A review of research on ambidextrous innovation

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Abstract. Nowadays, with the rapid development of science and technology, continuous innovation is the basis for enterprises to maintain their vitality, and ambidextrous innovation is a hot topic of enterprise innovation. At present, there is abundant research on ambidextrous innovation at home and abroad. Based on the existing research on ambidextrous innovation, this paper sorts out the relevant literature on the concept, influence mechanism, interaction process, and effect results of ambidextrous innovation, finds out the problems of exploring the theme and single method of ambidextrous innovation research and summarizes and looks forward to the research on ambidextrous innovation.

Keywords: Ambidextrous Innovation; Ambidexterity Theory; Exploratory Innovation; Exploitative Innovation.

1. Introduction

With the deepening of China's economic reform, the innovation-driven development strategy takes the realization of an innovation-oriented country as a strategic goal, relying on innovation to promote the high-quality development of the real economy. Government departments pay more attention to guiding and stimulating enterprises to conduct R&D and innovation through industrial policies. The number of patent applications and licenses keeps increasing, and the trend of innovation development keeps moving upward. However, compared with developed countries, China's overall innovation level is still relatively backward, and there is still a gap between China's innovation capability and the requirements of entering the forefront of innovative countries and high-quality development.

Innovation injects fresh blood and vigor into enterprises and is the lifeline for their growth and development. However, the current fierce market competition has put forward higher requirements for enterprises' resource reserves and capital needs. The weak capital market base to a certain extent limits the external financing of enterprises, and the shortage or interruption of funds may cause them to suffer difficulties. The lack of resources will also affect the sustainability of innovation activities. Enterprises not only need to deal with the complex external environment given great pressure but also face the threat of potential competitors. Therefore, new products and technologies are needed to enhance profitability and improve product quality and services to maintain market share. In a situation where it is not easy to obtain resources externally, enterprises can only focus on internal, using various resources and technologies as a foundation. At this time, it is an important way for enterprises to enhance their core competitiveness by exploring and using redundant resources from within, playing the positive role of "buffer" and "booster", and flexibly responding to changes in the external environment. To survive and develop in the dynamic market environment, enterprises should not only take the initiative to explore and discover new products and technologies, but also be good at developing and utilizing existing resources, and recognize two different types of innovation: exploratory innovation and exploitative innovation, and give full play to the "duality" of innovation to effectively enhance innovation strength and competitive advantage.

At present, ambidextrous innovation research has covered many aspects of its connotation, measurement, and influence mechanism. In addition, ambidextrous innovation research based on different relational perspectives has received attention and importance. Therefore, this paper reviews the studies related to ambidextrous innovation and summarizes the influence mechanisms of current research, and points out the research outlook.

2. Ambidextrous Innovation connotation

Duncan (1976) first proposed the concept of "dual organization" in the field of enterprise management, where organizations need both incremental and breakthrough capabilities to cope with the changes in the external environment [13]. March (1991) further enriched the duality of organizations by dividing organizational learning into exploratory and exploitative learning, effectively explaining the dual capabilities of organizations from an organizational learning perspective [34]. Benner and Tushman (2003) put forward two different ways of innovation from the perspective of the innovation field, introducing the concepts of exploratory and exploitative innovation, and exploring the different roles that exploration and exploitation play in business management activities [35].

Table 1. The comparison between exploratory innovation and exploitative innovation

	Exploratory Innovation	Exploitative Innovation
Objective	Emerging markets, new customer groups	Original market, maintain customer demand
Feature	Breakthrough innovation	Incremental innovation
Source	New knowledge, new skills	Existing knowledge, existing skills
Mode	Experiment, exploration, creation	Copy, refine, improvement
Result	Open up new markets, completely new designs and new products	Improve products and services, consolidate market share
Risks and expectations	High risk, high uncertainty	Low risk, predictability
Innovation cycle	Focus on the future, long cycle	Focus on the present, short cycle
Performance impact	Impact on long-term performance	Impact on short-term performance

