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# Driving green digital innovation in higher education: the influence of leadership and dynamic capabilities on cultivating a green digital mindset and knowledge sharing for sustainable practices

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## Abstract

**Purpose** The new generation loves to interact with digital technologies. On the other hand, due to the soaring digital innovation trends, sustainability is crucial in higher educational institutes (HEI), necessitating investigating the factors that lead to green innovations. Therefore, drawing on the Stimulus-organism-response approach (SOR) and dynamic capability view, the current study examines the intricate relationship between digital leadership, dynamic capability, knowledge sharing, green digital mindset and green digital innovation in higher education settings.

**Methods** This research utilized the three-wave (T1 = digital leadership, dynamic capability, T2 knowledge sharing, green digital mindset, T3 = green digital innovation) research approach to collect the data in a one-month time lag from the top management of universities working in China. At T3, 425 filled questionnaires were received, which were utilized for the final data analysis. SmartPLS 4.0 was employed for data analysis.

**Results** The results present mixed findings, as digital leadership was an insignificant predictor of green digital innovation. However, Dynamic capability and knowledge sharing underscore the crucial role of both as predictors to foster green digital innovation in Chinese universities. Furthermore, the study reveals the significant mediating role of knowledge sharing between digital leadership, dynamic capability and green digital innovation.

**Conclusion** This study postulates that knowledge sharing and green digital innovation will be stronger in the presence of a green digital mindset in Higher education institutions. HEIs should ensure a dynamic culture that adapts technology and sustainability principles to remain at the forefront of digital and green innovation.

**Keywords** Green digital innovation, Green digital mindset, Digital leadership, Knowledge sharing, Dynamic capabilities, Higher education

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## Introduction

The rapid advancement of digital technology and the increasing apprehension over environmental concerns have compelled firms to include sustainability in their innovation plans [1, 2]. In this framework, institutions of higher education assume a significant role. They foster innovation that is congruent with sustainability objectives. The increasing significance of tackling environmental sustainability challenges has prompted the implementation of green action techniques in distinctive manners throughout several sectors, including higher education [3]. While digital innovation focuses on technological breakthroughs to improve efficiency and competitiveness, Green Digital Innovation (GDI) extends this by integrating environmental goals into the innovation process [4]. GDI leverages digital technology. Moreover, it guarantees that these distinctive attributes facilitate environmental conservation, optimal resource use, and decreased carbon emissions.

This research enhances the literature on digital uniqueness by examining the attributes of GDI within higher education. Unlike other digital sectors, GDI anticipates that institutions will reconcile technological advancement with sustainability goals, presenting distinct difficulties and possibilities [5]. Nevertheless, the effective implementation of Green Digital Innovation (GDI) requires more than only the use of technology. The increasing significance of tackling environmental sustainability challenges has prompted the implementation of green action techniques in distinctive manners throughout several sectors, including higher education [3, 6]. While digital innovation focuses on technological breakthroughs to improve efficiency and competitiveness, Green Digital Innovation (GDI) extends this by integrating environmental goals into the innovation process. GDI leverages digital technology. Moreover, it guarantees that these distinctive attributes facilitate environmental conservation, optimal resource use, and decreased carbon emissions [7]. This study investigates the influence of Digital Leadership (DL) and Dynamic Capabilities (DC), including Knowledge Sharing (KS) as an intervening variable and Green Digital Mindset (GDM) as a moderating factor. To comprehend how leadership and organizational competencies foster sustainable innovation.

This research enhances the literature on digital uniqueness by examining the attributes of GDI within higher education. Unlike other digital sectors, GDI anticipates that institutions will reconcile technological advancement with sustainability goals, presenting distinct difficulties and possibilities [8]. This study investigates the influence of Digital Leadership (DL) and Dynamic Capabilities (DC), including Knowledge Sharing (KS) as an intervening variable and Green Digital Mindset (GDM) as a moderating factor. To comprehend how leadership and organizational competencies foster sustainable innovation. However, there is also a need for leadership and organizational competencies that promote information exchange and foster a mentality favorable to sustainability [7, 9]. Digitization is transforming the global world into a technology-driven village, transforming it from a conventional global village/ world due to the emergence of digital technology (DT). DT refers to unique technologies such as artificial intelligence, the Internet of Things, and big data analytics derived from new infrastructures like 5G and data centers [10]. As a foundation of innovation in diverse fields, DT capitalizes on data algorithms and logics to facilitate organizational operations and enhance better decision-making to gain a competitive advantage [11]. Due to the soaring trends of digital innovation, sustainability is crucial in organizations for environmental preservation [12]. Green digital innovation has diverse positive impacts on organizational functions. It saves the environment and improves environmental performance, leading to greater economic value for organizations and a livable human society [12, 13] in developed and developing economies like China.

China has entered a new digital era. Therefore, it is transforming towards digitization that impacts the economy and brings digital innovation based on sustainability principles [14]. China has participated well in the global sustainability movement by lowering carbon emission projects [15]. China has gained a prominent position in global work concerning its economic growth, sustainability initiatives and innovation, based on five core pillars of green development: innovation, openness, sharing and coordination [14]. Chinese society is embracing technology so rapidly that the share of digitized output is increasing daily, becoming a profound base for regional development concerning green digital innovation and a better digital economy [15]. Thus, three primary reasons exist for concentrating on Chinese higher education institutions. China has emerged as a worldwide leader in digital transformation, yet the integration of sustainability into digital innovation within higher education remains inadequately explored [16]. dedication to advancing education and attaining carbon neutrality creates a distinctive atmosphere. To investigate the influence of policy-driven sustainability objectives on organizational behaviors. The industry has problems like resource scarcity, antiquated processes, and unsustainable leadership approaches, which impede the implementation of Green Digital Innovation (GDI). These problems underscore the need for a comprehensive framework encompassing leadership and capacity development to mitigate these obstacles effectively.

On the one hand, the economy based on digitization improves resource allocation as it utilises modern technology and methods and curtails environmental pollution

by reducing CO2 emissions. On the other hand, innovation, competence, and low innovation costs are exquisite benefits of the digital economy, ultimately mitigating environmental problems [17]. Considering the above discussion, green digital innovation became a key area for diverse fields in China, including higher education institutions, for better environmental performance [18]. Therefore, green digital innovation systems in universities must adopt digital technologies that act as two-edged swords that should harness innovation and preserve the natural environment [13]. Thus, harnessing green digital innovation in universities has become crucial in the management and innovation literature [18]. These days, digital technology is widely employed in modern economic operations, boosting productivity, accelerating economic structure change, and contributing significantly to the global economy's recovery [19]. Examining the effects of leadership and other organizational traits is crucial for green digital innovation research. For our reference, the literature is abundant on green digital innovation; however, most studies focus on green technology or process innovation issues, largely ignoring the perspective of leadership and dynamic capacities, especially in the context of Chinese higher education [20]. The study investigates the influence of digital leadership (DL) and dynamic competencies (DC) inside higher education institutions in China. It integrates Knowledge Sharing (KS) as an intervention component and Green Digital Mindset (GDM) as a moderating factor. The study seeks to elucidate how leadership and organizational competencies might augment creativity for green digital innovation in China.

Consequently, HEIs are now more focused on digital leadership due to advancements in communication and technology [21]. University leaders must possess a strong foundation in technology and related professional competencies. Therefore, in the age of digital education, digital leadership is essential [22]. Since the present age loves to interact with technology, digital leaders should be familiar with globalization [23]. According to McLeod and Lehmann (2012), in order to create digital classrooms and hands-on learning activities and maintain innovations in their schools, leaders must possess the necessary knowledge and abilities. Research on leadership has changed quickly in the twenty-first century [21].

Previous studies have documented a correlation between digital leadership and innovation at the individual level. These studies have particularly investigated how individual factors such as self-efficacy [24], psychological empowerment [25] and intrinsic motivation [26] moderate and mediate this relationship. Nevertheless, a meta-analysis carried out by Lin, Zhang [27] revealed a lack of adequate data about the specific mechanisms via which digital leadership impacts green digital innovation at the organisational level, namely at higher education institutions (HEIs).

Thus [27], proposed the need for more investigation to analyse the specific mechanisms accountable for this phenomenon thoroughly. The primary objective of this study is to address the current research void by investigating the mediating function of information sharing. This study aims to analyze the impact of digital leadership and capitalism on green digital innovation. Knowledge sharing has been widely acknowledged as substantially impacting innovation [28]. While prior research has highlighted the significance of knowledge sharing in enabling the incorporation of various leadership styles into innovation [29], the mediating role of knowledge sharing in the relationship between digital leadership and digital transformations (DCs) has been neglected in the particular context of Chinese higher education institutions. Thus, the primary objective of this paper is: "In what ways do digital leadership and dynamic capabilities affect green digital innovation within higher education institutions, and what is the significance of knowledge exchange and a green digital mindset in this context?"

This study contributes to the literature in three primary domains:

- Understanding the relationship between leadership and green digital innovation: To examine the interaction between DL and DC in promoting GDI.
- Emphasizing knowledge sharing as a pivotal mediator: To examine how knowledge sharing, as a dynamic skill, converts leadership and talent into green digital innovation.
- Understanding the green digital mindset as a moderator: Understanding the circumstances that optimize the efficacy of KS in augmenting GDI, particularly with environmental problems.

According to the systematic review undertaken by Harms [30], only a limited amount of research has employed a contingency approach to examine the mechanism of the relationship between digital leadership, digital corporate culture, knowledge sharing, and innovation. Expanding on the above exposition, the notion might be defined as the interrelation among these variables. The primary objective of this study is to comprehensively examine the moderating impact of the green digital mentality on the connection within the context of Chinese higher education. A green digital mentality among employees pertains to their cognitive attitudes, beliefs, and values towards using digital technology to advance environmental sustainability [31]. The cultivation of digital awareness, expertise and promotion of ecological impacts of digital technology among employees are fundamental elements of the green digital mindset [23]. Therefore, this

study examines the mediating role of knowledge sharing between digital leadership, DCs and digital green innovation in higher education settings with the moderating role of digital green mindfulness. This research offers many significant contributions to the domain of digital innovation. It enriches the digital innovation literature by distinguishing Green Digital Innovation (GDI) from conventional digital innovation, augmenting the theoretical comprehension of how sustainability goals transform innovation processes. It emphasizes the essential role of Digital Leadership and Dynamic Capabilities in fostering sustainability-oriented innovation, offering practical guidance for organizational advancement. Based on empirical data from Chinese higher education, the paper elucidates how distinct sector-specific difficulties, including resource constraints and policy-driven expectations, affect GDI adoption. Furthermore, the study enhances theoretical understanding by examining the functions of Knowledge Sharing and Green Digital Mindset as essential mediating and moderating variables, respectively. This research enhances the academic dialogue on sustainability-oriented innovation and provides practical advice for higher education institutions undergoing digital transformation in a swiftly evolving environmental and technical context.

