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The Impact of Digital Orientation on New Product Development Performance: Does Knowledge Intensity Matter?

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Abstract: Digital orientation has become increasingly crucial for driving business success, but its impact on new product development (NPD) has not been fully explored in the existing literature. To address this gap, this paper draws upon dynamic capability theory to examine the relationship between digital orientation and NPD performance, as well as to elucidate the mechanism through which the former affects the latter. Hierarchical multiple regression analysis and partial least-square structure equation modeling are employed to analyze the data of 175 Chinese firms. The results indicate that digital orientation has a positive impact on NPD performance. Exploitation capability, exploration capability, and exploitation–exploration ambidexterity capability play partial mediating roles in the connection between digital orientation and NPD performance. Moreover, knowledge intensity exerts positive moderating effects on the relationships between digital orientation and exploitation, exploration, and exploitation–exploration ambidexterity capabilities.

Keywords: digital orientation; dynamic capabilities; NPD performance; knowledge intensity

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1. Introduction

Digital orientation is a strategic orientation that reflects a firm's strategic decision to pursue opportunities created by digital technologies [1,2]. It has gained attention in recent years as the rapid advancement of digital technologies leads to a significant transformation in the way organizations operate and compete in the marketplace, and firms prioritize the integration of digital technologies into their operations. Studies have shown that firms that prioritize digital orientation in their strategy and operations are more likely to achieve better financial success, environmental performance, and sustainable innovation [3]. Despite the recognized importance of new product development (NPD) for the survival and growth of organizations, the specific implications of digital orientation on NPD have received relatively little attention. As digital technologies are increasingly incorporated into products and services, understanding the impact of digital orientation on NPD becomes very crucial for business success. However, research on digital orientation and its impact on a firm's innovation outcomes, specifically on NPD, is still in its early stages. It remains unclear whether and how digital orientation can benefit a firm's product innovation or NPD performance [4]. In such a theoretical context, scholars have highlighted the need for further research to explore the relationship between digital orientation and NPD performance [2].

Furthermore, the existing literature has demonstrated that digitalization is closely associated with knowledge intensity. In terms of industries, digitalization tends to have a more pronounced positive impact on the competitiveness of value chains in knowledge-intensive industries compared to less knowledge-intensive ones [5]. In terms of firms, the implementation of digitalization may pose a greater challenge for knowledge-intensive firms in comparison to less knowledge-intensive ones. However, digitalization can bring more positive outcomes for knowledge-intensive firms by reducing the level of workforce professionalization required for operations and service provision [6]. This can ultimately lead to enhanced operational efficiency and value delivery. As such, the existing literature suggests that knowledge intensity plays a role in shaping the impact of digitalization on value creation and delivery. However, it remains unclear whether knowledge intensity also influences the relationship between digital orientation and NPD performance.

In addressing the identified gaps, this study adopts the dynamic capability view to explore the influence of digital orientation on NPD performance while also considering the potential impact of knowledge intensity on this relationship. The choice of dynamic capabilities as a theoretical framework is justified by its effectiveness in examining a firm's digital transformation [7], value creation and delivery in digital environments [8], and product development [9]. By leveraging the dynamic capability view, this research aims to provide a comprehensive understanding of how digital orientation contributes to NPD performance through dynamic capabilities such as exploitation, exploration, and ambidexterity capabilities, particularly in the context of knowledge-intensive firms, and to offer valuable insights for both theory and practice in the field of management. To account for the possible variations, dynamic capabilities are delineated and operationalized as exploitation capability, exploration capability, and exploitation–exploration ambidexterity capability [10,11]. The specific research questions of this study are as follows: (1) What is the effect of digital orientation on NPD performance? (2) In what way do dynamic capabilities unlock the process mechanism through which digital orientation affects NPD performance? (3) Does the level of knowledge intensity impact the relationship between digital orientation and NPD performance?

To address these questions, we first investigate the primary relationship between digital orientation and NPD performance to ascertain whether the former has a direct impact on the latter. Secondly, we examine the direct effect of digital orientation on exploitation, exploration, and exploitation–exploration ambidexterity capabilities. Moreover, we evaluate the mediating roles of these dynamic capabilities in the link between digital orientation and NPD performance to identify crucial paths. Lastly, we introduce knowledge intensity as the intra-firm environmental context that regulates the relationships between digital orientation and dynamic capabilities. Knowledge intensity reflects the extent to which a firm depends on the knowledge inherent in its activities and outputs as a source of competitive advantage [12]. As dynamic capabilities are defined as a firm's capabilities to seize new opportunities and realize sustainable competitive advantage by reconfiguring and protecting knowledge assets [13], a firm's knowledge density will influence the shaping and exertion of dynamic capabilities in the digital era. Therefore, we investigate the moderating effect of knowledge intensity to reveal the context in which digital orientation affects dynamic capabilities strongly or weakly.

This study makes a significant contribution to the literature on digital orientation and NPD performance by examining the role of dynamic capabilities and knowledge intensity in this relationship. To be specific, it makes contributions in three distinct ways. Firstly, this research responds to scholars' explicit calling for research on the impact of digital orientation on a firm's innovation outcome [2]. Although researchers have conceptualized digital orientation and investigated its impact on financial performance, sustainable innovation, and exploratory and exploitative innovation, the effect of digital orientation on NPD and how firms benefit from digital orientation to develop new products have not been studied extensively [4]. This study helps fill the gap by identifying the three pathways through which digital orientation affects NPD performance. Secondly, the study advances our knowledge of the antecedents of dynamic capabilities by identifying digital orientation as a new antecedent of exploitation capability, exploration capability, and exploitation–exploration ambidexterity capability. Although several studies have explored the antecedents of dynamic capabilities, little is known about how digital orientation relates to them. Additionally, extant research has not answered whether digital orientation helps balance exploitation activities and exploration activities [2]. This study highlights the positive effects of digital orientation on exploitation capability, exploration capability, and exploitation–exploration ambidexterity capability, contributing to our understanding of the antecedents of dynamic capabilities. Thirdly, this study emphasizes the crucial role of knowledge intensity as a moderating factor in the relationship between digital orientation and dynamic capabilities. While prior research has highlighted the significance of knowledge-intensive firms in aggressively embracing digital technologies to increase exploitation and exploration capabilities [14,15], whether the impact of digital orientation on dynamic capabilities would be stronger in knowledge-intensive firms remains unclear. This study contributes to the literature on dynamic capabilities by investigating the moderating effects of knowledge intensity on the relationship between digital orientation and dynamic capabilities, including exploitation, exploration, and ambidexterity capabilities. By focusing on knowledge intensity as a key moderating factor, this research sheds light on the unique challenges and opportunities faced by knowledge-intensive firms in leveraging digital orientation to strengthen their dynamic capabilities and promote new product development.

This study aligns perfectly with the scope and objectives of sustainable development, making it a suitable fit for publication in a journal on sustainability. First, digital orientation is a topic highly related to sustainable development because a firm's digital orientation enables it to leverage technology and digital platforms to enhance its sustainability efforts. Digital technologies provide opportunities for firms to optimize their operations, reduce resource consumption, and minimize waste. For example, firms can use data analytics and artificial intelligence to optimize their supply chain, reduce energy consumption, and improve resource allocation. This digitally oriented development can lead to more sustainable practices and contribute to sustainable development. Second, new product development driven by a firm's digital orientation can lead to the creation of sustainable products and services. Digital technologies enable firms to develop innovative solutions that address environmental and social challenges. For instance, firms can develop smart products that promote energy efficiency, enable waste reduction, or facilitate sustainable transportation. These products not only meet consumer demands but also contribute to sustainable development by reducing environmental impacts. Third, this topic has high relevance to the journal of *Sustainability*. *Sustainability* is an international and cross-disciplinary journal that focuses on the technical, environmental, cultural, economic, and social sustainability of human beings. Our research explores the impact of digital orientation on new product development performance, which is directly related to the economic and social sustainability of organizations. By understanding how digital orientation affects the performance of new product development, organizations can make informed decisions that contribute to sustainable development.

