enable them to become more environmentally responsible, supporting them in improving their CEP. This research thereby contributes to a growing body of knowledge by introducing a novel interpretive framework—via the use of GKA and GKM—that transcends the direct relationship between GTI and CEP and more accurately reflects contemporary complexities. Thus, in recognizing that GKM and GTI impact the influence of GKA on CEP, these findings constitute a significant contribution to the literature.

Finally, the research illuminates RC's role as a moderator in GKM and GTI processes. The findings associated with H6 and H7 are consistent with the findings of several recent studies on the implementation of green manufacturing practices (Joshi & Dhar, 2020; Konadu et al., 2020; J. A. Zhang & Walton, 2017), studies emphasizing RC's important role in empowering manufacturers to explore the best strategies for operating and innovating and ultimately adopt proactive policies designed to preserve the natural environment. However, manufacturers cannot rely solely on accurate data and metadata and effective information refining. They must also utilize GKM to strengthen teamwork and coordination between all members of the value-chain ecosystem to foster the co-construction of common ideas and innovations for eco-friendly initiatives. Accordingly, this study's findings suggest that a firm's GKA significantly enhances both GKM and GTI practices when RC is greater. Manufacturers, in particular, can benefit from allocating more budgetary, technological, and administrative resources to GKA to improve the efficacy of GKM and GTI strategies. These findings are especially significant as a theoretical contribution to the literature on the RBV toward establishing a conceptual generalization of the moderating role of RC and as a pragmatic message for managers who should closely attend to RC in the context of their sustainable-development-driven activities. This discussion section has effectively addressed the primary research objective (presented in this paper's introduction section) and demonstrated an in-depth understanding of the results in a manufacturing context.

6.2 | Managerial implications

This study's findings suggest various implications for administrators and managing decision-makers from the manufacturing sector. First, decision-makers can leverage their existent technical capability with big data analytics to create a proactive environmental management system that spans the entire manufacturing value chain (Biscotti et al., 2018; Frondel et al., 2008). Sustainability reporting is bolstered by a firm's use of its GKA capability, which can act upon new assessments and metrics to provide managers with immediate access to fresh data, allowing the responsive development and implementation of new green strategies (Tiscini et al., 2022). In the pursuit of green policies and ideologies, managers at manufacturing companies can greatly benefit from this advance.

Second, given the diverse topologies associated with manufacturing operations and the (frequent) lack of expertise in environmental practices, this paper's findings recommend that managers invest in cutting-edge information technology infrastructure to accommodate the effectiveness of GKM and GTI activities (Mao et al., 2016; Soto-Acosta et al., 2018). This investment may be advantageous if it aligns with a manufacturer's strategic "mission and vision" declarations, which are clearly transitioning to an interconnected administration paradigm. To effectively utilize the green data gathered, administrators in manufacturing contexts should consider synchronizing all of the organization's technological resources, that is, achieving interoperability (Benzidia et al., 2021; Nimmagadda et al., 2018). Furthermore, manufacturers are urged to increase operational vigilance to shield the confidential information and knowledge assets associated with the organization.

Anecdotal evidence suggests that the deployment of GKM and GTI activities appears extremely helpful for manufacturers wanting to foster a collaborative green orientation across diverse organizational teams and their ecosystem of business associates (Y. Abbas et al., 2022; Del Río Castro et al., 2021). Given the large number of participants in manufacturing settings, GKM enables effective communication about an organization's green interests and attitude, which should improve management of GTI activities focused on incorporating an environmental perspective into design and operations. Green projects have the greatest influence when they are undertaken as a collective effort (Benabdellah et al., 2021; Papa et al., 2021). Therefore, managers are urged to facilitate corporate discussions or periodic meetings to practice making their organizations greener, assess the environmental impact, and identify areas for improvement. This would empower administrators to set realistic goals for green programs, track progress toward those goals, and celebrate achievement. These incremental successes may increase the awareness and credibility of an organization's green initiatives, encouraging more stakeholders to join the green revolution by taking action to preserve the environment.

In practice, manufacturing firms that incorporate green principles into their corporate market orientation must attempt to spend proportionately on GKM activities, and even greater expenditures may be required for GTI activities (Adomako et al., 2022). The results of this analysis have contributed to the realization that it is insufficient to merely adopt a green perspective as a strategic market direction. Instead, it is also necessary to create the social capabilities for the organization to translate these concepts into effective technological innovation (Huang & Li, 2017; Singh et al., 2020). Given this study's finding that the effect of GKM and GTI on firm CEP is moderated by GKA and RC, manufacturing organizations should invest in technologies that improve GKA functioning, with higher levels of RC increasing the benefits. Having the right information is crucial to successful GKM (Ashrafi et al., 2019), which eventually promotes GTI (Singh & El-Kassar, 2019), which, in turn, improves a firm's CEP. GKA keep businesses up-to-date on changing customer demands, enabling them to create new solutions that both fulfill those needs (particularly those of green consumers) and meet regulatory obligations.