The research employs both the Stimulus-Organism-Response (SOR) framework and the Dynamic Capabilities Theory. Thus, that the motivations and processes of green digital innovation in higher education institutions are well understood. The SOR framework provides a psychological and behavioral approach [32], with digital leadership and dynamic capacities serving as stimuli, affecting the interventional process of knowledge sharing, and ultimately leading to green digital innovation as the solution. This framework encapsulates the conceptual and behavioral processes by which leadership and organizational resources affect innovative outcomes.

The Dynamic Capabilities Theory enhances the SOR framework because it emphasizes strategic gradient and resource reorientation to develop distinctiveness in a continually changing context. This theory explains how businesses discover opportunities, deploy resources, and reorganize capabilities to successfully react to sustainability concerns. Using these ideas, the research connects micro-level behavioral processes of people to macro-level strategic activities of companies. The combination of SOR with Dynamic Capabilities Theory is novel and crucial. While the SOR framework has generally been used to analyze individual or group behavior, it is seldom applied to organizational processes. The Dynamic Capabilities Theory bridges this gap. Because it connects these attitudes to strategic organizational results, it gives a two-pronged explanation for the rise of green digital innovation. This innovation stems from the fact that it provides a comprehensive approach to understanding long-term uniqueness by integrating psychological factors (such as knowledge sharing) with organizational methods.

#### Theoretical contributions

This integration adds to existing literature because it fills significant gaps in the research of digital innovation and sustainability. First, it defines the relationship between leadership and capabilities as important drivers. So as to encourage knowledge sharing behavior, which improves green digital innovation. Second, it offers a novel theoretical viewpoint for investigating the persistent innovation of higher education institutions, which is an understudied study area. Third, it highlights the need of coordinating individual behavior with corporate strategy. To tackle modern issues including sustainability and digital transformation.

## Literature review and hypothesis development

### Theoretical background

The "Stimulus-organism-response approach" (SOR) illustrated that individual behavioral and thinking patterns are dependent on external stimuli as they shape them [33]. According to the paradigm, stimuli such as digital leadership can affect employees' perceptions and attitudes, specifically, their knowledge sharing, affecting their behavioral responses [23]. These responses are influenced by their cognitive inclination, such as a green digital mindset. The objective of the digital leadership strategy is to encourage sustainable environmental practices by utilizing digital technologies [34]. Accepting and implementing technology-driven interventions and policies act as an external stimulus. This phenomenon impacts the internal organizational contexts of employees, including their attitudes and perspectives on green digital innovation [35]. Therefore, it affects people's readiness to embrace modern technologies to preserve the ecosystem [23]. The SOR methodology is the analytical foundation for understanding the relationships between digital leadership, knowledge sharing, green digital mindset, and green digital innovation. This methodology provides a solid foundation to highlight how the factors being studied together contribute to advancing sustainable practices and attaining environmentally friendly outcomes. The Stimulus-Organism-Response framework is well acknowledged for its adaptability in many research settings, and its use in research offers a novel method for investigating the link between digital distinctiveness and sustainability in higher education institutions. Although widely used, the Stimulus-Organism-Response Framework formulation approach is ideal for examining how external stimuli like Digital Leadership and Dynamic Capabilities influence internal organizational processes like Knowledge Sharing. So that outcomes such as green

digital innovation may be realized. Its new role in this context is to solve the unique issues that higher education institutions face, such as inadequate digital infrastructure, opposition to change, and merging sustainability aims with pedagogical priorities. Furthermore, this study broadens the Stimulus-Organism-Response framework by include the Green Digital Mindset as a moderator, clarifying the circumstances under which internal processes efficiently lead to green digital uniqueness. This study applies the Stimulus-Organism-Response framework to the understudied context of China's higher education institutions, providing evidence in the literature on how this framework can understand the complexities of digital uniqueness in a sustainability-focused educational environment, as well as theoretical and practical implications.

#### Dynamic capability view

Dynamic Capabilities Theory provides a fundamental framework. Understanding how organizations adapt, integrate, and rearrange resources in a dynamic environment. DCT explains how higher education institutions may manage the simultaneous constraints of digital transformation and sustainability objectives. The importance of dynamic capacities in supporting innovation has been extensively investigated in research; nevertheless, its application to sustainability-driven digital innovation, especially green digital innovation (GDI), remains underexplored. This divide is especially noticeable in higher education institutions, where synergy between technological advancements and environmental goals is critical for practical implementation. Organizational dynamic skills pertain to the ability of businesses to adjust to evolving circumstances and precisely recognize and restructure their competencies and unique resources in order to maintain their competitive success. DCs, as defined by [36], refer to the capacities of a company to integrate, cultivate, and adjust internal and external capabilities to react to rapidly evolving environments efficiently. This may be accomplished via restructuring routines, procedures, operations, and governance, among other elements [37]. Within the domain of services and Higher Education Institutions (HEIs), the capacity to perceive allows businesses to recognize and understand possible areas for providing services, as well as any shortcomings in their capabilities. Skills of this nature may include active participation in training sessions and conferences, meticulous examination of example methodologies, and so forth.

The ability to seize allows for the precise definition of a business model that combines service delivery skills to efficiently solve the organization's shortcomings, particularly to improve quality capabilities. Exemplary instances of these capacities include augmenting services according to student feedback and adopting optimal methodologies. The reconfiguration includes the functional execution of new programs [38]. Colleges must develop strategies to ensure effective management in unpredictable circumstances, considering competition and current management practices. Present circumstances require competent leadership and strategic planning to maintain evolutionary adaptability by making modifications that bolster its competitive advantage and improve its long-term financial performance.

#### Digital leadership and green digital innovation

Leadership in the digital sphere is essential for green digital innovation. According to [21], digital leadership guides an organization's digital transformation following its strategic plan, including fostering sustainability. CEOs are likely to promote green innovation by offering a vision that aligns with environmental goals and the technology necessary to realize the vision. CEOs have an ecological and people-oriented management orientation [39]. Several academics suggest that green digital innovation is the result of digital leadership [21]. Researchers found that executives who are well-versed in digital technologies and sustainability concepts are well-positioned to accept cutting-edge, environmentally friendly solutions [15]. Digital leadership as a method that guarantees the strategic achievement of digitalization for the company and its organizational environment.

Nevertheless, the environmental milieu for organizations is very unpredictable, uncertain, intricate, and unclear for generating rapid (re)actions [18]. Organizational culture and innovation are significantly influenced by digital leadership. SOR theory posits that digital leadership functions as an external driver (S) that facilitates the integration of digital technologies into sustainable practices and encourages strategic thinking. (O), which ultimately results in ecological digital innovation Additionally, DCT recommends that executives who possess strong dynamic abilities should recognize and capitalize on digital opportunities, while simultaneously redirecting organizational resources toward green innovation [40]. Nevertheless, innovation cannot be achieved through leadership alone; it necessitates the effective application of knowledge and skills. The present research emphasizes the importance of digital leadership in promoting institution innovation. Leaders have a significant influence on this. For example, determining strategic direction, developing a collaborative atmosphere, and exploiting digital technologies. Although there is an increasing focus on digital leadership, it is unclear how it relates to dynamic capabilities. To allow Green Digital Innovation. In most theoretical research, digital leadership and dynamic skills are seen as distinct contributors to innovation, with little consideration given to their combined influence on

attaining sustainability-driven results. Thus, based on the above discussion, following hypothesis is drawn:

**H1** Digital leadership is positively related to green digital innovation.

#### Dynamic capabilities and green digital innovation

Dynamic capabilities refer to the firm's capacity to adapt, integrate, and reconfigure internal and external resources and competencies to respond to the rapidly changing environment. Generally, the essential elements of dynamic capacities are identifying potential advantages and risks, capitalizing on opportunities, and reorganizing resources to maintain competitiveness. During innovation processes, firms face significant obstacles in efficiently obtaining and controlling dynamic skills [31].

According to [37], an organization's dynamic capabilities refer to its capacity to plan and adjust its resource allocation based on changing circumstances. In the sense that companies with dynamic capabilities may use digital innovations to achieve sustainable organizational transformation, this is connected to green digital innovation. For example, the likelihood of achieving sustainability objectives is highly dependent on an organization's capacity to adopt and incorporate green innovations into its technologies and procedures. Businesses with strong dynamic capabilities are better positioned to take advantage of novel concepts and methods and cutting-edge technology and practices, such as sustainable practices [41]. Nevertheless, acquiring these cognitive abilities can be intricate, as they often exhibit internal complexity and reliance on certain pathways, leading to intricate cause-and-effect relationships. The capacity of DCs to provide competitive advantages and cultivate a climate conducive to innovation is well-documented. Within the complexities of a rapidly changing environment, organizations can employ digital transformations to facilitate environmentally sustainable innovation. By assimilating, exchanging, and adapting resources, firms and their collaborators can develop tailored products or services that precisely cater to the individual requirements of clients. Sustainable innovation necessitates dynamic capabilities, including the capacity to detect environmental changes, capitalize on opportunities, and modify resources. In the green digital landscape, companies that continuously innovate and reorient their strategies are able to evolve, as their dynamic capabilities are strengthened, according to DCT [42]. SOR theory similarly asserts that the extent of green digital innovation of an organization is contingent upon its capacity to respond to external stimuli, such as regulation and market pressure. This is particularly pertinent in green development in manufacturing facilities, where the primary emphasis is on the development and enhancement of green distributed capabilities (DCs). Green DCs are measures of a company's ability to improve and cultivate environmentally sustainable organizational capabilities by utilizing existing resources and skills to respond to market changes effectively. The concept of green DCs has gained paramount significance in green innovation due to market shocks in business operations. The present viewpoint posits that a direct relationship exists between dynamic capability and green digital innovation through establishing a comprehensive framework that integrates green technology and green process innovation. Thus, the relevant hypothesis is derived below:

**H2** Dynamic Capabilities are positively related to green digital innovation.

#### Digital leadership and knowledge sharing

Current literature in knowledge management and technology highlights that Knowledge sharing is affected by digital leadership in today's dynamic environment. Knowledge sharing is encouraged in firms by managers who support the culture [43]. Both innovation and the successful use of digital technology depend on this facilitation. Previously, scholars in knowledge management have shown a correlation between digital leadership and knowledge-sharing performance. Effective leadership often directs employees to conform to and cultivate viewpoints that will enhance their organizational contributions [44]. Leaders play a crucial role in knowledge-sharing management inside an organization. Digital leadership creates a favorable atmosphere for the online sharing of knowledge and a plethora of technology-facilitated tools. Digital leadership, often characterized by the use of advanced technological tools such as artificial intelligence and big data analytics, is often seen as an inspiring approach that impacts followers' favorable attitudes and personal growth [44]. A common perception of digital leadership is that it serves as a structure for including employees in the decision-making process, fostering innovation and implementing changes [45]. Digital leadership encourages a culture of knowledge sharing, which promotes cooperation and information interchange. According to SOR theory, leadership operates as an external stimulus (S) that impacts workers' perceptual and behavioral reactions (O) while also promoting a knowledge-sharing culture (R). Furthermore, DCT reveals that dynamic leaders create learning settings [46] that facilitate the successful transfer and application of information. An effective leader is essential for creating a conducive work atmosphere, as many jobs are collaborative and require teamwork. Digital leadership may be seen in the SOR framework as an antecedent that positively encourages organizational activities like knowledge sharing, which influences the performance of the organization. Consequently, there is empirical support for the

positive association between the influence on knowledge sharing and the distinct idea of digital leadership. Regulating element, the degree to which workers are eager to share their expertise is favorably influenced by leaders who utilize information technology and foster a good learning culture, which enhances organizational performance [12]. Therefore, this study hypothesizes that:

**H3** Digital leadership is positively related to knowledge sharing.

#### Dynamic capabilities and knowledge sharing

Dynamic capabilities stress the capacity to integrate and coordinate heterogeneous assets for greater competitive advantage, as was said in the preceding section. The availability of dynamic capabilities in the context of knowledge sharing is another factor that must be considered. Businesses with certain dynamic capabilities have an advantage in creating an environment conducive to knowledge sharing [47]. Organizations with strong dynamic skills are better positioned to absorb, adapt, and use information for innovation. DCT shows that organizations with more dynamic capacities increase their knowledge exchange channels, ensuring that valuable information spreads across industries [48]. The SOR hypothesis lends weight to this viewpoint. Suggesting that companies that deal with information sharing procedures (S) encourage collective learning behaviors (O), resulting in improved cooperation and innovation. Furthermore, by using these capabilities, businesses may improve the process overall by coordinating knowledge management and sharing it with the current environmental conditions [49]. Hence, the current study derived the following hypothesis:

**H4** Dynamic capabilities are positively related to knowledge sharing.

#### Knowledge sharing and green digital innovation

Knowledge sharing (KS) has a vital role in fostering green innovation [12]. The concept of Knowledge Sharing includes the processes of both transmitting and acquiring knowledge [28]. Collaboration and exchange of information among the individuals in a company's network facilitate the acquisition of the complementary skills and knowledge its members possess. These strategies facilitate the flow of information that is inherently integrated into the organization's daily operations and the generation of new knowledge, therefore ensuring the maintenance of current organizational abilities. The sharing and application of knowledge are the primary drivers of innovation. The SOR hypothesis claims that knowledge exchange procedures (S) increase workers' comprehension of sustainability issues. (O), which improves their capacity to create green digital breakthroughs. Furthermore, DCT indicates that firms that use shared knowledge may continuously reposition their capabilities, allowing long-term digital transformation [40]. Moreover, in order to minimize uncertainty and successfully embrace the green innovation required to meet sustainability standards, companies should actively participate in knowledge sharing among network participants. Therefore, being dependent on the active participation of members, green innovation is significantly more vital than any other invention. The following hypothesis is based on the preceding discussion:

**H5** Knowledge sharing is positively related to green digital innovation.

#### Mediating role of knowledge sharing

According to [50], leaders who foster dialogue are crucial in fostering an atmosphere that fosters the creation and advancement of environmentally friendly ideas. According to [51], dynamic capability also facilitates the spread of information that is necessary for the use of green technologies. Knowledge sharing may be able to moderate links between KM practices, organizational characteristics, and innovation, according to a review of the research. It has been suggested that the relationship between digital leadership and innovative situations is mediated via information sharing. The sharing of knowledge serves as a link between leadership, dynamic qualities, and inspiration. According to SOR theory, digital leadership and dynamic skills offer the essential impetus (S) to build knowledge-sharing behavior (O), which eventually leads to green digital invitations (R). DCT emphasizes the importance of knowledge sharing methods in transforming organizational capabilities into long-term innovative achievements [52]. According to [51], the SOR Framework, supported by this mediation, holds that knowledge sharing, as an internal element, affects an organization's capacity to cope with external variables like digital leadership and dynamic capability [23]. Thereby, the pertinent hypothesis is written below:

**H6** Knowledge sharing mediates the relationship between digital leadership and green digital innovation.

**H7** Knowledge sharing mediates the relationship between dynamic capabilities and green digital innovation.

#### Moderating role of green digital mindset

The moderator role between the predictor variable and the specified outcome variable is another key idea in the green digital theory. Consequently, IT strengthens the case for the hypothesis by highlighting the importance of knowledge sharing in green digital innovation [23], the phrase "green digital mindset" refers to an attitude

or mindset that embraces sustainable practices and principles in concepts and procedures using digital technology. This way of thinking demonstrates how information is disseminated and used concerning environmentally friendly digital advancement [14, 53]. Additionally, it was shown that businesses with a greater degree of green digital mentality could anticipate being more impacted by knowledge exchanges on green digital innovation than businesses with a lower degree of green digital mindset [54]. The green digital mindset improves the efficacy of knowledge sharing methods for driving innovation. According to the SOR hypothesis, when workers have a strong environmental orientation (S), their participation in knowledge exchange activities (O) leads to superior experimental results (R). The DCT lends credence to this viewpoint. Companies with a sustainability mindset may make better use of their knowledge sharing process for green innovation [55]. It has been discovered that the green digital mentality, which combines knowledge management sharing strategies with sustainable KM sharing methods, improves the link between KM sharing and green digital innovation. Following hypothesis is derived:

H8: Green digital Mindset moderates the relationship between knowledge sharing and green digital innovation.

Based on the above discussion and hypothesis generation, the following is this study's theoretical framework (Fig. 1).

#### Rationale of framework

The Stimulus-Organism-Response framework theoretically underpins knowledge sharing as an interventional factor, establishing a robust framework for the impact of external stimuli on internal organizational processes to generate significant outcomes. In this study, digital leadership and dynamic capabilities are conceptualized as drivers that influence organizational attitudes. Knowledge sharing is presented as the internal organizational process that converts these drivers into useful outputs, particularly green digital innovation. Consequently, the interventionist function of knowledge exchange is substantiated. Because it encapsulates the critical pathway by which leadership and competencies promote innovation, knowledge integration, and shared learning within the organization. This research demonstrates in the literature the central role of internal processes in attaining sustainable innovation, particularly in higher education institutions, by emphasizing this interventional process.

The justification for the moderating factor (green digital mindset) The Stimulus-Organism-Response framework is expanded by including the Green Digital Mindset as a moderating factor, which introduces a contextual aspect that influences the efficacy of internal processes to foster innovation. Although the exchange of knowledge is an essential component of converting stimuli into responses, the efficacy of this process is contingent upon the presence of a supportive mentality consistent with the sustainability objectives. The green digital mindset influences the relationship between knowledge exchange and green digital uniqueness, which functions as a boundary condition. This new addition emphasizes the influence of internal processes on organizational culture and attitudes toward sustainability, thereby addressing a critical lacuna in the literature. These concepts are validated by utilizing the Stimulus-Organism-Response framework in this research, which provides two significant benefits. Initially, it enhances the framework's adaptability. Sustainability-focused concepts, knowledge sharing, and a green digital mindset further broaden its ideological scope. It addresses critical voids in the literature. Because it demonstrates the nuanced pathways and contextual factors

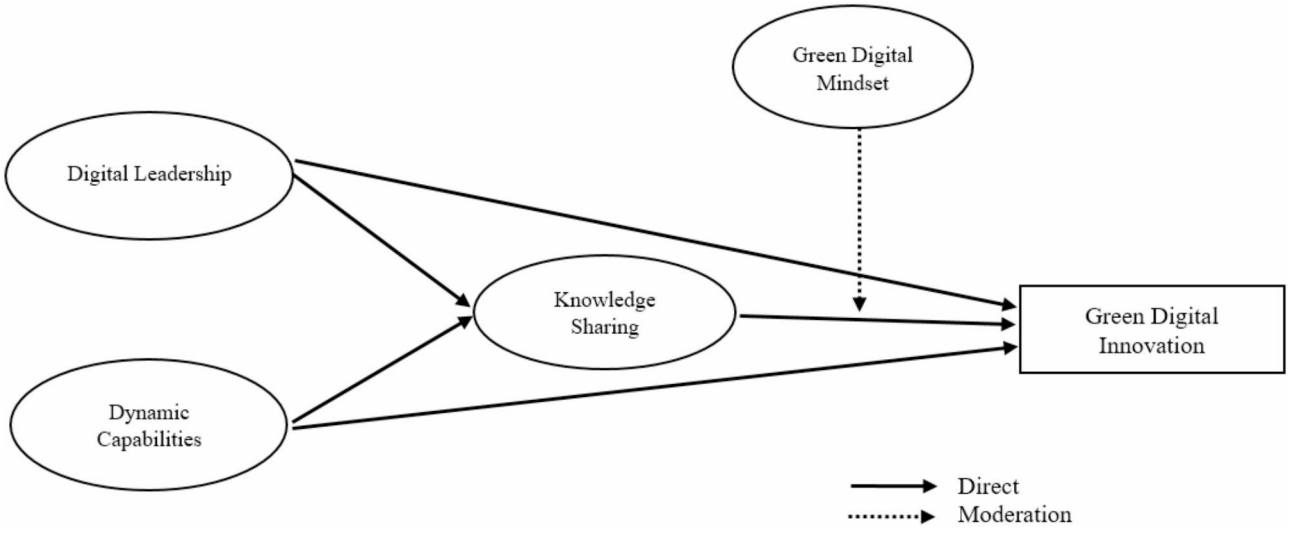


**Fig. 1** Theoretical framework of study

that drive green innovation, it offers critical theoretical and practical insights for advancing sustainability-based innovation in higher education.