2. Theory and Hypothesis

2.1. Dynamic Capabilities

The term "dynamic capabilities" was labeled by Winter et al. (2003) as a firm's ability to achieve new forms of competitive advantage in rapidly changing environments [16]. Dynamic capabilities refer to an organization's ability to sense and seize emerging opportunities, as well as reconfigure its resources to achieve sustainable competitive advantages [13]. This concept has gained significant attention in both strategic management and innovation management over the past two decades. Reviewing the literature, three basic views emerged regarding the understanding of dynamic capabilities. First, it is viewed as a higher-order capability that creates, extends, or modifies existing low-order capabilities. Ordinary capabilities, such as operational, production, and marketing capabilities are considered zero-order capabilities, while dynamic ones are viewed as the first-order capabilities that initiate changes in the former [17]. Additionally, dynamic capabilities are often described as third-order capabilities that help firms renew or reconstruct the zero-order (organizational resources), first-order (resource allocation to achieve objectives), and second-order (core competence to build competitive advantages) capabilities to adapt to changing environments [18]. Second, dynamic capabilities are embedded in organizational processes such as product development, alliance building, strategic decision making [19], mergers and acquisitions [20], organizational learning, reverse engineering, flexible manufacturing [21], and information technology deployment [22]. Third, dynamic capability is a multidimensional concept with various perspectives on how to divide its dimensions. For instance, it can be deconstructed into resource integration, reconfiguration, gain, and release capabilities, or sensing, seizing, and reconfiguring capabilities [23]. It can also be deconstructed into exploration and exploitation capabilities [10].

Dynamic capabilities have attracted extensive interest and attention among scholars and managers not only because they can enhance short-term firm performance [18] but also because they can help shape long-term competitive advantage [24]. While early research suggests that dynamic capabilities have a direct effect on firm performance, recent studies argue for an indirect effect through creativity, operational capability [25], and other capability configurations [26].

As a critical area of inquiry, both internal and external facilitators have been identified as important contributors to a firm's dynamic capabilities. The internal facilitators include firm-level factors such as organizational structure, resources, culture, climate for trust, and information technology [22], as well as individual-level factors such as managers' tenure, knowledge, and experience [27]. The external facilitators include inter-organizational alliances and environmental factors such as changes in institutions, markets, and technology [28].

With the rise of digital technology and the development of the digital economy, the dynamic capability view has become an essential theoretical perspective for research on enterprise digital transformation and innovation management in the digital context [7]. Several studies have found that digital technology can significantly reshape business processes [29], accelerate knowledge flow and sharing [30], and promote different forms of dynamic capabilities [31]. However, more exploration is needed to determine which dynamic capabilities digital orientation can promote and under what conditions digital orientation is conducive to the formation of dynamic capabilities.

2.2. Hypothesis Development

(1) Digital orientation and NPD performance

Digital orientation refers to the strategic orientation of a firm toward leveraging opportunities presented by digital technologies [1] by integrating them into business processes to enhance value creation [32]. NPD performance simply refers to the success of new product development efforts [33]. Usually, it could be assessed by the extent to which new products are perceived to achieve the objectives. Previous studies show that strategic orientation is closely linked to resource allocation and has a significant impact on NPD performance [34]. Based on this premise, we aim to investigate the effect of digital orientation on NPD performance by drawing on the existing literature that explores the relationship between strategic orientation and NPD.

Firstly, digital orientation accelerates NPD speed, a critical factor for new product success [35]. Rapid NPD enables firms to introduce products to the market early, increasing their chances of attaining a first-mover advantage. NPD speed is influenced by factors such as process formalization, cross-functional coordination, communication within project teams, external suppliers, partners, logistic operators, and customer involvement [36–39]. Digital orientation positively influences NPD efficiency in several ways. It allows firms to incorporate digital systems for automated and efficient NPD processes, facilitates internal communication and collaboration, and empowers collaboration with value chain participants for customer-specific data and seamless supplier support [4,40]. The Haier Group's digital MBE life cycle management platform is a prime example of efficient NPD facilitated by digital orientation.

Secondly, digital orientation enhances the innovativeness of new products, a crucial indicator of NPD performance [41,42]. It can be defined as a kind of technology orientation that creates an environment that encourages experimentation and the application of digital technologies in product innovation [43,44]. Digitally oriented firms are inclined to acquire the latest technological advancements and utilize digital technologies in product development, swiftly transforming original offerings into innovative ones. Furthermore, digital platforms initiated by digital orientation connect firms with external partners who possess diverse knowledge and intelligence, fostering mutually beneficial cooperation and support for the development of new technologies and products of the digitally oriented firms [32].

Thirdly, digital orientation enables firms to better meet customers' needs and expectations with their new products, thus improving NPD performance. By embracing digital technologies such as data mining and big data analytics, digital orientation stimulates firms to gain insight into market trends and consumer behavior. Additionally, digitally oriented firms can leverage technologies such as augmented reality and instant social applications to enhance communication and interaction with customers. As a result, they can acquire comprehensive knowledge of the market and customers, keeping abreast of dynamic market opportunities and customer expectations. Both insights are essential to achieving NPD performance, including sales, profit margin, and market share [41]. NPD refers to the process of developing and introducing a new product or service to the market. Having a deep understanding of the real needs and opportunities of the market, familiarizing oneself with customer preferences, and integrating innovative market information and customer knowledge into NPD are key factors in ensuring new products are recognized and accepted by customers. Consequently, digital orientation helps adjust new products to better meet customers' needs and expectations [45], improving the likelihood of achieving the firm's expected NPD performance. Based on the above three aspects, we propose the following hypothesis:

H1. *Digital orientation positively relates to NPD performance.*

(2) Digital orientation and dynamic capabilities

After conducting an in-depth analysis of recent research, we conceptualize dynamic capabilities as exploitation capability and exploration capability [10,11]. Exploitation refers to the usage of existing resources to improve organizational products and processes, which involves activities such as refinement, selection, production, efficiency, implementation, and execution [46]. Contrarily, exploration encompasses elements like searching, variation, experimentation, flexibility, and innovation [46]. Accordingly, exploitation capability could be defined as a firm's capacity to leverage existing resources such as knowledge, experience, technologies, and skills to enhance and refine organizational products and processes. Additionally, exploration capability, in contrast, pertains to a company's ability to acquire new knowledge, technologies, and skills that are currently lacking. By developing exploration capability, companies can remain competitive in a changing environment by continually improving their products and operations.

Digital orientation is proposed to be a means to enhance a firm's exploitation capability. Firstly, digital orientation enhances the exploitation capability of a firm by promoting the storage and transfer of existing knowledge and other resources. This involves the digitalization of knowledge, experience, and other resources to create a substantial digital pool of internal resources, which enables a broader and deeper knowledge search [47]. Employees can gain access to this digital pool and acquire a comprehensive understanding of what they have and can utilize. The broad and deep search for existing knowledge and the rapid transfer of digital resources can significantly boost a firm's exploitation capability. Secondly, digital orientation facilitates cross-functional knowledge sharing and interpersonal interaction. Although implementing digital tools poses challenges [48], the use of digital tools such as social media for knowledge sharing and interaction is helpful for cross-functional knowledge sharing and interpersonal interaction in digitally oriented firms. This contributes to the efficient utilization of existing knowledge and solutions. Thirdly, digitization enables firms to optimize processes and streamline routines by enhancing standardization and automation processes [49]. This refinement of routines and processes improves the efficiency of production and execution, thereby promoting a firm's exploitation capability. Based on these points, we propose the following hypothesis:

H2a. *Digital orientation positively relates to a firm's exploitation capability.*

Exploration capability reflects a firm's ability to pursue new knowledge [46], which usually involves the acquisition of new knowledge from external environments and the creation of new knowledge within the firm. We contend that digital orientation can aid in enhancing exploration capability. First, pursuing digital orientation pushes firms to acquire new knowledge, skills, and competences. Digital orientation represents a firm's strategic decision to digitize organizational functions [47]. To implement such a strategic decision, firms need to show commitment to the application of digital technologies in their activities and create an organizational climate to encourage experimentation with digital technologies. As a result, firms keep an open attitude toward emerging digital technologies and learn to embrace digital initiatives in their traditional functions. This would stimulate firms to engage in explorative activities, for example, searching for new knowledge [50], generating new ways to create value [45], and trying new ideas [51]. Second, digital technology blurs organizational boundaries [52]. Digitally oriented firms usually build digital platforms both inside and outside the firms, through which cross-organizational coordination for product and process would be more effective and efficient. Meanwhile, focal firms are tightly connected to partners in the supply chain and strategic alliance who have complementary knowledge and technology. With exposure to rich heterogeneous resources and tight collaboration, digitally oriented firms are more likely to acquire, assimilate, and adopt new knowledge and technologies in their operations. In other words, digital orientation potentially enables firms to go beyond organizational limits to adopt explorative behaviors. Therefore, we suggest the following hypothesis:

H2b. *Digital orientation positively relates to a firm's exploration capability.*

Ambidexterity capability refers to a firm's capacity to pursue exploitation and exploration simultaneously. A firm's digital orientation can facilitate this capability. First, digital orientation aims to digitize intra-firm and inter-firm processes, allowing firms of all sizes to pursue both exploitation and exploration simultaneously and achieve ambidexterity [53]. By digitizing intra-firm processes, firms increase the efficiency of their operations, allowing them to pursue exploitation. Meanwhile, digitizing inter-firm processes streamlines and strengthens collaboration, enabling exploration. Second, exploration is challenging and risky, requiring substantial knowledge and technology support, while exploitation is typically low-risk and provides quick results. As a result, managers often have a high propensity for exploitative activities, causing a gap between exploitation and exploration capabilities. Digital orientation can help bridge this gap, as digital technologies such as social media have a stronger impact on exploration, while also having positive effects on exploitation [54]. Additionally, the evolution of digital platforms can improve a firm's exploitation and exploration capabilities, enabling them to dynamically balance these capabilities by blurring boundaries across firms and accessing a broader range of knowledge and technology support [55]. Therefore, digitally oriented firms would be more likely to achieve exploitation–exploration ambidexterity. And thus, we propose Hypothesis 2c.