In a competitive landscape, where manufacturers are under great pressure to deliver eco-friendly, technically complex goods and services with limited financing, resources must be effectively deployed and focused on the highest priorities at all times (G.-C. Wu, 2017). However, managers should not misinterpret these implications; it is imperative to recognize that high levels of resource utilization do not necessarily imply effective resource management. The results associated with the visualizations presented in Figures 3 and 4 demonstrate that administrators (or decision-makers) should adopt an incremental approach, with the key being ensuring that organizational resources are used for projects that align with strategic priorities, fit core competencies, and match the firm's capacity. As a first step to achieving this, administrators should establish a resource management system that captures various parameters, including human capital skill sets, process capacity, market demand, resource utilization rate, project progress, and time monitoring. Subsequently, following the logic of continuous improvement, short-term targets should be established, and progress toward achieving operational objectives should be prioritized. Any problems faced during this stage should also be articulated. More concretely, senior leadership must (1) prioritize high-value activity in accordance with available resource capacity to maximize resource usage, (2) ensure that the strategic objectives are supported by the relevant resources, and (3) ensure that actual progress can be tracked and monitored, particularly when applying time tracking. Periodic comparison of planned progression with actual progression is needed to improve estimations and better understand where an organization's resources are really being used. When a planned short-term target is met, senior managers should prepare for the next phase—which should have a bigger strategic goal than the previous phase—and motivate human capital by emphasizing the strategy for continuous improvement and rewarding those who exceed expectations. Imbibing a culture of continuous improvement by incrementally and appropriately allocating resources can undoubtedly improve the ability of GKA to influence GKM and GTI by accruing improvements via successfully reaching short-term targets and ultimately enabling manufacturers to achieve the long-term strategic goal of improving CEP. Based on these recommendations, this research strongly supports the functional adoption of a proactive environmental management system combined with a resource management system to fulfill strategic goals related to GKM and GTI programs (Andersén, 2021; Farrukh et al., 2022; Nisar, Haider, et al., 2021). This could be established as a new department inside an organization—alongside other essential departments (i.e., human resources, marketing, operations, and finance)—to ensure the accountability and sustainability of the proposed model for establishing proactive green orientation.

Finally, in the face of regulatory pressures, administrators are acutely aware of the need to mobilize all funds and resources to convert incumbent manufacturing strategies into approaches suited to an environmentally sustainable paradigm (Joshi & Dhar, 2020; J. A. Zhang & Walton, 2017). In this context, it is becoming increasingly necessary to integrate environmental consciousness into a workforce's cognitive behaviors and deliver strategic initiatives within organizations (Biscotti et al., 2018; Konadu et al., 2020). Thus, administrators should seize this opportunity to strengthen corporate ethos via mechanisms (e.g., green training, green quality circles, and green walls of accomplishment) designed to help them realize an ambitious environmental agenda.

7 | CONCLUSION

The present investigation represents the first academic attempt within the knowledge management domain to use RBV theory to highlight the multifaceted relationship between various green strategies adopted by manufacturers to enhance CEP. With the exception of a few conceptual studies or studies pertaining to environmental management research, this study is unique and contributes to the growing literature on the impact of GKA enabled by big data analytics on CEP. This research has investigated the multifaceted interaction between GKA, GKM, GTI, RC, and CEP using theorizations of the KBV and the NRBV, theoretical extensions of the RBV. The two research questions posed in the paper's introduction have been adequately addressed. Regarding the first, in the manufacturing world, GKA enabled by big data analytics represents the vanguard, having the potential to strengthen both GKM and GTI. Introducing big data analytics enables manufacturers to handle massive amounts of data, which clearly aligns with their strategic objectives by allowing operations to focus on the environment-related search for hidden patterns, correlations, and other insights. This can be converted into successful GKM and GTI. The operative role of GKM in enhancing GTI was explored, allowing the clarification of the mediating role of GTI in the realization of CEP. Meanwhile, regarding the second research question, GKA was observed to substantially impact both GKM and GTI when RC was greater, a finding that is relevant for Indian manufacturers. Consequently, it can be inferred that green-oriented manufacturers with higher levels of RC might outperform their competitors.

This investigation features several limitations mainly caused by time and budgetary constraints. These are highlighted to facilitate the work of scholars in conducting follow-up research. First, because this is a cross-sectional survey, establishing a causal relationship between the variables in the research that utilize implementation period as a dimensional parameter of inquiry is challenging. Future research might explore determining how the interactions between GKA, GKM, GTI, and CEP influence each other over time to provide more definitive answers. Second, survey responses were specifically collected from employees working in ISO-certified Indian manufacturing firms to demonstrate the importance of green-oriented knowledge management practices and innovations with the potential to minimize environmental impact. Because all respondents were employed at an ISO-certified organization, it was assumed that they all had a comparable level of understanding of the questions or items included in the survey instrument. When the responses were evaluated in terms of early and late responses, no significant differences were found. Despite the fact that this study also provides a roadmap for non-ISO-certified manufacturers, future research could include such organizations to provide different perspectives. Third, future research should consider the degree to which environmental dynamism (i.e., the rate of change in an environment) affects the hypothesized connection between knowledge acquisition activities and green manufacturing practices.

CONFLICT OF INTEREST

There is no conflict of interest among authors.

ORCID

Saumyaranjan Sahoo https://orcid.org/0000-0003-3609-2448
Anil Kumar https://orcid.org/0000-0002-1691-0098
Arvind Upadhyay https://orcid.org/0000-0002-6906-5369

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