In contrast to prior research that has investigated digital innovation in a more general sense [56, 57], our investigation concentrates on green digital innovation, which combines environmental sustainability objectives with digital transformation. Green Digital Innovation is distinctive in that it focuses on the development and implementation of digital technologies that promote sustainable practices, increase resource efficiency, and reduce environmental impact. Our research emphasizes the importance of sustainability-based digital transformation in higher education institutions by distinguishing green digital innovation from conventional digital innovation. Although previous research has shown that digital leadership is a driving force behind digital innovation, our research extends the understanding of how digital leadership and dynamic capabilities specifically drive green digital innovation. Our contention is that digital leaders in higher education institutions have a critical role to play in ensuring that digital transformation strategies are in alignment with sustainability objectives. Additionally, dynamic capabilities assist institutions in adapting to environmental challenges and leveraging digital technologies to achieve sustainable outcomes.

In relation to digital leadership, dynamic capabilities, and green digital innovation, our research demonstrates that knowledge exchange plays a critical intermediate role. We demonstrate that the interchange of ideas, best practices, and unique solutions is essential for the realization of a green digital innovation and is facilitated by the effective knowledge sharing among senior management. Furthermore, this intermediary mechanism has not been extensively investigated in prior research, particularly in the context of higher education institutions.

An additional significant contribution is the introduction of the green digital mindset as a moderator in green digital innovation and knowledge exchange. This study demonstrates that the positive influence of knowledge exchange on green digital innovation is exacerbated by a sustainability-based perspective among leaders and employees. The gap of the study is highlighted below in Table 1:

## Methodology

### Data collection

Chinese higher education institutions were selected as a research setting due to their immense efforts, transformation and contribution towards green and technology-driven policies and awareness through their universities [18]. as one of the pioneers in implementing green economic measures [18]. China proposed innovation, coordination, green, openness, and sharing at the Fifth Plenary Session of the Eighteenth Central Committee of the Communist Party of China. In addition, recent data shows that demand for Chinese higher education is soaring [14]. Chinese universities play a dominant role in creating awareness by imparting the conventional ways of delivering superior education to local and international students to glean optimum benefits from technology and

**Table 1** Research GAP

| Author(s) & Year | Focus Area | Methodology | Key Findings | Research Gap | Current Study's Contribution |
|---|---|---|---|---|---|
| [58] | Digital transformation in higher education institutions | Systematic literature review | Identified the need for a comprehensive digital transformation in HEIs, emphasizing the integration of technology in all dimensions | Lack of specific strategies for integrating sustainability into digital transformation efforts | Provides a framework for incorporating sustainability into digital transformation strategies in HEIs |
| [59] | Barriers to digital transformation in higher education | Systematic literature review | Classified barriers into environmental, strategic, organizational, technological, people-related, and cultural categories | Limited research on overcoming these barriers with a focus on sustainability | Offers solutions to overcome identified barriers, emphasizing sustainable digital transformation |
| [60] | Green IT in designing sustainable learning environments | Theoretical analysis | Proposed the use of Green IT as a tool for creating cloud-oriented sustainable learning environments in HEIs | Need for empirical validation of proposed models | Empirically tests the proposed Green IT framework in HEIs |
| [61] | Green coding and sustainable software development | Literature review | Highlighted the importance of integrating green coding practices in software development to enhance sustainability | Scarcity of studies on implementing green coding in educational curricula | Investigates the integration of green coding practices in HEI curricula |
| [62] | Green innovation adoption | Survey-based analysis (faculty and staff at multiple universities) | Organizational readiness and leadership support are strong predictors of green innovation success; resource constraints and resistance to change are identified as the main barriers. | Gap in research specifically examining the enablers and barriers to green innovation within the context of higher education. | Examines the key enablers and barriers to green innovation adoption in the university context, providing insights for promoting sustainable practices. |

innovation through effective leadership and other various capabilities [14].

Moreover, these researchers identify the leadership construct as an antecedent of organizational innovation and urge subsequent researchers to examine these constructs. Considering these criteria, we collected a data sample from Chinese universities. The data collection commenced in March 2024 and was conducted in three successive waves, each one month apart, to mitigate the impact of common method bias [63]. The data for this study was obtained through an online survey, a widely used approach in management research that is particularly suitable for collecting data from bigger samples [64]. The study's potential participants were selected from top management personnel employed at Chinese universities. Several precautions were adopted to guarantee the seamless progress of the research.

For instance, top management personnel were contacted and shared the research cover letter highlighting the current research's aim and scope. Furthermore, a cover letter also ensures the anonymity and security of the gathered information, which contributes to lowering the potential common method bias, which frequently occurs in primary data studies. Hence, informed consent was taken from all participants. Data were gathered in three waves: T1 (digital leadership, dynamic capabilities), T2 (knowledge sharing, green digital mindset), and T3 (green digital innovation), with a one-month interval. Between each time interval, reminder calls were made after every two weeks to increase the response rate [26]. At the first wave (T1), 557 questionnaires were received in a completed form. Each questionnaire was assigned a unique code for further correspondence with the respondent. After one month, at T2, these 557 questionnaires were emailed back to the same respondents. A total number of 441 questionnaires were received back. Again, after one month, at T3, questionnaires were sent back to the respondents, and 425 questionnaires were received in a fully completed form, hence used for the final analysis. The questionnaires received reveal that the majority of the respondents were male (62%), most respondents were aged between 40 and 50 (58%), most of the respondents held PhD degrees (74%), and finally, a large proportion of the respondents having work experience 20–25 years (49%). The demographic profile of respondents is also shown in Table 2.

**Table 2** Demographic profile

| Demographic Characteristics | Category | Frequency (*n*) | Percentage (%) |
|---|---|---|---|
| Gender | Male | 264 | 62% |
| | Female | 161 | 38% |
| Age | 30–39 years | 68 | 16% |
| | 40–50 years | 247 | 58% |
| | 51–60 years | 110 | 26% |
| Education Level | PhD | 314 | 74% |
| | Master's Degree | 111 | 26% |
| Work Experience | 10–15 years | 72 | 17% |
| | 16–20 years | 145 | 34% |
| | 21–25 years | 208 | 49% |
| Job Position | Dean | 85 | 20% |
| | Department Head | 172 | 40% |
| | Senior Administrator | 168 | 40% |

### Sampling procedure and sample frame

The research used a purposive sample technique to identify participants. We used purposive sampling to identify top management individuals from Chinese higher education institutions. This methodology is particularly appropriate for this study since it emphasizes the strategic decision-making aspects of Digital Leadership, Dynamic Capabilities, and Green Digital Innovation. Top management individuals, such as department heads, Deans, directors, senior administrators, and principals, are the primary informants who shape or implement organizational policies and strategies inside higher education institutions. This study established particular criteria that participants must fulfil to verify the data's relevancy and rigor. The primary criterion was at least two years of involvement in strategic decision-making at their institution. The second criterion was that they must have past expertise in transformation and sustainability efforts at their institution. We primarily focused on Chinese universities with active digital innovation programs that correspond to our research. The purpose of concentrating on Chinese universities is to highlight how Green Digital Transformation may facilitate the attainment of national sustainability objectives. The Chinese higher education sector serves as a dynamic context for examining the adoption and integration of Green Digital Innovation into sustainable practices and its potential to enhance institutional strategy.

### Measures

Measurement scales have been taken from prior studies, which have been established and tested to ensure content validity [63]. Following is the measurement scale utilized for the current study. All measurement scale ranges from 1 to five, where "1 = strongly disagree" and "5 = strongly agree". We implemented a rigorous translation and back-translation methodology to guarantee the survey items' cultural relevance and accuracy, as they were submitted to respondents who spoke Chinese. An expert initially translated the survey from English to Chinese. The Chinese version was subsequently independently translated back into English by a second expert, and any discrepancies were resolved through dialogue and reconciliation.

**Table 3** Common method bias

| Total variance explained | | | | | | |
|---|---|---|---|---|---|---|
| Component | Initial eigenvalues | | | Extraction sums of squared loadings | | |
| | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % |
| 1 | 1.796 | 35.928 | 35.928 | 1.796 | 35.928 | 35.928 |
| 2 | 1.355 | 27.097 | 63.024 | 1.355 | 27.097 | 63.024 |
| 3 | 0.997 | 19.946 | 82.97 | | | |
| 4 | 0.489 | 9.782 | 92.753 | | | |
| 5 | 0.362 | 7.247 | 100 | | | |

In order to guarantee conceptual coherence and clarity, the final Chinese survey was pilot-tested with a limited number of senior management personnel. This procedure guaranteed that the survey elements were translated precisely with no major changes because the audience is well educated and understand the both Chinese and English language.

Digital green innovation was measured using a scale of 5 items adapted from Yin and Yu [53]. Digital leadership was assessed through the scale of Cai, Wu [65], comprising six items. The dynamic capability scale was derived from the work of Yuan and Cao [66], which assesses this scale with five items. Knowledge sharing is measured through a five-item scale from Zhou, Deng [67]. A green digital Mindset is measured through 5-item scale derived from the work of Steg, Dreijerink [68]. The questionnaire items are given in appendix A.

### Analysis tool

To deal with the complicated model, the research used PLS-SEM (Partial Least Squares Structural Equation Modeling) using Smart PLS. This was important since our model has mediation and moderation effects, making it appropriate for prediction-focused research. PLS-SEM is thought to be more suited for dealing with complicated models and evaluating hypotheses about prediction and model fit. It is especially useful for explaining variation and evaluating predictive significance, which is consistent with the nature of our research, which focuses on causal linkages and predictive paths between variables. Furthermore, PLS-SEM performs well with small to medium sample sizes and non-normally distributed data, which are practical features of our data. Its bootstrapping approach improves the robustness of findings, particularly in mediation and moderation analysis. Given these benefits, we used PLS-SEM with Smart PLS to determine the findings of our investigation.

## Results and findings

The "partial least square structural equation modeling" PLS-SEM 4.0 was employed to analyze the data. The PLS-SEM is one of the dominant techniques in social science research that provides accurate results [69]. Ghasemy, Teeroovengadum [70] argued that PLS-SEM is one of the leading techniques for data analysis in higher education settings. The current study examines data into two categories: measurement and structural model, as suggested by [71]. The measurement model consists of factor loadings, composite reliability, and convergent and discriminant validity. The structural model consists of hypothesis testing through the bootstrapping technique of direct, mediation, and moderation relationships in the hypothesized model.