H2c. *Digital orientation positively relates to a firm's ambidexterity capability.*

(3) The mediating role of dynamic capabilities

A firm's dynamic capabilities refer to its ability to leverage internal and external resources to address changing environments, resulting in positive outcomes such as financial performance, product innovation, organizational process restructuring, and NPD. On the one hand, dynamic capabilities can contribute to NPD by reconfiguring knowledge resources and operational capabilities [56]. On the other hand, digital technology and resources can shape dynamic capabilities through integration into organizational processes [57]. However, this integration process is challenging and requires not only technological investments but also an organizational strategic orientation toward digital transformation [58]. As is known, digital orientation reflects such a strategic orientation to digitizing a firm's organizational process and functions [47]. Therefore, dynamic capability theory is a suitable lens to explore the mediating mechanism of the relationship between digital orientation and NPD performance.

To achieve NPD performance, firms need to respond quickly to market demand. Particularly, in dynamic markets, customer demands change continuously [59], which requires firms to develop products and make them available efficiently. This requirement can be met by enhancing exploitation capability which involves activities related to cost savings and efficiency improvement [60]. Exploitation saves the cost of NPD because it uses resources that firms already have. By refining existing routines and processes, exploitation capability leads to increased familiarity with operational domains [61], making the effective production of newly developed products possible. As a result, exploitation capability contributes to NPD performance by means of efficient development and production of new products. Meanwhile, as hypothesized, exploitation capability can be shaped by digital orientation through the standardization and automation of routines and processes. Therefore, exploitation capability acts as the "efficiency logic" and mediates the impact of digital orientation on NPD performance. Based on the above, we hypothesize H3a.

H3a. *Exploitation capability mediates the positive effect of digital orientation on NPD performance.*

Novelty represents the uniqueness of new products in comparison to competitors in the marketplace. This becomes a critical aspect for new products to achieve good performance. However, a firm's exploration capability determines product novelty [62]. High exploration capability allows firms to identify new opportunities, generate fresh ideas, and introduce new elements in NPD. This is especially important in a dynamic market environment where customers are constantly seeking new products. Therefore, consistent with prior research, we concur that exploration capability is positively related to NPD performance [63,64]. Meanwhile, based on our arguments for Hypotheses 1 and 3, both NPD performance and exploration capability are influenced by digital orientation. It implies that digital orientation may enhance a firm's exploration capability, which, in turn, increases the firm's NPD performance through variation and experimentation [65]. In other words, exploration capability acts as "novelty logic" and partly mediates the positive effect of digital orientation on NPD performance. Hence, we suggest H3b.

H3b. *Exploration capability mediates the positive effect of digital orientation on NPD performance.*

In developing new products, exploitation capability and exploration capability are complementary. Exploitation capability enables firms to offer customers new products with incremental improvement and cost-efficient advantage [66], whereas exploration capability allows firms to create new products with radical innovation and differentiated advantage [67]. Exploitation capability increases the meaningfulness of new products, contributing to NPD performance, while exploration capability increases novelty and uniqueness, also contributing to NPD performance [62]. Therefore, it is necessary for firms to possess both exploitation and exploration capabilities for effective NPD. Instead of overemphasizing either capability, a simultaneous pursuit of both can lead to better

NPD performance. Meanwhile, as hypothesized based on dynamic capability theory, digital orientation can facilitate a simultaneous pursuit of both exploitation and exploration capabilities. It implies that digital orientation may enhance a firm's ambidexterity capability and indirectly impact NPD performance through the ambidexterity capability. In other words, ambidexterity capability serves as a "balancing logic" between efficiency and novelty and partially mediates the positive effect of digital orientation on NPD performance. Hence, we develop H3c.

H3c. *Ambidexterity capability mediates the positive effect of digital orientation on NPD performance.*

(4) The moderating role of knowledge intensity

Knowledge intensity generally refers to the extent to which a firm depends on the knowledge inherent in its core value-creation activities and outcomes as a source of competitive advantage [12,68]. It is a critical concept in dynamic capability theory because dynamic capabilities can be understood as the abilities of an organization to perceive and seize new opportunities and realize sustainable competitive advantage by reconfiguring and protecting knowledge assets [13]. In other words, dynamic capabilities are essentially the abilities to integrate or reconfigure the existing knowledge base of an organization, and thus, a firm's knowledge density is inextricably related to the shaping and exertion of dynamic capabilities. High knowledge intensity means that the main operational process, final products, and even competitive advantage of the firm depend on a wide variety of knowledge and skills to a great extent. Hence, knowledge intensity increases the difficulties of exploitation. To improve exploitation capability, knowledge-intensive firms need to efficiently leverage a large amount of diversified knowledge. In this case, the efficient storage, search, and sharing of existing knowledge is particularly important for knowledge-intensive firms compared with non-knowledge-intensive firms [69]. Digital orientation helps achieve the efficient storage, search, and transfer of large-scale knowledge through digital technologies such as big data management, cloud storage, and social media. This enables employees to easily search and quickly acquire the existing knowledge within the firm. Additionally, the rapid knowledge search and the quick access to the exact knowledge pool would be of great importance for frontline employees to apply the existing knowledge and skills efficiently in value creation. In this vein, digital orientation meets well the high requirement of knowledge-intensive firms, and thus, it contributes more significantly to exploitation capability in the case of high knowledge intensity. The positive effect of digital orientation on exploitation capability would be stronger when knowledge intensity is high. Based on the above, we hypothesize H4a.

H4a. *Knowledge intensity positively moderates the relationship between digital orientation and exploitation capability.*

Knowledge intensity affects not only the leverage of existing knowledge but also the pursuit of new knowledge. In a knowledge-intensive context, firms need to pursue new knowledge constantly, which involves frequent knowledge creation or acquisition activities [51]. Therefore, in addition to exploitation capability, knowledge-intensive firms expect more eagerly than other firms to develop exploration capability as well. We argue that digital orientation plays a more positive role in the exploration capability in the context of high knowledge intensity than it does in less knowledge-intensive situations. First, digital orientation well supports intensive knowledge-creation activities. Knowledge-intensive firms require constant knowledge-creation activities. Frequent intra-firm knowledge sharing, social interactions, and collaborations are very critical for them [68]. In this sense, digital orientation can give full play to its advantages in the context of high knowledge intensity because it facilitates cross-functional communication and interpersonal interaction among employees, which in turn would promote knowledge sharing and cooperation within a firm, while for less knowledge-intensive firms, the activities are mostly characterized by routine, certainty, and standardization, which requires less collaborative knowledge structures and processes [70]. And thus, the corresponding effect of digital orientation on exploration capability is constrained to some extent. Second, knowledge intensity will amplify the positive influence of digital orientation on exploration capability in terms of new knowledge acquisition. In knowledge-intensive firms, the exploration usually involves experiments with a wide variety of professional knowledge [71], which is complex and challenging. External knowledge acquisition would be very helpful for conducting such experiments. The more knowledge-intensive a firm is, the more intense is its external knowledge acquisition [69]. Digital orientation is constructive and meaningful to the intense external knowledge acquisition. With digital orientation, both internal and external digital platforms would be built and put into practice so that the knowledge-intensive firms are able to acquire complementary knowledge and assistance from partners and get qualified customers involved in the experiments. As a result, knowledge-intensive firms can achieve a high level of exploration capability. Based on the above, we develop H4b.