Exploratory innovation is a kind of innovation process "from scratch", which means that the enterprise overturns the original technical route, uses new knowledge and new skills to open up new markets, develop new products, explore new designs, and so on, and uses new processes and new services to meet the potential needs of future customers. Exploration and experimentation often require high costs, so this type of innovation requires higher risk and uncertainty. In contrast, exploitative innovation is a process of improvement "from existing to changing", in which enterprises follow the traditional technical route, replicate, refine and promote products and technologies based on existing knowledge and technology, in response to existing market changes, to secure the existing market share, meet existing demand and improve business performance. It is of great significance in reducing the risk of product development and innovation, and in the sustainable development of enterprises. There are significant differences between the two, both in terms of the objectives, sources, and results of innovation activities as well as risks, cycles, and benefits (see Table 1 for comparison details). The innovation activities of an enterprise are distinguished from the perspective of exploration and exploitation, all of which show the enthusiasm and initiative of an enterprise for the implementation of innovation strategy, reflecting its ability to use all aspects of knowledge, technology, and resources, as well as its plans for current development and vision of future markets, and are closely linked to its performance.

3. Ambidextrous innovation measurement

There are three existing studies on ambidextrous innovation performance measurement methods, as follows: scale method, text analysis method, and patent method.

(1) Scale method

Jansen (2006) was the first scholar to measure the performance of ambidextrous innovation by designing a questionnaire scale. In the beginning, the scale consisted of 14 items, but after careful

research and selection, 8 items were left, and 4 items were used to measure the performance of each kind of technology innovation [22]. Since then, many domestic scholars have conducted a lot of research on ambidextrous innovation based on the scale, such as Wu (2014) and Dang et al. (2016), who conducted research on enterprises by distributing questionnaires to explore the relationship between market orientation, innovation network resource integration, and so on, and ambidextrous innovation [12] [55]. The contents of exploratory innovation mainly include whether to launch new products, adopt new technologies, open up new sales channels, and so on; the contents of exploitative innovation mainly include whether to improve existing products, improve quality, expand the product range, and so on.

The questionnaire survey method can be set according to your actual research needs in terms of design, and the questionnaire answers can be converted into quantitative data, which is convenient for subsequent data processing and questionnaire analysis. The operation is simple and the cost is saved. However, at the same time, the questionnaire interview will solidify the thinking of the respondents, resulting in the inability to collect the most effective information. Meanwhile, the questionnaire recovery procedures are complex, and the quantity and quality of questionnaire recovery are vulnerable to certain impacts, which leads to bias in the data. Therefore, the scale method has certain limitations in generalizability.

(2) Text analysis method

The text analysis method measures the ambidextrous innovation performance of enterprises by searching for keywords in news reports. The occurrence of words such as "reform, risk, experiment, search" implies exploration, while exploitation is reflected by words such as "improvement, selection, refinement, efficiency". Based on March's (1991) definition of ambidextrous innovation, Uotila (2008) was the first to use the text analysis method, using a sample of 11, 124 news reports from 18 enterprises, to judge whether there was a bias toward some of the behaviors appearing in the news reports based on the frequency of occurrence of the aforementioned words, and then to determine the type of behavior attributed [34] [50].

The samples of the text analysis method come from news reports, which are inevitably subjective to journalists, editors-in-chief, and readers, so it is impossible to objectively and scientifically measure ambidextrous innovation performance, which has major drawbacks. Therefore, few scholars in China have applied this method to measure ambidextrous innovation performance.

(3) Patent method

A patent is an important tool for measuring enterprise innovation. Many scholars at home and abroad have introduced patents into enterprise technological innovation, dividing and combining different dimensions of patents as a way to measure enterprise technological innovation performance [18] [39]. To summarize the existing studies, there are three main methods of a patent method to measure the ambidextrous innovation performance of enterprises: patent citation measure, international patent classification number (IPC) measure, and patent classification measure. In the first measurement method, the cited patents are divided into newly cited patents and non-newly cited patents, and then the ratio between them and the total number of patents is calculated respectively as the proxy variable of exploratory innovation performance and exploitative innovation performance. Foreign scholars Phelps (2010), Rosenkopf and Nerkar (2001) used patent citation measures to study the impact of enterprise alliance structure, cross-organizational boundaries, and cross-industry boundaries on enterprise ambidextrous innovation [40] [42]. Due to the lack of patent citation data in Chinese patent data, few scholars adopted this method to study ambidextrous innovation performance. The IPC measurement method is mainly based on the first four characters of the IPC, which are a combination of numbers and letters, to determine the field to which the patent belongs. If the field has not appeared in the previous five years, the patent will be regarded as an exploratory innovation; otherwise, it will be classified as an exploitative innovation. Because of its scientific classification and convenient data acquisition, many scholars at home and abroad have used this classification method to measure the performance of ambidextrous innovation[31] [51].In addition, according to the classification of patents, some domestic scholars measure the exploratory innovation performance