**Table 4** Correlation

| | DL | DC | KS | GDM | GDI | MVT |
|---|---|---|---|---|---|---|
| DL | 1 | | | | | |
| DC | 0.435** | 1 | | | | |
| KS | 0.455** | 0.566** | 1 | | | |
| GDM | −0.206** | −0.115* | −0.108* | 1 | | |
| GDI | 0.398** | 0.546** | 0.560** | −0.183** | 1 | |
| MVT | **0.079** | **-0.068** | **0.005** | **0.029** | **0.093** | **1** |

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

### Common method bias

Common method bias (CMB) is a crucial issue in the primary data that hampers the study results [72]. Prior literature indicates two ways to deal with CMB issues: (i) qualitative and (ii) quantitative. The current study adopted both to eradicate the CMB problem from the data set. For instance, this study has sent a cover letter highlighting the study's clear scope and aim and ensuring the anonymity and security of gathered information [63]. In addition, this research employed multiple wave techniques to mitigate straight-line response [26]. Likewise, Harman's one-factor test was executed to assess whether a single factor explains a variance of around 50%. The largest single factor emerged, explaining (35.92%) variance; hence, no CMB issue is found in this study, as indicated in Table 3.

Moreover, the correlations of the research constructs with the marker variable test (MVT) were not significant (ranging between – 0.068 and 0.093, as shown in Table 4). Both results indicate that the likelihood of common method bias is low.

### Assessment of measurement model

Table 3 exhibits the results of the measurement model. Inter-item loadings were examined using factor loadings. All factor loadings exceed the threshold value of 0.70 [73]. Furthermore, internal consistency was assessed through the composite reliability (CR). The results show that all five factors contain CR values greater than 0.70 [74] as shown in Table 5 below.

Similarly, convergent validity was measured through average variance extracted (AVE). It shows that all factors have an AVE value greater than 0.50, thus establishing the convergent validity. Moreover, the "value inflation factor" (VIF) technique also ensured multicollinearity. All factors in the hypothesized model unfold value less than 5 [75].

Furthermore, Table 6 shows the discriminant validity results assessed through the HTMT ratio [76]. It demonstrates that all HTMT values are less than 0.90 [76]. Therefore, it is established that all latent constructs are distinct.

The cross-loading result confirms the item loading in the respective factor, as shown in Table 7.

### Assessment of structural model

The bootstrapping technique (subsample = 5000) was utilized for hypothesis testing. Table 8 reveals that all empirical results have been substantiated. H1 demonstrates that digital leadership is insignificant to green digital innovation ($\beta = 0.041$, $p = 0.463$). H2 reveals the positive and significant impact of DCs on green digital innovation ($\beta = 0.302$, $p = 0.000$). Moreover, H3 highlights that digital leadership positively and significantly correlates with knowledge sharing ($\beta = 0.222$, $p = 0.000$).

The findings of H4 corroborate the significant and positive impact of DCs on knowledge sharing ($\beta = 0.549$, $p = 0.000$). In addition, H5 exhibits a significant and positive relationship between knowledge sharing and green digital innovation ($\beta = 0.265$, $p = 0.000$).

Similarly, H6 and H7 confirmed the significant mediating role of knowledge sharing between digital leadership and green digital innovation ($\beta = 0.0.059$, $p = 0.002$) and DCs and green digital innovation ($\beta = 0.146$, $p = 0.000$). Finally, the current study establishes that a green digital mindset positively moderates the relationship between knowledge sharing and green digital innovation ($\beta = 0.217$, $p = 0.000$) as H8. The current study provides mixed findings as H1 is rejected and all other seven hypotheses from H2 to H7 are accepted. The path modelling results are also shown in Fig. 2.

**Table 5** Reliability and convergent validity

| Latent Construct | Items | Factor loadings | VIF | CR | AVE |
|---|---|---|---|---|---|
| Knowledge Sharing | KS1 | 0.684 | 2.635 | 0.840 | 0.512 |
| | KS2 | 0.730 | 2.798 | | |
| | KS3 | 0.717 | 2.763 | | |
| | KS4 | 0.732 | 1.323 | | |
| | KS5 | 0.714 | 2.455 | | |
| Digital Leadership | DL1 | 0.856 | 1.265 | 0.954 | 0.813 |
| | DL2 | 0.914 | 2.597 | | |
| | DL3 | 0.935 | 2.565 | | |
| | DL4 | 0.912 | 2.721 | | |
| | DL5 | 0.934 | 2.824 | | |
| | DL6 | 0.857 | 2.913 | | |
| Green Digital Innovation | GDI1 | 0.842 | 2.041 | 0.916 | 0.731 |
| | GDI2 | 0.871 | 2.447 | | |
| | GD3 | 0.824 | 1.912 | | |
| | GDI4 | 0.882 | 2.613 | | |
| Dynamic Capability | DC1 | 0.917 | 2.922 | 0.935 | 0.827 |
| | DC2 | 0.898 | 2.477 | | |
| | DC3 | 0.914 | 2.821 | | |
| Green Digital Mindset | GDM1 | 0.787 | 2.519 | 0.922 | 0.702 |
| | GDM2 | 0.854 | 3.210 | | |
| | GDM3 | 0.851 | 3.193 | | |
| | GDM4 | 0.909 | 3.245 | | |
| | GDM5 | 0.783 | 1.725 | | |

### Coefficient of determination and effect size

"Coefficient of determination" ($R^2$) measures the "variation in the endogenous latent construct explained by all exogenous constructs included in the hypothesised model" [77]. It ranges from substantial (0.75), moderate (0.50) and low (0.25) respectively as shown in Table 9.

The $R^2$ for the current study is considered to be moderate, as shown in Table 5 (Green digital innovation = 0.471, knowledge sharing = 0.457), as it illustrates that 47% for green digital innovation and 45% for knowledge sharing variations, respectively, due to the exogenous variables included in the hypothesized model which is well acceptable in the higher education settings [63]. Similarly, $f^2$ represents the significance of the effect size of each predictor [71]. Likewise, Table 5 also depicts the effect size ($f^2$) for all exogenous constructs in the

**Table 6** Discriminant validity (HTMT Ratio)

| | Digital leadership | Dynamic capabilities | Green digital innovation | Green digital mindset | Knowledge sharing |
|---|---|---|---|---|---|
| Digital leadership | | | | | |
| Dynamic Capabilities | 0.469 | | | | |
| Green digital Innovation | 0.396 | 0.667 | | | |
| Green digital Mindset | 0.344 | 0.271 | 0.304 | | |
| Knowledge Sharing | 0.533 | 0.739 | 0.674 | 0.295 | |

**Table 7** Cross loadings

| | Digital leadership | Dynamic capabilities | Green digital innovation | Green digital mindset | Knowledge sharing |
|---|---|---|---|---|---|
| DC1 | 0.430 | **0.917** | 0.548 | -0.229 | 0.574 |
| DC2 | 0.388 | **0.898** | 0.506 | -0.236 | 0.610 |
| DC3 | 0.365 | **0.914** | 0.559 | -0.215 | 0.577 |
| DL1 | **0.912** | 0.370 | 0.311 | -0.255 | 0.410 |
| DL2 | **0.934** | 0.405 | 0.342 | -0.335 | 0.414 |
| DL3 | **0.857** | 0.409 | 0.292 | -0.264 | 0.422 |
| DL4 | **0.856** | 0.384 | 0.364 | -0.299 | 0.413 |
| DL5 | **0.914** | 0.381 | 0.319 | -0.258 | 0.423 |
| DL6 | **0.935** | 0.394 | 0.330 | -0.330 | 0.405 |
| GDI1 | 0.335 | 0.505 | **0.842** | -0.205 | 0.518 |
| GDI2 | 0.270 | 0.527 | **0.871** | -0.261 | 0.480 |
| GDI3 | 0.355 | 0.500 | **0.824** | -0.268 | 0.468 |
| GDI4 | 0.281 | 0.489 | **0.882** | -0.256 | 0.502 |
| GDM1 | -0.242 | -0.164 | -0.152 | **0.787** | -0.153 |
| GDM2 | -0.287 | -0.203 | -0.218 | **0.854** | -0.226 |
| GDM3 | -0.253 | -0.207 | -0.171 | **0.851** | -0.186 |
| GDM4 | -0.316 | -0.255 | -0.284 | **0.909** | -0.251 |
| GDM5 | -0.241 | -0.195 | -0.307 | **0.783** | -0.240 |
| KS1 | 0.346 | 0.345 | 0.273 | -0.106 | **0.684** |
| KS2 | 0.363 | 0.407 | 0.313 | -0.113 | **0.730** |
| KS3 | 0.366 | 0.670 | 0.504 | -0.179 | **0.717** |
| KS4 | 0.287 | 0.409 | 0.465 | -0.269 | **0.732** |
| KS5 | 0.279 | 0.372 | 0.434 | -0.253 | **0.714** |

**Table 8** Results of hypothesis testing

| Hypothesized Path | | β | T statistics | *P* values | Decision |
|---|---|---|---|---|---|
| **Direct Path** | | | | | |
| 1 | Digital leadership -> Green digital Innovation | 0.041 | 0.734 | 0.463 | **Rejected** |
| 2 | Dynamic Capabilities -> Green digital Innovation | 0.302 | 5.175 | 0.000 | **Accepted** |
| 3 | Digital leadership -> Knowledge Sharing | 0.222 | 4.459 | 0.000 | **Accepted** |
| 4 | Dynamic Capabilities -> Knowledge Sharing | 0.549 | 12.629 | 0.000 | **Accepted** |
| 5 | Knowledge Sharing -> Green digital Innovation | 0.265 | 5.082 | 0.000 | **Accepted** |
| **Indirect Path** | | | | | |
| 6 | Digital leadership -> Knowledge Sharing -> Green digital Innovation | 0.059 | 3.160 | 0.002 | **Accepted** |
| 7 | Dynamic Capabilities -> Knowledge Sharing -> Green digital Innovation | 0.146 | 4.843 | 0.000 | **Accepted** |
| 8 | Green digital mindset x knowledge Sharing -> Green digital Innovation | 0.217 | 5.757 | 0.000 | **Accepted** |

hypothesized model. All latent constructs show small to large $f^{2,}$ depicting ranges from 0.002 to 0.452 for all exogenous constructs.