H4b. *Knowledge intensity positively moderates the relationship between digital orientation and exploration capability.*

As we argue for Hypothesis 2c, digital orientation can facilitate a firm's ambidexterity capability. However, for knowledge-intensive firms, the effect of digital orientation on ambidexterity capability would be stronger than that for less knowledge-intensive firms. This argument is based on the following three aspects: First, knowledge intensity increases the need to balance exploitation and exploration [15]. In contrast to others, knowledge-intensive firms are more eager to make full use of the advantage of digital orientation in the simultaneous pursuit of exploitation and exploration to achieve ambidexterity. As a result, the effect of digital orientation on ambidexterity capability will be stronger with the increase in knowledge intensity. Second, both the leverage of existing knowledge and the pursuit of new knowledge involve complex processes and structural arrangements. Knowledge intensity increases the complexity of processes and arrangements, which requires efficient intra-firm knowledge sharing and collaborations. In this case, the advantages of digital orientation can be well reflected. It can not only provide technological support but also create a favorable climate and change the structure for cross-functional sharing [58], intra-firm interactions, and collaborations [53]. As a result, the role of digital orientation in the simultaneous pursuit of exploitation and exploration would be more significant in the context of high knowledge intensity. Thus, in the case of knowledge intensity, the effect of digital orientation on exploitation–exploration ambidexterity is stronger. Third, knowledge-intensive firms, if pursuing exploitation–exploration ambidexterity, should increasingly involve external sources of knowledge and should adopt an open approach considering knowledge from customers, clients, suppliers, competitors, universities, and various external partnerships. As we know, digitally orientated firms are more likely to effectively establish digital infrastructures, which connect the firms well with external stakeholders [5] and leverage an ecosystem of external partners for complementary competencies [72]. Therefore, digital orientation could play a more significant role in achieving exploitation–exploration ambidexterity in the context of high knowledge intensity. Based on the above, this paper suggests H4c.

H4c. *Knowledge intensity positively moderates the relationship between digital orientation and ambidexterity capability.*

Based on the above hypothesis development, the research model is depicted in Figure 1.

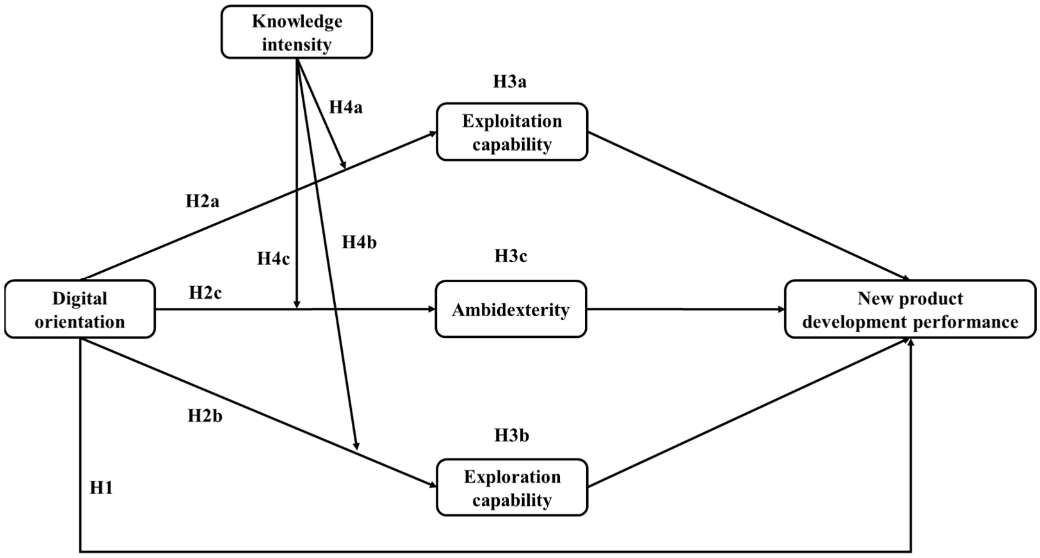

Figure 1. Hypothesis model.

3. Research Method

3.1. Sample and Data Collection

A questionnaire was developed in Chinese and all items were ensured to be consistent with the original ones by adopting the back-translation method recommended by Schaffer and Riordan (2003) [73]. We invited two translators to accomplish this. One is an associate professor who majored in both linguistics and business administration, and the other is a professional translator specializing in business English. After the questionnaire was generated, a small sample of 25 managers was selected to pretest the questionnaire. According to the feedback, the questionnaire was carefully polished. For the final survey, the formal questionnaire was distributed via mail, email, and social media to 763 managers who oversee NPD or digital technology through 90 alumni randomly selected from the alumni database of our school. The managers were selected randomly by the alumni from the database of their suppliers, customers, and business partners who meet the requirements of the survey. The first reminder was sent at the beginning of April, and the second reminder was sent at the beginning of May 2022. Eventually, 175 usable responses were received (response rate 22.93%). The population size was 175,962, and the required sample size was calculated with an acceptable error of 10% and a confidence level of 95%. The recommended minimum sample size was 96. As we finally acquired 175 valid samples, the actual margin of error was 7.40%. Non-response bias was determined by comparing the early responses and the late ones [74]. The results show no significant differences at the 5% level, which verified that non-response bias is not a concern. Considering the respondents, they had to be working in their current firms for more than one year so that they would have a general perception of the whole business. Furthermore, as required, all of them were senior managers who were familiar with their firms' digital technology management, product development, and technological innovation.

We surveyed the firms in a wide variety of manufacturing industries, for example, auto and motorcycle parts, biomedicine, textile, furniture, special equipment, general equipment, electronic equipment, communication equipment, electrical appliances, chemical industry, and advanced equipment from Hangzhou, Wenzhou, Jinhua, Ningbo, Shaoxin, Taizhou, Huzhou, and Quanzhou. These cities are all in the list of top 100 cities ranked by digital and innovation development, and the surveyed industries are all pillar industries in the corresponding cities. The inclusion of firms from a diverse range of manufacturing industries enhances the industry representativeness of the sample. By covering the sectors, the sample ensures a comprehensive representation of the manufacturing landscape, thereby increasing its representativeness. The strategic selection of cities known for digital development and innovative practices ensures that the sample is representative of areas with a strong focus on digital technology application and product innovation. This geographic relevance aligns with the research objectives and enhances the representativeness of the sample by capturing firms from regions at the forefront of digital and innovative development. The sample size is sufficient, contributing to the statistical significance of the findings. The large sample size enhances the representativeness of the sample and increases the reliability of the research outcomes. The details of the samples are presented in Table 1.

Table 1. Descriptive statistics of the survey sample.

Items	Numbers of Firms	Percentage (%)
Firm age (years)		
≤5	16	9.14
6–10	34	19.43
11–15	58	33.14
16–20	52	29.71
21–25	9	5.14
26–30	3	1.71
≥31	3	1.71
Firm size (employees)		
<100	12	6.86
100–299	26	14.86
300–499	42	24.00
500–999	66	37.71
1000–1999	16	9.14
2000–2999	8	4.57
≥3000	5	2.86
Firm ownership		
State-owned	36	20.57
Non-state-owned	139	79.43

3.2. Measures

The measures were drawn from existing studies, and 7-point Likert scales were applied for all items. Digital orientation was measured by four items from Khin and Ho (2019) [43]. The items were also adopted by Yousaf et al. (2021) in their research [32], which inquired about the extent to which a firm committed to using digital technologies in solutions, innovations, and other activities. Exploitation capability was measured by five items asking the extent to which a firm funded, updated, or strengthened current knowledge, skills, or technologies in innovations and operations [10]. Exploration capability was measured by five items asking the extent to which a firm funded, acquired, or strengthened new knowledge, skills or technologies in innovations and operations [10]. Ambidexterity capability was measured with a new method taking both combined dimension and balanced dimension into consideration [75]. This method was adopted because it overcomes the main drawbacks of summing or multiplying. The calculation is as follows:

$$\text{Ambidexterity} = (\text{exploitation} + \text{exploration})/(|\text{exploitation} - \text{exploration}|)$$

Whenever the value of the denominator is zero for any of the observations, the following formula is used instead:

$$\text{Ambidexterity} = (\text{exploitation} + \text{exploration})/(|\text{exploitation} - \text{exploration}| + 1)$$

Following the examples of Ferreras-Mendez et al. (2021) and Shan et al. (2016), NPD performance was measured by three items asking if the new product develop programs achieved profitability and overall objectives [76,77]. Knowledge intensity was measured by the scale developed by Autio et al. (2000) [12]. Unlike counting the number of patents, this scale can be adopted to inquire about a wide variety of companies across industries [69].

As for control variables, firm age, firm size, and firm ownership were included, which is in line with the previous literature on NPD [34,35]. Firm age was measured by seven levels based on the duration since the firm was founded, and firm size was measured by seven levels based on the number of employees [78]. Firm ownership was a dichotomous variable coded as "0" for state-owned enterprises and "1" for non-state-owned enterprises.

We believe the measures are proper and applicable to this study. First, the measures of all the focal variables were carefully examined and selected from the existing literature. Through extensive literature review and comparison, we selected the measures that best match the connotations of our variables and research context. This endows the preliminary legitimacy of the measures. Second, we adopted the conventional and commonly accepted expression of those items as much as possible where applicable. Third, a pretest was conducted to ensure the applicability of the measures. After designing the survey questionnaire, we selected some appropriate research subjects to pretest the questionnaire. Based on the feedback from the respondents, appropriate polishing where necessary was carried out to the questionnaire in the Chinese context. The results of our early test indicate that the measurement items of these variables in this study are not ambiguous and can easily be understood by the respondents. Additionally, the reliability and validity tests support the appropriateness of the measures. As a result, the measurement items are appropriate and applicable to this study.