### Mediation analysis

The mediation analysis, conducted using the bias-corrected bootstrap method (5,000 samples, 95% CI) in SPSS PROCESS Macro, revealed significant direct and indirect effects. Digital leadership had a significant direct effect on green digital innovation (β = 0.1404, $p < 0.001$, 95% CI (0.0725, 0.2082), indicating that digital leadership positively influences green digital innovation independent of knowledge sharing. Dynamic capabilities (DC) had a significant direct effect on green digital innovation (GDI) (β = 0.3003, $p < 0.001$, 95% CI (0.2195, 0.3811), indicating that DC positively influences GDI independent of knowledge sharing. Additionally, knowledge sharing (KS) significantly mediated the relationship between DC and GDI (β = 0.1866, 95% Bootstrapped CI (0.1277, 0.2542). Additionally, knowledge sharing significantly mediated the relationship between digital leadership and green digital innovation (β = 0.1692, 95% Bootstrapped CI (0.1192, 0.2339), confirming the presence of partial mediation. The detail results as shown in Appendix B.

## Discussion and conclusion

The current study puts forward various empirical results based on the data gathered from higher education institutions in China. H1 shows digital leadership's significant and positive impact on green digital innovation. The result is surprisingly inconsistent with previous findings [12, 21, 65]. The first direct hypothesis posits a

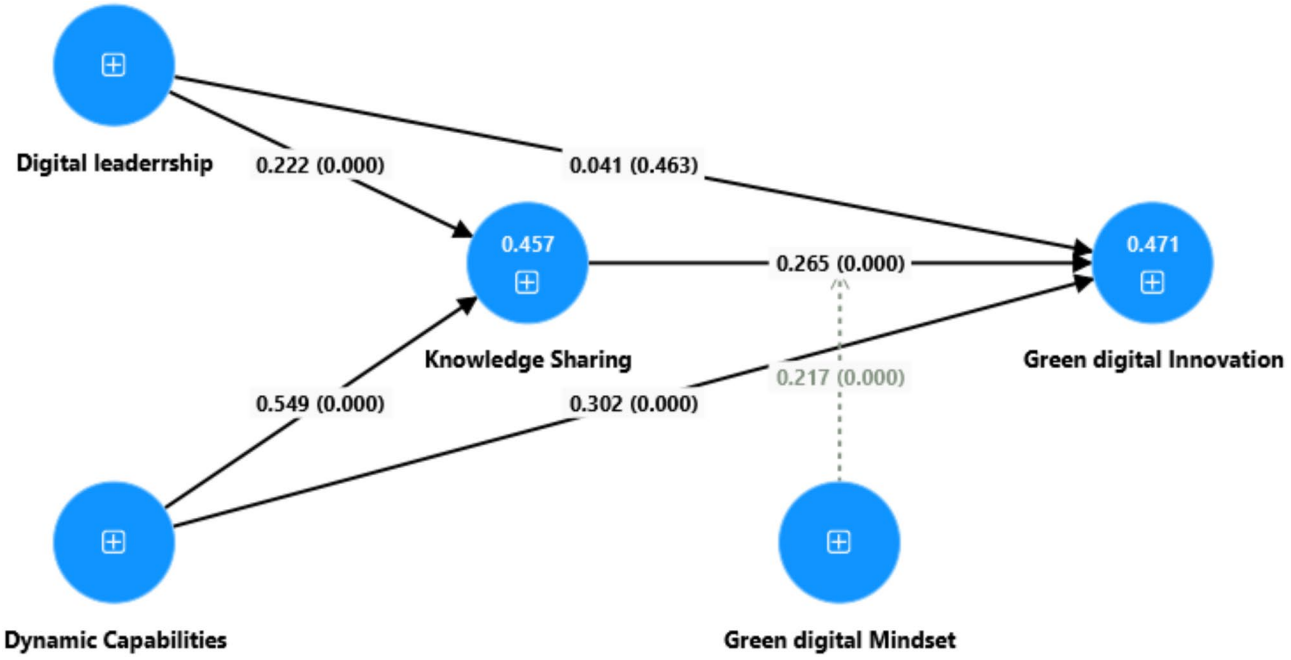


**Fig. 2** Path coefficient and P values

**Table 9** Effect size and $R^2$

| | Green digital Innovation ($f^2$) | Knowledge Sharing ($f^2$) | $R^2$ |
|---|---|---|---|
| Digital leadership | 0.002 | 0.074 | |
| Dynamic Capabilities | 0.093 | 0.452 | |
| Green digital Innovation | | | 0.471 |
| Green digital Mindset | 0.041 | | |
| Knowledge Sharing | 0.071 | | 0.457 |

correlation between Digital Leadership and Green Digital Innovation. The primary reason for the rejection is that digital leadership influences the organizational dynamics of green digital innovation. It is influenced by and originates from the same process of mechanism [78]. indicated that significant digital leadership does not directly influence numerous factors, such as organizational structure and employee engagement. They serve as intermediaries, which explains the existence of these initial-directed hypotheses. The possible reason may be that green digital innovation is idiosyncratic in higher education settings where digital leadership is still at early stage to acknowledge its positive outcomes [65]. This insignificant relationship may be attributed to the centralized and controlled structure of the many Chinese universities, which likely hinders digital leadership's positive impact in bringing green digital innovation as centralization and decision-making concentration stifle creative and innovative ideas [20]. Another crucial aspect that may not be ignored is understanding sustainability principles and policies to ensure them vary across Chinese universities; therefore, implementation mechanisms are not coherent enough to create a synergy effect for green digital innovation through digital leadership.

However, DCs and green digital innovation have established a strong and significant nexus in the context of Chinese higher education institutions. This result aligns with the prior literature where several authors, for example [37, 66], reveal that DCs, particularly when these capabilities are built on technology and the latest advanced tools, bring product and innovation considering sustainability, consequently giving a competitive advantage. Hypothesis 2 found a significant and positive connection ($\beta = 0.302$, $p < 0.001$) between dynamic capabilities and green digital distinctiveness. This is congruent with [79] research, which underlined the need for dynamic capabilities, such as the capacity to integrate and reconfigure resources, for firms to innovate and adapt to climate change. The beneficial influence of dynamic capabilities on green digital innovation demonstrates that businesses with more dynamic capabilities may better use their resources and capabilities when implementing sustainable digital innovations. In addition, the study also established a significant and positive relationship between digital leadership and knowledge sharing, known as H3. This result is similar to the previous findings [12, 23] that when leaders are knowledgeable about utilizing current technologies and modern equipment, they pass on this knowledge to other employees and followers. Hypothesis 3 found a positive and significant influence of digital leadership on knowledge sharing ($\beta = 0.222$, $p < 0.001$), supporting the results [80]. These

studies show that digital leaders encourage an open culture of collaboration, allowing information to flow across the firm. In the context of green digital innovation, digital leadership plays a critical role in promoting a knowledge-sharing environment since knowledge-sharing allows for the exchange of best practices and long-term practical solutions.

The H4 of the current study postulates the significant and positive impact of DCs on knowledge sharing. The results validate the previous findings [15, 38], in which organizations with reconfiguration assimilation and adoption of tools, techniques and the latest technology are more likely to train their employees to enhance their performance. DCs support organizations to be flexible and compatible with the ever-changing environment by continuously enriching through knowledge resources [17]. Furthermore, knowledge sharing establishes a significant and positive relationship with green digital innovation, such as H5. The result is in accord with the prior literature. Knowledge sharing involves transferring expertise and skills through digital platforms, which urges people to think and act innovatively [28]. A soaring technological environment contributes towards more knowledge sharing, which is a pivotal factor of every type of innovation, including green innovation [47]. Knowledge sharing is also a significant mediator between digital leadership, DCs, and green digital innovation, as in H6 and H7, respectively. Although studies are scant that examined knowledge sharing as a mediator between the aforementioned construct, few notions of arguments have been put forward by previous researchers. For instance [50], argued that leaders with technology expertise create an environment that fosters knowledge sharing about modern technological equipment and tools likely to be exchanged at work. It is also believed that adopting technology is a kind of dynamic capability [14], which facilitates knowledge sharing within organizations to bring innovation [51].

Likewise, the current study, H8, shows that a green digital mindset significantly moderates the relationship between knowledge sharing and green digital innovation in Chinese higher education settings. The result corroborates with the prior literature, where a green digital Mindset appeared to be a key element for strengthening knowledge and digital innovation. Soon and Salamzadeh [21] asserted that a green digital mentality upsurges the eco-friendly knowledge and information sharing that employees utilize to produce green innovation. People develop a green digital mindset, a significant instrument for molding environmentally friendly behavior and awareness, to grow their conceptual knowledge library and get a competitive advantage over their contemporaries.

## Conclusion

The research investigates the influence of digital leadership and dynamism on green digital innovation in Chinese higher education, where knowledge sharing plays an interventional role and green digital mindset acts as a modifier. Using the Stimulus-Organism-Response paradigm, the findings revealed the importance of leadership and organizational abilities in generating long-term innovation. These results add to the literature by broadening the framework to include green digital distinctiveness and providing insight into specific difficulties and possibilities in Chinese institutions. These results have practical significance for governments and education leaders looking to advance sustainability and digital transformation in higher education.

## Theoretical contribution

This investigation makes several significant theoretical contributions. Initially, it expands the Stimulus-Organism-Response (SOR) framework by integrating sustainability-related constructs, including the Green Digital Mindset and Knowledge Sharing, into the context of digital innovation. Although the SOR framework is frequently employed in various research contexts, this study emphasizes its significance in promoting Green Digital Innovation, particularly in higher education institutions, and enhances its explanatory power. This paper demonstrates the impact of internal organizational processes and contextual factors on the outcome of sustainable innovation, and it offers a novel theoretical perspective for future research. Second, the study addresses a significant lacuna in the literature by establishing a connection between Sustainable Innovation and Digital Leadership and Dynamic Capabilities, with Knowledge Sharing as an intermediary. This research contributes to the expanding literature on organizational sustainability and uniqueness by depicting Knowledge Sharing as a central "organismic process," emphasizing its transformative role in driving leadership and skills-based initiatives. Third, including the Green Digital Mindset as a modifying factor enhances our comprehension of how cultural and attitudinal factors influence the efficacy of knowledge sharing. This theoretical advancement emphasizes the interdependence of internal organizational processes and external contextual factors, offering a fresh perspective on the innovation processes in sustainability-based environments. Lastly, this study underscores the potential for harmonizing digital transformation and sustainability in a sector that presents distinctive challenges and opportunities by contextualizing this research in Chinese higher education. This scientific collaboration opens the door to additional research on the digital uniqueness of educational institutions worldwide.