3.3. Method Validity Tests

To examine the reliability of the measures, the internal consistency coefficient and composite reliability were assessed by SPSS and SmartPLS. As shown in Table 2, Cronbach's alpha ranges from 0.894 to 0.954, and the minimum composite reliability (α = 0.934) is above 0.7, which represents a strong internal consistency reliability. To test the convergent and discriminant validity, loadings, cross-loadings, and the average variance extracted (AVE) were calculated. The minimum loading is 0.881 and the maximum cross-loading is 0.259, which indicates an adequate convergent validity. Moreover, the lowest value of AVE (AVE = 0.795) is higher than the threshold of 0.5, and the value of the square root of AVE is also larger than that of the correlation coefficient with other constructs. The results indicate that the model has adequate discriminant validity. The discriminant validity was further assessed by using the Heterotrait–Monotrait (HTMT) ratio. The HTMT ratios between constructs presented in Table 3 are all less than 0.9 [79], which repeatedly supports the discriminant validity.

Table 2. Measures, loadings, and reliability.

Variables	Items	Loading	α	CR
Digital orientation (Khin and Ho, 2019) [43]	We are committed to using digital technologies in developing our new solutions.	0.894	0.914	0.940
	Our solutions have superior digital technology.	0.892		
	New digital technology is readily accepted in our organization.	0.885		
	We always look out for opportunities to use digital technology in our innovation.	0.895		
Knowledge Intensity (Autio et al., 2000) [12]	We have a strong reputation for technological excellence.	0.913	0.894	0.934
	Knowledge intensity is characteristic of our business.	0.895		
	There is a strong knowledge component in our products and services.	0.916		

Table 2. *Cont.*

Variables	Items	Loading	α	CR
Exploitation capability (Ferreira et al., 2020) [10]	In the last three years, we upgraded our current knowledge and skills to familiar products and technologies.	0.896	0.938	0.953
	In the last three years, we invested in enhancing skills in exploiting mature technologies that improve the productivity of current innovation operations.	0.881		
	In the last three years, we enhanced our competencies in searching for solutions to customer problems that are near to existing solutions.	0.892		
	In the last three years, we upgraded skills in the current product development processes.	0.915		
	In the last three years, we strengthened our knowledge and skills for projects that improve the efficiency of existing innovation activities.	0.893		
Exploration capability (Ferreira et al., 2020) [10]	In the last three years, we acquired manufacturing technologies and skills entirely new to our firm.	0.927	0.955	0.965
	In the last three years, we learned product development skills and processes entirely new to the industry.	0.919		
	In the last three years, we acquired entirely new managerial and organizational skills that are important for innovation.	0.922		
	In the last three years, we learned new skills in areas such as funding new technology, staffing R&D functions, and training and development of R&D and engineering personnel.	0.913		
	In the last three years, we strengthened innovation skills in areas where we had no prior experience.	0.923		
NPD performance (Ferreras-Mendez et al., 2021; Shan et al., 2016) [76,77]	The overall performance of our new product development program has met our objectives.	0.931	0.918	0.948
	From an overall profitability standpoint, our new product development program has been successful.	0.923		
	Compared with our major competitors, our new product development program is far more successful.	0.926		

Note: α = Cronbach's alpha; CR = composite reliability.

To test non-response bias, we conducted a multivariate analysis of variance concerning the firm's age, size, and ownership. The results showed no significant differences between respondents and non-respondents (Wilk's lambda = 0.971; Pillai's trace = 0.029, $p > 0.5$). Regarding potential common method bias, the techniques recommended by Podsakoff et al. (2003) to reduce the potential risk of common method bias (CMB) were adopted in this research [80]. First, the measures for digital orientation, exploitation, exploration, knowledge intensity, and NPD performance are all well-established scales from the extant literature, which can capture the exact effects. Second, the independent variable and dependent variable were separated in the questionnaire so that they seemed to be unrelated. Third, it was underlined in the survey that the response was fully autonomous, and there were no right or wrong answers to the items. After data collection, CMB was examined by performing Harman's one-factor test [81]. The explorative factor analysis with varimax rotation yielded more than one factor, among which the first factor accounted for 21. 404% of total variance only. Confirmative one-factor analysis with four key constructs was conducted as well. The results show that the confirmative one-factor model (χ^2 (170) = 9.849, SRMR = 0.135, RMSEA = 0.226, CFI = 0.522, IFI = 0.525, TLI = 0.466) is not acceptable, and it is much worse than the four-factor model (χ^2 (160) = 1.606, SRMR = 0.034, RMSEA = 0.059, CFI = 0.969, IFI = 0.969, TLI = 0.963). Therefore, the common method bias is not a concern in this study.

Table 3. Correlation, square root of AVE, and statistics.

Number	Variables	Mean	SD	1	2	3	4	5	6	7	8	9
1	Firm age	3.143	1.216	—	0.106	0.010	0.028	0.085	0.021	0.034	0.054	0.097
2	Firm size	3.526	1.330	0.106	—	0.063	0.106	0.046	0.100	0.062	0.025	0.035
3	Firm ownership	0.794	0.405	−0.010	0.063	—	0.112	0.106	0.099	0.226	0.080	0.042
4	Digital orientation	4.137	1.497	0.016	0.102	0.107	**(0.892)**	0.467	0.609	0.552	0.575	0.399
5	Knowledge intensity	4.351	1.455	−0.080	0.044	0.099	0.423 **	**(0.908)**	0.482	0.421	0.355	0.255
6	Exploitation capability	4.067	1.474	−0.016	0.097	0.096	0.565 ***	0.444 ***	**(0.896)**	0.473	0.552	0.325
7	Exploration capability	4.032	1.591	−0.033	0.061	0.220 **	0.517 ***	0.391 ***	0.448 ***	**(0.921)**	0.549	0.345
8	NPD performance	3.951	1.614	0.052	0.021	0.077	0.527 ***	0.326 **	0.513 ***	0.515 ***	**(0.927)**	0.367
9	Ambidexterity capability	10.178	12.139	−0.097	0.035	0.042	0.383 ***	0.241 ***	0.316 ***	0.338 ***	0.352 ***	—

Note: ** $p < 0.01$, *** $p < 0.001$; SD = standard deviation. The diagonal values in bold indicate the square root of the average variances extracted (AVE). The scores in the lower diagonal indicate inter-construct correlations. The scores in the upper diagonal indicate the Heterotrait–Monotrait (HTMT) ratio.

4. Empirical Results

4.1. Hypothesis Test

This study adopted hierarchical multiple regression modeling to test the hypotheses. Hierarchical multiple regression enables us to scrutinize the effects of each variable step by step and the altogether effect of them as well. SPSS was used for data processing. The results are presented in Table 4. Firstly, the direct effects were tested. Model 1 and Model 2 were created to test the direct effect of digital orientation on NPD performance. The results show that the coefficient of digital orientation is positive and significant ($\beta = 0.511$, $p < 0.001$) after controlling firm age, size, and ownership, which indicates there is a positive relationship between digital orientation and NPD performance. Hence, Hypothesis H1 is supported. Model 10, Model 12, and Model 14 were created to test the direct effects of digital orientation on dynamic capabilities. The results show that the coefficients of digital orientation are all positive and significant, which supports Hypothesis H2a proposing the positive influence of digital orientation on exploitation capability ($\beta = 0.540$, $p < 0.001$), Hypothesis H2b proposing the positive impact of digital orientation on exploration capability ($\beta = 0.498$, $p < 0.001$), and Hypothesis H2c proposing the positive effect of digital orientation on ambidexterity capability ($\beta = 0.381$, $p < 0.001$).

Table 4. The results of hierarchical multiple regression analysis.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15
Firm age	0.048	0.047	0.063	0.068	0.086	0.057	0.061	0.068	0.078	−0.031	−0.003	−0.041	−0.013	−0.103	−0.082
Firm size	0.003	−0.044	−0.040	−0.022	−0.014	−0.056	−0.045	−0.046	−0.055	0.035	0.023	0.022	−0.015	0.009	−0.010
Firm ownership	0.072	0.020	0.029	−0.039	0.058	0.010	−0.036	0.020	−0.031	0.030	0.004	0.166 *	0.136 *	−0.001	−0.030
Digital orientation		0.511 ***				0.331 ***	0.342 ***	0.433 ***	0.193 *	0.540 ***	0.393 ***	0.498 ***	0.345 ***	0.381 ***	0.257 ***
Knowledge intensity											0.227 **		0.184 **		0.077
Exploitation capability			0.512 ***			0.334 ***			0.259 **						
Exploration capability				0.515 ***			0.338 ***		0.259 **						
Ambidexterity capability					0.369 ***			0.206 **	0.128 †						
Digital orientation × Knowledge intensity											0.153 *		0.225 **		0.274 ***
R^2	0.008	0.263	0.266	0.259	0.142	0.342	0.344	0.299	0.408	0.301	0.365	0.295	0.369	0.155	0.226
F test	0.433	15.195 ***	15.363 ***	14.823 ***	7.043 ***	17.532 ***	17.730 ***	14.423 ***	16.439 ***	18.288 ***	16.092 ***	17.783 ***	16.363 ***	7.818 ***	8.194 ***
VIF (max)	1.016	1.024	1.023	1.055	1.022	1.437	1.418	1.192	1.720	1.024	1.354	1.024	1.354	1.024	1.354

Note: The dependent variable of Model 1 to Model 9 is NPD performance. The dependent variable of Model 10 and Model 11 is exploitation capability. The dependent variable of Model 12 and Model 13 is exploration capability. The dependent variable of Model 14 and Model 15 is ambidexterity capability. † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Secondly, to test the mediating effects, a series of models were created by following the procedure proposed by Kenny et al. (1998) [82]. In Step 1, Model 2, Model 10, Model 12, and Model 14 were created, and the results show the positive effects of digital orientation on NPD performance, exploitation capability, exploration capability, and ambidexterity capability separately, which has already been stated above. In Step 2, Model 3, Model 4, and Model 5 were created, and the results present the positive impacts of exploitation capability ($\beta = 0.512$, $p < 0.001$), exploration capability ($\beta = 0.515$, $p < 0.001$), and ambidexterity capability ($\beta = 0.369$, $p < 0.001$) on NPD performance. After that, in Step 3, Model 6, Model 7, and Model 8 were created to test the mediating effect of exploitation capability ($\beta = 0.334$, $p < 0.001$), exploration capability ($\beta = 0.338$, $p < 0.001$), and ambidexterity capability ($\beta = 0.206$, $p < 0.01$) separately, which indicated that each of them mediates partially the influence of digital orientation on NPD performance, while Model 9 was created to test the mediating effects altogether. The results show that the significance level of digital orientation is reduced dramatically from $p < 0.001$ to $p < 0.05$ after adding the mediating variables to the model. Among the three paths through which digital orientation affects NPD indirectly, path exploitation capability ($\beta = 0.259$, $p < 0.01$) and path exploration capability ($\beta = 0.259$, $p < 0.01$) are more significant than path ambidexterity capability ($\beta = 0.128$, $p < 0.1$). The above results support Hypothesis H3a, Hypothesis H3b, and Hypothesis H3c.

Thirdly, the moderating effects were finally tested. Model 11, Model 13, and Model 15 were created to test the moderating effects, and the results show that the effects of digital orientation on exploitation capability ($\beta = 0.393$, $p < 0.001$), exploration capability ($\beta = 0.345$, $p < 0.001$), and ambidexterity capability ($\beta = 0.257$, $p < 0.001$) are significant and meanwhile, the interaction item of digital orientation and knowledge intensity is also positive and significant in Model 11 ($\beta = 0.153$, $p < 0.05$), Model 13 ($\beta = 0.225$, $p < 0.01$), and Model 15 ($\beta = 0.274$, $p < 0.001$). These empirical results support Hypothesis H4a, Hypothesis H4b, and Hypothesis H4c proposing the moderating effects of knowledge intensity on the relationship between digital orientation and exploitation capability, the relationship between digital orientation and exploration capability, and the relationship between digital orientation and ambidexterity capability.

Subsequently, a simple slope analysis was conducted. The results show that the effect of digital orientation on exploitation capability is stronger ($b = 0.528$, $p < 0.001$) for a high level (+1 SD) of knowledge intensity than for a low level (−1 SD) of knowledge intensity ($b = 0.261$, $p < 0.05$). As demonstrated in Figure 2a, Figure 2a illustrates the moderating effect of knowledge intensity on the relationship between digital orientation and exploitation capability. The relationships between digital orientation and exploration capability as well as the relationship between digital orientation and ambidexterity capability are also similar. They are stronger ($b = 0.555$, $p < 0.001$; $b = 0.485$, $p < 0.001$ separately) in the case of high knowledge intensity (+1 SD) than they are ($b = 0.144$, $p > 0.1$; $b = 0.013$, $p > 0.1$ separately) in the case of low knowledge intensity (−1 SD). Figure 2b demonstrates the moderating effect of knowledge intensity on the relationship between digital orientation and exploration capability, while Figure 2c shows the moderating effect of knowledge intensity on the relationship between digital orientation and ambidexterity capability. As is shown, the slashes become steeper when knowledge intensity increases. Moreover, the moderated mediations were assessed. The moderated mediating effects for the path from the interaction item (digital orientation and knowledge intensity) to NPD performance via exploration capability (path coefficient = 0.056, $p < 0.05$) and ambidexterity capability (path coefficient = 0.027, $p < 0.05$) are a little higher than that for the path from the interaction item (digital orientation and knowledge intensity) to NPD performance via exploitation capability (path coefficient = 0.037, $p < 0.1$). The results imply that exploration capability and ambidexterity capability, compared with exploitation capability, are two more significant paths through which digital orientation affects NPD performance under the circumstance of knowledge intensity.

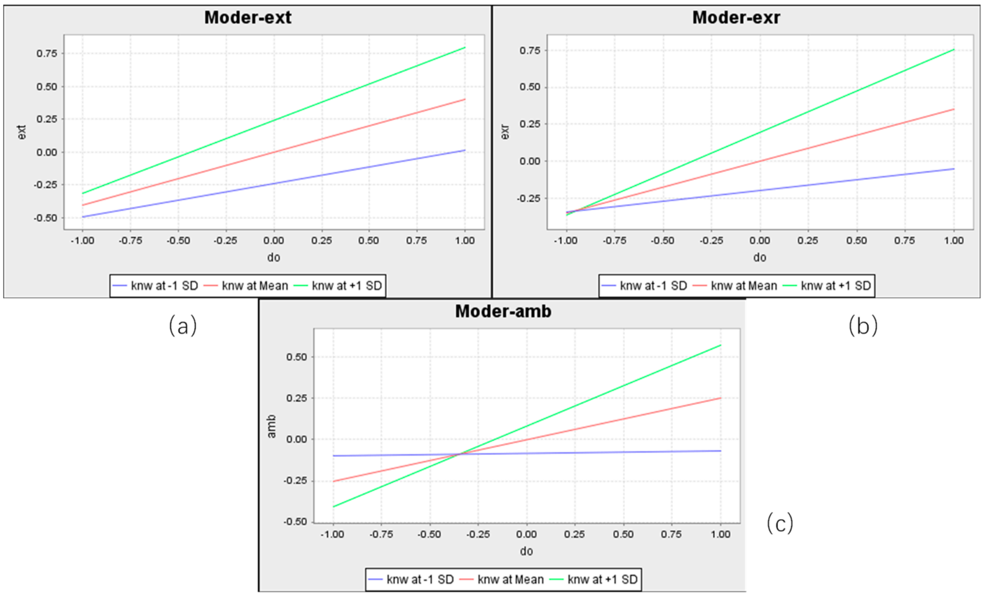

Figure 2. The results of the simple slope analysis. (**a**) shows the result of the simple slope analysis for the moderating effect of knowledge intensity on relationship between digital orientation and exploitation capability. (**b**) shows the result of the simple slope analysis of the moderating effect of knowledge intensity on the relationship between digital orientation and exploration capability. (**c**) shows the result of the simple slope analysis of the moderating effect of knowledge intensity on the relationship beween digital orientation and ambidexterity capability. Note: ext = exploitation, exr = exploration, amb = ambidexterity, knw = knowledge intensity.