### Implications for theory

The current study adds many ways to the current research and debate on digital leadership, DCs and green digital innovation in the Chinese higher education sector. First and foremost, the current study extends the leadership literature by incorporating and analyzing digital leadership as an antecedent at the organizational level to assess knowledge sharing and green digital innovation in Chines higher education settings [81]. In addition, prior literature examined leadership at an individual level to assess innovation [47]. However, green digital innovation is nascent in the prior literature in higher education settings. It is pertinent to ponder that green digital innovation has become a vital performance indicator for universities, and it shows the undeterred contribution of universities towards environment friendliness and technology adoption [82]. Secondly, based on the "dynamic capability theory" [36], dynamic capabilities are recognized as pivotal contributors to the green digital innovation of Chinese universities. Although DCs as a construct have been under immense discussion in the corporate sector, their application in higher education is underrepresentation, specifically in how they contribute to green digital innovation. This study adds to the existing literature that DCs are crucial to accentuate green digital innovation. DCs are likely to rapidly pace organizational technology adoption by continuously identifying, assimilating and reconfiguring higher education resources and capabilities [17].

Moreover, this study adds to the current field of research on digital leadership and digital changes in higher education by investigating the intermediary function of knowledge sharing. In order to define the essential pathway of green digital innovation in the higher education environment of China, this study is one of the early investigations into the combined influence of digital leadership and dynamic capabilities on knowledge sharing [36]. In order to enhance the dynamic capability theory, we demonstrate the role of dynamic capability as both a concept and a means of knowledge sharing in facilitating the digital green innovation of Chinese institutions. Moreover, this study is among the few papers that examined how the green digital mindset moderates the relationship between knowledge sharing and green digital innovation. Although previous studies have examined the function of a green digital mindset as a mediator, there is restricted attention given to its influence as a moderator within the framework of Chinese higher education.

### Implications for practice

Based on the empirical findings, this study shares profound practical implications for the policymakers and strategists of Chinese higher education institutions who keenly indulge in technology-driven leadership and innovation and the current study. Digital leadership established a significant and positive impact on green digital innovation, which urges Chinese universities to develop leaders proficient in utilizing modern technologies and committed to environment friendliness. Chinese universities should incept training programs that equip their leaders with digital strategies and are equally aware of green principles. In addition, universities should ensure a dynamic culture that adapts technology and sustainability principles to remain at the forefront of digital and green innovation. Furthermore, this study also implicates that DCs are crucial for green digital innovation. DCs enable universities to continuously adapt to the ever-changing environment, especially regarding technology adoption and utilization. Considering it as an important mantra, universities must develop and nurture a flexible structure responsive to environmental dynamism. Various initiatives can be taken in this regard, such as enhancing the ability of faculty, students, and staff to acclimate to the environment by anticipating, responding to, and capitalizing on digital innovations with a green focus.

Similarly, knowledge sharing emerged as a significant mediator between digital leadership, DCs and green digital innovation. Therefore, Chinese universities should eagerly work on developing a robust and stipulative knowledge-sharing ecosystem. As knowledge sharing is a social construct, universities can provide opportunities for employees from various levels and departments to glean a current and updated flow of information and learn the latest tools to facilitate eco-friendly digital innovations. Chinese universities also foster and harness the value-driven culture that rewards knowledge sharing, enabling knowledge to permeate across all departments and disciplines within the universities. By doing so, universities can accelerate the adoption of green digital practices and enhance their overall innovation capacity. In addition, a green digital mindset is crucial to strengthen the relationship between knowledge sharing and green digital innovation in Chinese universities. Policymakers should incorporate curricula and programs based on sustainability and digitalization and encourage students to benefit from them. This initiative can shape and enhance the thinking patterns of faculty, staff and students to adopt digitization to preserve the environment. This can also be achieved through various seminars, workshops and social interaction within and outside the universities. By cultivating a green digital mindset, universities can ensure that their knowledge-sharing efforts lead to meaningful and sustainable innovation. The research offers practical implications for higher education institutions that aspire to align digital transformation with sustainability objectives. It underscores the significance of fostering digital leadership at the highest

echelons of management. To improve distinctiveness and ensure that environmental objectives are met. To facilitate innovation, universities should prioritize leadership development, cultivate dynamic capabilities such as organizational learning and flexibility, and encourage knowledge sharing. Cultivating a green digital mindset within the organizational culture is crucial in integrating sustainability into employee training programs, policies, and missions. By implementing these practical measures, universities can enhance operational efficiency, attain sustainability, and obtain a competitive advantage in the education sector.

## Limitations and future research avenues

Notwithstanding its significance in comprehending the correlation between digital leadership, knowledge sharing, green digital mindset, and green digital innovation in higher education, this study has certain limitations. Specifically, the generalizability of the results may be constrained by the sample and setting from which they were obtained. To enhance the applicability of the findings, future research should replicate this study using a varied range of samples from different industries and cultural settings. Enhancing our understanding of digital leadership, knowledge sharing, green digital mindset, and green digital innovation would be facilitated by comprehensively examining its manifestations in many settings like culture, organizations and industries.

The analysis of possible variations in the connections between these concepts in various contexts may offer a valuable understanding of the limitations and contextual elements that impact these interactions. Research of this nature can offer favorable insights through systematic and scientific-driven strategies that companies can employ to accomplish sustainable objectives. Moreover, this work employed a three-wave time lag technique to tackle common method bias. Nevertheless, experimental methodologies can offer a more comprehensive understanding of the causal connections among these variables. The proposed method can offer a significant understanding of the enduring effects and interconnections of these constructs and their evolutionary trends within organizational settings. Moreover, the study relied on self-report measures, which were susceptible to systematic methodological response biases. In order to enhance the accuracy of findings, future research should incorporate a diverse range of data sources. Utilizing a multilevel analytical approach allows for a thorough comprehension of the interplay and influence of green digital leadership, digital DCs, knowledge sharing, green digital mindset, and green digital innovation structures in an organization at different levels, encompassing the individual and team. Multilevel analysis facilitates comprehension of the complexities and instability of these connections within intricate organizational frameworks.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40359-025-02552-z.

Supplementary Material 1

### Author contributions

Conceptualization: YS and YD; Data curation: ZZ and RD; Formal analysis: YS and ZX; Methodology: ZX and RD; Project Administration: YS; Software: ZX; Validation: RD; Visualization: ZZ and RD; Review and Editing: YS, YD and ZZ.

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### Data availability

All the relevant data is included in the paper. Further inquires can be directed to corresponding author.

## Declarations

### Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and prior to data collection, informed consent was obtained from all participants, who were fully briefed on the study's purpose. Moreover, the committee of Jilin International Studies University reviewed this study and approved that it meets all of the ethical standards for research involving human participants.

### Consent for publication

All authors agreed to submit and publish paper in BMC psychology.

### Competing interests

The authors declare no competing interests.

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### References

1. Khan AJ, et al. Green behaviors and innovations: A green Hrm perspective to move from traditional to sustainable environmental performance. Empl Responsibilities Rights J. 2024;36(2):231–48.
2. Liu Y, et al. Strategic management of natural resources through human, technological, and institutional resources: sustainable curing the resource curse. Resour Policy. 2023;86:104233.
3. Ma W et al. Am I Safe at My Educational Place? Creating Secure and Sustainable Urban Learning Spaces Through Green Infrastructure and Ecological Education. Education and Urban Society, 2024: p. 00131245241249980.
4. Khan AJ, et al. Greening for greater good: investigating the critical factors for customer satisfaction with sustainable e-banking. Environmental Science and Pollution Research; 2023.
5. Yin X et al. Green human resource management: a need of time and a sustainable solution for organizations and environment. Environment, Development and Sustainability, 2023: pp. 1–22.
6. Ma H, et al. Unpacking the optimistic mindset of business students towards entrepreneurship. PLoS ONE. 2024;19(2):e0297868.
7. Qi R, et al. Handling the mishandling: resolving the resource curse through effective utilization of available natural resources and claiming sustainable development. Resour Policy. 2023;87:104285.
8. Tang H, et al. The moderating role of sustainable development goals in reviving the economy through green initiatives. Front Environ Sci. 2023;11:509.
9. Zheng H, et al. Tourist revisit intention: A focus on perceived service quality, place attachment, and tourist intimacy. Social Behav Personality: Int J. 2024;52(4):1–11.