4.2. Robustness Test

To assess the robustness of the empirical results, two additional tests were conducted. First, following the approach suggested by Choi et al. (2014), we adopted alternative measures and estimation methods to reassess the effects [83]. The alternative measure of digital orientation from Ardito et al. (2021) was adopted, which measured digital orientation by counting the number of functional areas where digital technologies had been applied [55]. Partial least-square structure equation modeling (PLS-SEM) was adopted, and Smart-PLS was used for the robustness test. PLS-SEM could address a broad spectrum of issues with less restrictive assumptions, and it is suitable for assessing multiple mediation effects [79]. A complete structural model was created (SRMR = 0.051, d_ULS = 0.599, d_G = 0.322). The partial least-square algorithm was established by setting maximum iterations to 300 and stop criterion to 7. Following the bootstrapping procedure using 5000 subsamples, the bias-corrected and accelerated bootstrap was selected as the confidence interval method to test the direct effects, mediating effects, and moderating effects simultaneously. The results are presented in Table 5 (Model 1). The R^2 values show that the model explains 37.7%, 39.0%, 20.8%, and 41.2% of the variance in exploitation capability, exploration capability, ambidexterity capability, and NPD performance, respectively. The Q^2 values were 0.292 for exploitation capability, 0.318 for exploration capability, 0.189 for ambidexterity capability, and 0.335 for NPD performance. The R^2 values and the Q^2 values indicate the predictive relevance of the model [82]. Hypothesis H1, Hypothesis H2a, Hypothesis H2b, and Hypothesis H2c state that digital orientation contributes to a firm's NPD performance, exploitation capability, exploration capability, and ambidexterity capability, which is supported by the direct path analysis, specifically, β = 0.195 ($p < 0.05$) for the path from digital orientation to NPD performance, β = 0.360 ($p < 0.001$) for the path from digital orientation to exploitation capability, β = 0.364 ($p < 0.001$) for the path from digital orientation to exploration capability, and β = 0.259 ($p < 0.001$) for the path from digital orientation to ambidexterity capability. To assess the robustness of the mediating effects, we checked the bias-corrected confidence intervals (CIs) as suggested by Zhao et al. (2010) [84]. The mediation analysis shows that the coefficients for the path from digital orientation to NPD performance via exploitation capability (path coefficient = 0.094, $p < 0.01$), exploration capability (path coefficient = 0.097, $p < 0.01$), and ambidexterity capability (path coefficient = 0.030, $p < 0.05$) are all positive and significant. The bootstrapping confidence intervals for the first path (95% CI [0.034, 0.172]), the second path (95% CI [0.032, 0.176]), and the third path (95% CI [0.007, 0.059]) do not contain zero. The above results repeatedly support H3a, H3b, and H3c indicating that exploitation capability, exploration capability, and ambidexterity capability separately mediate the relationship between digital orientation and NPD performance. The mediations can be categorized into partial mediations since the direct effect of digital orientation on NPD performance still reaches the significance level ($\beta = 0.195$, $p < 0.05$). To assess the robustness of the moderating effects of knowledge intensity, we checked the coefficients of interaction items of digital orientation and knowledge intensity. The coefficients of the path from the interaction item to exploitation capability ($\beta = 0.150$, $p < 0.01$), exploration capability ($\beta = 0.216$, $p < 0.001$), and ambidexterity capability ($\beta = 0.195$, $p < 0.001$) are also positive and significant, which repeatedly supports H4a, H4b, and H4c.

Second, the influence of COVID-19 was used as an instrumental variable to test the endogeneity of bidirectional causality. Recent studies show that COVID-19 has significantly accelerated the digitalization of firms across different industries [85–87]. The firms whose businesses and operations seriously suffer from COVID-19 have a strong motivation to incorporate digital aspects into their strategic orientation [88]. However, there is no evidence reporting that COVID-19 has a direct connection with the disturbance terms to exploitation capability, exploration capability, and NPD performance. Furthermore, Model 2 in Table 5 shows that COVID-19 has a positive impact on a firm's digital orientation ($\beta = 0.619$, $p < 0.001$). The minimum eigenvalue statistic (107.42) is more than the two-stage least square of the nominal 5% Wald test (16.38), which suggests that the effect of COVID-19 is not a weak instrument. Model 3 to Model 6 show that the positive influences of digital orientation on exploitation capability ($\beta = 0.503$, $p < 0.001$), exploration capability ($\beta = 0.557$, $p < 0.001$), ambidexterity capability ($\beta = 0.318$, $p < 0.01$), and NPD performance ($\beta = 0.646$, $p < 0.001$) are still significant after controlling the endogeneity. Therefore, the endogeneity of bidirectional causality is not a concern in this research.

Table 5. Robust test and endogeneity test.

To / From	Partial Least-Square Structure Equation Modeling				Instrumental Variable Regression Modeling				
	Model 1				**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
	Exploitation Capability	**Exploration Capability**	**Ambidexterity Capability**	**NPD Performance**	**Digital Orientation**	**Exploitation Capability**	**Exploration Capability**	**Ambidexterity Capability**	**NPD Performance**
Firm age				0.088 (1.343)	−0.041 (−0.68)	−0.031 (−0.48)	−0.041 (−0.64)	−0.103 (−1.46)	0.046 (0.70)
Firm size				−0.053 (0.915)	0.073 (1.21)	0.038 (0.59)	−0.004 (−0.05)	0.015 (0.21)	−0.056 (−0.84)
Firm ownership				−0.054 (0.829)	0.071 (1.19)	0.034 (0.52)	0.160 (2.48) *	0.005 (0.08)	0.006 (0.09)
Digital orientation	0.360 (4.872) ***	0.364 (4.465) ***	0.259 (4.374) ***	0.195 (2.359) *		0.503 (4.89) ***	0.557 (5.39) ***	0.318 (2.81) **	0.646 (6.06) ***
Knowledge intensity									
Exploitation capability				0.261 (3.238) **					
Exploration capability				0.268 (3.326) **					
Ambidexterity capability				0.114 (2.484) *					
Digital orientation × Knowledge intensity	0.150 (2.956) **	0.216 (3.587) ***	0.195 (3.488) ***						
Digital orientation->exploitation				0.094 (2.662) **					
Digital orientation->exploration				0.097 (2.640) **					
Digital orientation->ambidexterity				0.030 (2.135) *					
Effect of COVID−19					0.619 (9.12) ***				
R^2	0.377 ***	0.390 ***	0.208 ***	0.412 ***	0.400	0.299	0.292	0.152	0.246
Q^2	0.292	0.318	0.189	0.335					
SRMR	0.051								
d_ULS	0.599								
d_G	0.322								
F test					28.27 ***				
Wald Chi^2						27.84 ***	41.89 ***	10.60 *	38.45 ***

Note: SRMR = standardized root mean square residual; t values in the brackets; * $p < 0.05$; ** $p < 0.01$, *** $p < 0.001$.

5. Discussion

Digital orientation has a positive effect on NPD performance. The effect is partially mediated by dynamic capabilities such as exploitation capability, exploration capability, and ambidexterity capability. The results highlight three paths to improving NPD performance through digital orientation. Among these paths, exploitation capability and exploration capability are found to be comparatively more significant than ambidexterity capability. However, the relationships between digital orientation and exploitation, exploration, and ambidexterity capabilities are moderated by the firms' knowledge intensity. Further moderated mediation analysis shows that in firms with high knowledge intensity, exploration capability and ambidexterity capability are more significant in mediating the effect of digital orientation on NPD performance than exploitation capability. The findings have some significant theoretical and practical implications.

5.1. Theoretical Implications

First, this study addresses the research gap at the intersection of digital orientation and new product development (NPD) by investigating the direct and indirect effects of digital orientation on NPD performance. Digital orientation was conceptualized as a novel form of firm-level strategic orientation. While prior research has examined the effects of specific strategic orientations such as customer orientation and entrepreneurial orientation on NPD [89], the impact of digital orientation on a firm's innovation outcomes, particularly NPD, remains relatively unexplored. This study fills this gap by not only exploring the direct effect of digital orientation on NPD performance but also examining three paths through which digital orientation impacts NPD performance.

Second, this study advances our understanding of the antecedents of dynamic capabilities by identifying digital orientation as an additional antecedent of exploitation and exploration capabilities. While prior research has focused on factors such as strategic alliance [64] and the investment of smart technology such as advanced automation, additive manufacturing, augmented human–machine interface technology, simulation, and cloud manufacturing as antecedents of exploitation and exploration capabilities [90], the relationship between digital orientation and dynamic capabilities has yet to be thoroughly explored. By identifying digital orientation as a new antecedent of both exploitation and exploration capabilities, this study enriches dynamic capability theory by expanding our knowledge of factors that enhance these capabilities.

Third, this study contributes to the ambidexterity literature by examining the impact of digital orientation on exploitation–exploration ambidexterity capability. Scholars have claimed that whether digital orientation could facilitate the achievement of exploitation–exploration ambidexterity is still a theoretical issue that requires investigation [2]. Our findings provide empirical evidence for the positive effect of digital orientation on the ambidexterity capability of exploitation and exploration, particularly when firms possess a high level of knowledge intensity. This adds to our insights on the antecedents of ambidexterity and sheds light on the relationship between digital orientation and ambidexterity capability.

Fourth, this study expands the boundary conditions regulating the linkage between strategic orientation and dynamic capabilities by justifying the moderating effect of knowledge intensity on the relationship between digital orientation and dynamic capabilities. Prior research has indicated that knowledge-intensive firms are more likely to adopt digital technologies early and aggressively [14]. It seems that digital orientation holds greater significance for knowledge-intensive firms. However, it remains unclear whether knowledge-intensive firms benefit more from digital orientation for dynamic capability advancement in the existing literature. Our study bridges this gap by shedding light on the positive moderating effect of knowledge intensity on the relationship between digital orientation and dynamic capabilities. This finding deepens our understanding of the boundary conditions that govern the relationship between strategic orientation and dynamic capabilities.

5.2. Managerial Implications

The first practical implication of the study is that firms seeking to increase their NPD performance can benefit from developing a digital orientation. This means leveraging digital technologies to enhance innovation efficiency and improve connections between product development teams and customers. To put this into action, firms can take the following concrete steps: (1) Create online communities and forums: Firms should establish online communities or forums where customers can actively participate by sharing their ideas, feedback, usage experience, and expectations for new products. This platform will enable direct interaction between customers and product development teams, fostering a collaborative environment for idea generation and feedback collection. (2) Engage customers through social media: Product development teams can utilize social media platforms to engage with customers, share progress on new product development, and seek customer opinions and suggestions. By actively involving customers in the product design process, firms can gain valuable insights and build a sense of co-creation with their target audience. (3) Conduct online surveys and research: Firms should conduct online surveys and research to collect customer feedback and opinions on new products. Understanding customers' willingness to purchase and pay, as well as their specific needs and wants, will provide crucial input for efficient product development. (4) Incorporate digital technology into products and services: Digital orientation also involves incorporating digital technology and resources into existing products or services. This can increase the innovativeness of new products and services, providing firms with a competitive edge in the market. However, the successful development of a new product is not an easy task and requires a systematic and integrated methodology to evaluate the actual digital status of the firm and how these technologies support its NPD process [91,92]. By implementing these actions, firms can effectively cultivate a digital orientation and realize the direct and indirect impact it has on NPD performance. Managers responsible for product development should actively promote the development and implementation of digital orientation to drive innovation and better serve their customers.

The study's second practical implication pertains to dynamic capability building, particularly in the context of exploitation and exploration capabilities, which are crucial for firms' NPD performance and technological innovation [93]. To put these implications into action, managers can take the following concrete steps: (1) Develop digital strategies for goal clarity: Firms should develop digital strategies to clearly define their digital goals and vision. This strategy should be communicated across the organization to ensure that all employees understand and align with the digital orientation. By establishing a clear digital roadmap, firms can effectively streamline routines and optimize processes to enhance exploitation capability. (2) Select suitable digital tools: Firms should choose digital tools such as project management software, collaboration platforms, and knowledge management systems that align with the specific needs of the firm. These tools can facilitate the automation of workflow, real-time data sharing, and remote collaboration, ultimately improving work efficiency and enabling cross-functional communication and knowledge transfer. (3) Optimize workflow with digital tools: Firms should utilize digital tools to optimize workflow by reducing unnecessary steps and time-consuming tasks. This optimization will streamline processes and enhance exploitation capability by improving the efficiency of routine tasks and operations. (4) Alleviate organizational boundaries with digital orientation: Firms should develop a digital orientation that enables them to interact more efficiently with suppliers, customers, and even competitors. By leveraging digital platforms for communication and collaboration, firms can overcome organizational boundaries and gain external knowledge, experience, and skills more efficiently, thereby enhancing their exploration capability. By implementing these actions, firms can effectively develop exploitation and exploration capabilities through a digital orientation, ultimately contributing to improved NPD performance and technological innovation. Managers should actively promote the adoption of digital strategies and tools to optimize routines, facilitate communication, and enhance knowledge transfer within the organization and beyond its boundaries.

The study's third practical implication focuses on providing insights for firms with high knowledge intensity, emphasizing the adoption of digital orientation as an additional approach for dynamic capability development and NPD performance enhancement. To translate these insights into actionable measures, managers of knowledge-intensive firms can take the following concrete steps: (1) Invest in key technologies: Knowledge-intensive firms should invest in key technologies such as cloud computing, big data, and artificial intelligence to enhance data processing and analysis capabilities. By leveraging these technologies, firms can effectively manage and derive insights from large volumes of data, thereby strengthening their dynamic capabilities and NPD performance. (2) Strengthen cooperation with ecological partners: Firms should collaborate with ecological partners to jointly promote digital transformation and innovation. By forming strategic partnerships with other organizations in the industry ecosystem, firms can share knowledge, resources, and expertise to drive digital initiatives and foster innovation, ultimately enhancing dynamic capabilities. (3) Establish digital monitoring and evaluation mechanism: Firms should establish a dedicated digital monitoring and evaluation mechanism to regularly assess the progress and effectiveness of enterprise digitization. This mechanism will enable firms to track the impact of digital orientation on dynamic capabilities and NPD performance, allowing for continuous improvement and adaptation of digital strategies. By implementing these measures, managers of knowledge-intensive firms can proactively advocate and develop a digital orientation to strengthen dynamic capabilities and promote NPD. The strategic investment in key technologies, collaboration with ecological partners, and the establishment of a robust monitoring and evaluation mechanism will enable firms to harness their knowledge intensity effectively and leverage digital orientation for sustainable competitive advantage.

The study's fourth practical implication highlights the importance of achieving ambidexterity for firms to improve NPD performance. Ambidexterity capability, which addresses the innovator's dilemma [94], is influenced by digital orientation and knowledge intensity. Knowledge-intensive firms should leverage digital orientation to balance exploration and exploitation capabilities effectively. Additionally, ambidexterity capability and exploration capability are comparatively more important routes for knowledge-intensive firms to achieve NPD performance through digital orientation. To put these implications into action, managers of knowledge-intensive firms can take the following concrete steps: (1) Balancing exploration and exploitation: Firms should leverage digital orientation to balance exploration and exploitation capabilities effectively. This can be achieved by implementing processes and structures that allow for a simultaneous exploration of new opportunities and exploitation of existing capabilities, leveraging digital tools and platforms to facilitate this balance. (2) Invest in exploration capability: With the growing importance of exploration capability, knowledge-intensive firms should invest in activities that promote exploration, such as research and development, innovation labs, and cross-functional collaboration. Digital orientation can be used to support and enhance these exploration activities, fostering a culture of digital innovation and creativity within the organization. (3) Enhance ambidexterity capability: Firms should foster ambidexterity capability by integrating digital orientation into the organizational strategy. This involves aligning digital initiatives with the overall business strategy and creating a seamless integration of digital technologies to support both exploration and exploitation activities. By implementing these measures, knowledge-intensive firms can effectively leverage digital orientation to achieve ambidexterity, balance exploration and exploitation capabilities, and ultimately improve NPD performance. The strategic focus on exploration, the integration of digital technologies, and the alignment of digital initiatives with the overall business strategy will enable firms to navigate the complexities of ambidexterity and drive innovation in the digital age.

5.3. Conclusions

This study has some limitations that open the opportunity for future research. First, we collected data from a single country context through a key respondent in each firm, which may limit the generalizability of the findings. The samples of this study are from China. The positive aspect of this sampling approach is that Chinese firms provide us with a good context to explore the relationship between firms' digital orientation and new product development. The Chinese government attaches great importance to the digital transformation of firms and has introduced a series of policies to encourage qualified firms to increase their investment in digitalization. Therefore, it is more likely to obtain sufficient variations in firms' digital orientation. Similarly, samples from developed countries with digital economies such as the United States, Germany, and South Korea are also suitable scenarios for this study. However, in some economies with underdeveloped digital economies and relatively backward digital technology and infrastructure, the variation in firms' digital orientation may not be as significant. This probably has an unknown impact on the research results. Therefore, in order to improve the generalizability of the model, future research needs to test the model in a wider and more diverse context. It would be insightful to examine the effects of digital orientation on dynamic capabilities and NPD performance from a global perspective. Moreover, it is also worth incorporating some economic environments as contextual variables into the model. Second, we treated NPD performance as a single dimension variable by following recent research [79], but the literature shows that NPD performance can be decomposed into different dimensions such as speed, innovativeness, or creativity [41]. Future research should decompose NPD performance into different dimensions and analyze the potential influences of digital orientation on each one separately to better understand the relationship between digital orientation and NPD performance. Third, in this study, dynamic capabilities were conceptualized as exploitation and exploration capability. However, it is essential to note that dynamic capabilities can be decomposed into other dimensions, such as sensing, seizing, and reconfiguring capabilities. Currently, the effects of digital orientation on these other dimensions of dynamic capabilities remain unclear. Therefore, future research should investigate the relationships between digital orientation and other dynamic capabilities. By doing so, a more comprehensive understanding of the impact of digital orientation on dynamic capabilities can be achieved.

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