10. Lian D. Deep learning in sports skill learning: a case study and performance evaluation. EAI Endorsed Trans Pervasive Health Technol, 2024;10.
11. Sutrisno S. Changes in Media Consumption Patterns and their Implications for People's Cultural Identity. Technology and Society Perspectives (TACIT), 2023. 1(1): pp. 18–25.
12. Anwar S, Saraih UN. Digital leadership in the digital era of education: enhancing knowledge sharing and emotional intelligence. International Journal of Educational Management, 2024. ahead-of-print(ahead-of-print)
13. Wang M, et al. Green process innovation, green product innovation and its economic performance improvement paths: A survey and structural model. J Environ Manage. 2021;297:113282.
14. Chen Y, Li J, Zhang J. Digitalisation, data-driven dynamic capabilities and responsible innovation: an empirical study of SMEs in China. Asia Pac J Manage, 2022;41. pp. 1–41.
15. Fan Z, Long R, Shen Z. Regional digitalization, dynamic capabilities and green innovation: evidence from e-commerce demonstration cities in China. Econ Model, 2024;139. p. 106846.
16. Wei Y-M, et al. Policy and management of carbon peaking and carbon neutrality: A literature review. Engineering. 2022;14:52–63.
17. Mao H, Lu J. Big data management capabilities and green innovation: a dynamic capabilities view. Sustainability. 2023;15(19):14637.
18. Sun J, Wu H, Shi S. Research on the relationship between higher education, technological innovation, and green Economy—Analysis based on Chinese data from 2011 to 2020. J Knowl Econ, 2024;15. pp. 1–42.
19. Khan SN, Riaz Z. Exploring the relevance of organizational learning for CSR strategy implementation: empirical evidence from a developing economy. J Knowl Econ, 2023;14. pp. 1–28.
20. Cheng X, Mo W, Duan Y. Factors contributing to learning satisfaction with blended learning teaching mode among higher education students in China. Front Psychol. 2023;14:1193675.
21. Soon CC, Salamzadeh Y. The impact of digital leadership competencies on virtual team effectiveness in MNC companies in Penang, Malaysia. J Entrepreneurship Bus Econ. 2021;8(2):219–53.
22. Minbaeva D, Santangelo GD. Boundary spanners and intra-MNC knowledge sharing: the roles of controlled motivation and immediate organizational context. Glob Strategy J. 2018;8(2):220–41.
23. Alabdali MA, et al. Unveiling green digital transformational leadership: Nexus between green digital culture, green digital mindset, and green digital transformation. J Clean Prod. 2024;450:141670.
24. Akbari M, et al. Does entrepreneurial leadership encourage innovation work behavior? The mediating role of creative self-efficacy and support for innovation. Eur J Innov Manage. 2021;24(1):1–22.
25. Mehmood S, Nazir S. The effect of psychological empowerment on employee performance: mediating role of psychological ownership. Interdisciplinary J Appl Basics Subj. 2021;1(9):30–41.
26. Hoang H, Perkmann M. Physician entrepreneurship: A study of early career physicians' founding motivations and actions. Soc Sci Med. 2023;339:116393.
27. Lin X, et al. Theory of Mind in adults with traumatic brain injury: A meta-analysis. Neurosci Biobehavioral Reviews. 2021;121:106–18.
28. Nguyen M, Sharma P, Malik A. Leadership styles and employee creativity: the interactive impact of online knowledge sharing and organizational innovation. J Knowl Manage. 2024;28(3):631–50.
29. Hussain ST, et al. Transactional leadership and organizational creativity: examining the mediating role of knowledge sharing behavior. Cogent Bus Manage. 2017;4(1):1361663.
30. Harms PD, et al. Leadership and stress: A meta-analytic review. Leadersh Q. 2017;28(1):178–94.
31. Mazon G, et al. Green absorptive capacity, green dynamic capabilities and green service innovation: a study in Brazilian universities. Int J Sustain High Educ. 2023;24(4):859–76.
32. Lingling L, Ye L. The impact of digital empowerment on open innovation performance of enterprises from the perspective of SOR. Front Psychol. 2023;14:1109149.
33. Russell JA, Mehrabian A. Distinguishing anger and anxiety in terms of emotional response factors. J Consult Clin Psychol. 1974;42(1):79.
34. Peng C, Kim YG. Application of the stimuli-organism-response (SOR) framework to online shopping behavior. J Internet Commer. 2014;13(3–4):159–76.
35. Tak P, Gupta M. Examining travel mobile app attributes and its impact on consumer engagement: an application of SOR framework. J Internet Commer. 2021;20(3):293–318.
36. Grindley PC, Teece DJ. Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics. Calif Manag Rev. 1997;39(2):8–41.
37. Beier CG, Schmidt S, Froehlich C. Dynamic capabilities and value co-creation in higher education. J Mark High Educ, 2023;33. pp. 1–20.
38. Hajiheydari N, et al. Digital sustainable business model innovation: applying dynamic capabilities approach (DSBMI-DC). Foresight. 2023;25(3):420–47.
39. Althnayan S, et al. Linking environmental transformational leadership, environmental organizational citizenship behavior, and organizational sustainability performance: A moderated mediation model. Sustainability. 2022;14(14):8779.
40. Warner KS, Wäger M. Building dynamic capabilities for digital transformation: an ongoing process of strategic renewal. Long Range Plann. 2019;52(3):326–49.
41. de Noronha MSES, et al. The role of foreign direct investment for the development of innovative capabilities in the Brazilian offshore wind energy industry. Revista Eletrônica De Negócios Internacionais: Internext. 2023;18(1):62–85.
42. Ambrosini V, Bowman C, Collier N. Dynamic capabilities: an exploration of how firms renew their resource base. Br J Manag. 2009;20:S9–24.
43. Tigre FB, Curado C, Henriques PL. Digital leadership: A bibliometric analysis. J Leadersh Organizational Stud. 2023;30(1):40–70.
44. Le PB, Lei H. Determinants of innovation capability: the roles of transformational leadership, knowledge sharing and perceived organizational support. J Knowl Manage. 2019;23(3):527–47.
45. Al-Husseini S, Elbeltagi I. Evaluating the effect of transformational leadership on knowledge sharing using structural equation modelling: the case of Iraqi higher education. Int J Leadersh Educ. 2018;21(4):506–17.
46. Easterby-Smith M, Prieto IM. Dynamic capabilities and knowledge management: an integrative role for learning? Br J Manag. 2008;19(3):235–49.
47. Nguyen T-M, Malik A. Cognitive processes, rewards and online knowledge sharing behaviour: the moderating effect of organisational innovation. J Knowl Manage. 2020;24(6):1241–61.
48. Gooderham PN. Enhancing knowledge transfer in multinational corporations: a dynamic capabilities driven model. Knowl Manage Res Pract. 2007;5(1):34–43.
49. Malik A, et al. Elevating talents' experience through innovative artificial intelligence-mediated knowledge sharing: evidence from an IT-multinational enterprise. J Int Manag. 2021;27(4):100871.
50. Robertson J, Caruana A, Ferreira C. Innovation performance: the effect of knowledge-based dynamic capabilities in cross-country innovation ecosystems. Int Bus Rev. 2023;32(2):101866.
51. Asyraff MA et al. Adoption of the Stimulus-Organism-Response (SOR) model in hospitality and tourism research: systematic literature review and future research directions. 2023.
52. Tran HT, Santarelli E, Wei WX. Open innovation knowledge management in transition to market economy: integrating dynamic capability and institutional theory. Econ Innov New Technol. 2022;31(7):575–603.
53. Yin S, Yu Y. An adoption-implementation framework of digital green knowledge to improve the performance of digital green innovation practices for industry 5.0. J Clean Prod. 2022;363:132608.
54. Anwar S, Saraih UN. Digital leadership in the digital era of education: enhancing knowledge sharing and emotional intelligence. Int J Educational Manage, 2024;38.
55. Riaz M et al. Assessing the role of organizational strategic factors in stimulating green innovation performance: moderating effects of green absorptive capacity. Bus Process Manage J, 2024;30.
56. Hund A, et al. Digital innovation: review and novel perspective. J Strateg Inf Syst. 2021;30(4):101695.
57. Di Vaio A, et al. The role of digital innovation in knowledge management systems: A systematic literature review. J Bus Res. 2021;123:220–31.
58. Benavides LMC, et al. Digital transformation in higher education institutions: A systematic literature review. Sensors. 2020;20(11):3291.
59. Gkrimpizi T, Peristeras V, Magnisalis I. Classification of barriers to digital transformation in higher education institutions: systematic literature review. Educ Sci. 2023;13(7):746.
60. Vakaliuk T et al. Green IT as a tool for design cloud-oriented sustainable learning environment of a higher education institution. arXiv preprint arXiv:2012.07744, 2020.
61. Junger D et al. Potentials of Green Coding–Findings and Recommendations for Industry, Education and Science–Extended Paper. arXiv preprint arXiv:2402.18227, 2024.

62. Zhang Y, et al. Organizational learning and green innovation: does environmental proactivity matter? Sustainability. 2018;10(10):3737.
63. Akram K et al. Factors affecting environmental performance during the Covid-19 period in the leather industry: A Moderated-Mediation approach. J Competitiveness, 2022(1).
64. Kremer H, Villamor I, Aguinis H. Innovation leadership: Best-practice recommendations for promoting employee creativity, voice, and knowledge sharing. Bus Horiz. 2019;62(1):65–74.
65. Cai Q, et al. The impact of digital leadership on hidden champions' competitive advantage: A moderated mediation model of ambidextrous innovation and value co-creation. J Bus Res. 2024;182:114819.
66. Yuan B, Cao X. Do corporate social responsibility practices contribute to green innovation? The mediating role of green dynamic capability. Technol Soc. 2022;68:101868.
67. Zhou Q, et al. Integrated framework of horizontal and vertical cross-project knowledge transfer mechanism within project-based organizations. J Manag Eng. 2020;36(5):04020062.
68. Steg L, Dreijerink L, Abrahamse W. Factors influencing the acceptability of energy policies: A test of VBN theory. J Environ Psychol. 2005;25(4):415–25.
69. Sarstedt M, et al. On the emancipation of PLS-SEM: A commentary on Rigdon (2012). Long Range Plann. 2014;47(3):154–60.
70. Ghasemy M, et al. This fast car can move faster: A review of PLS-SEM application in higher education research. High Educ. 2020;80(6):1121–52.
71. Hair JF, et al. When to use and how to report the results of PLS-SEM. Eur Bus Rev. 2019;31(1):2–24.
72. Legate AE, et al. PLS-SEM: Prediction-oriented solutions for HRD researchers. Hum Res Dev Q. 2023;34(1):91–109.
73. Hair JF Jr, et al. PLS-SEM or CB-SEM: updated guidelines on which method to use. Int J Multivar Data Anal. 2017;1(2):107–23.
74. Hair J, Alamer A. Partial least squares structural equation modeling (PLS-SEM) in second Language and education research: guidelines using an applied example. Res Methods Appl Linguistics. 2022;1(3):100027.
75. Kalnins A, Praitis Hill K. The VIF score. What is it good for? Absolutely nothing. Organizational Res Methods. 2025;28(1):58–75.
76. Ringle C, Silva DD, Bido D, Structural equation modeling with the SmartPLS., Bido D, da Silva D, Ringle C. (2014). Structural Equation Modeling with the Smartpls. Brazilian Journal Of Marketing, 2015. 13(2).
77. Shmueli G, Koppius OR. Predictive analytics in information systems research. MIS Q, 2011;35. pp. 553–72.
78. Erhan T, Uzunbacak HH, Aydin E. From conventional to digital leadership: exploring digitalization of leadership and innovative work behavior. Manage Res Rev. 2022;45(11):1524–43.
79. Chirumalla K. Building digitally-enabled process innovation in the process industries: A dynamic capabilities approach. Technovation. 2021;105:102256.
80. Ardi A, et al. The relationship between digital transformational leadership styles and knowledge-based empowering interaction for increasing organisational innovativeness. Int J Innov Creativity Change. 2020;11(3):259–77.
81. Tang J, et al. Flexible strain sensor based on CNT/TPU composite nanofiber yarn for smart sports bandage. Compos Part B: Eng. 2022;232:109605.
82. Shalev-Shwartz S, Ben-David S. Understanding machine learning: from theory to algorithms. Cambridge University Press; 2014.

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