by the number of invention patents obtained by enterprises and measure the exploitative innovation performance by the total number of design patents and practical patents. To some extent, this is unscientific. The three patents all have different degrees of creativity, so it is not possible to classify the two types of innovative methods based on this, which lacks rigor and science.

4. Theoretical basis

The ambidexterity theory was developed in the 1970s and is rooted in the theory of organizational evolution in response to changes in the external environment. The theory argues that organizations are caught in a dilemma in the process of survival and development, in which there is an "organizational productivity paradox", that is, excessive pursuit of standardization and efficiency improvement may undermine organizational flexibility; and there is an "organizational innovation paradox", that is, excessive pursuit of organizational flexibility may be difficult to develop scale effects. Based on this, Duncan (1976) built the ambidextrous organizational structure to balance and coordinate the paradoxes in the development process [13]. However, it was not until March (1991) proposed to explore and utilize two learning styles in the field of organizational learning that ambidexterity theory received extensive research attentio[n] [34].

(1) Research levels of ambidexterity theory

Individual level. Duality at the individual level refers to the behavioral orientation of managers to simultaneously conduct exploratory and exploitative activities at a given time [37]. At the same time, research on ambidexterity at the individual level is also reflected in the focus on dualistic leadership, a trait of leaders who deal with multiple conflicts simultaneously, multitask in parallel [32], and refine and update their knowledge, skills, and expertise simultaneously [37].

Team level. Team-level duality research aims to examine how top management teams design and structure duality organizational systems to adapt to external environmental changes through (formal and informal) behavioral integration mechanisms [21].

Organizational level. The duality of organizational levels study argues that both organizational structure (formal) and social relations (informal) influence organizational duality [32][57]. Here, the formal organizational structure mainly refers to the decentralization, routinization, and convention of the organizational structure, which makes the development and operation of enterprises have rules to follow [37].

Interorganizational level. The existing researches only focus on the field of enterprise alliance. On the one hand, the factors affecting alliance duality mainly include the strong joint and the bridge joint in inter-organizational alliances [48]; on the other hand, the balance between exploration and exploitation of enterprises across time, space, and fields helps to promote the formation of alliances. The domains spanned by enterprises mainly contain functional, structural, and attribute aspects, where the functional domain mainly emphasizes the nature of alliance relationships, the structural domain focuses on assessing the network status of alliance partners, and the attribute domain mainly refers to the deviation of organizational attributes of partners in time [25].

(2) Applied study of ambidexterity theory

The ambidexterity theory has gradually become a mainstream research paradigm in disciplines such as strategic management, technological innovation, human resource management, and entrepreneurship management. With the deepening of research, scholars at home and abroad have tried to explore the connotation and main types of dualities from different perspectives, and explore the realization mechanism of organizational duality based on different research fields. At present, the duality idea has been widely applied to the study of organizations' simultaneous execution of different and competing strategic behaviors, which mainly include: exploration and exploitation [34], flexibility and efficiency [14], internal and external sources of technological knowledge [44] and so on. The application area of ambidexterity theory is mainly reflected in organizational learning, technological innovation, organizational adaptation, and so on. The related studies are shown in Table 2.

Table 2. Applied study of Ambidexterity Theory

Research field	Ambidexterity Embodiment	Main implementation mechanisms	Main Authors
Organizational learning	Explorative learning and exploitative learning	Time separation, Organization separation, Domain separation	March (1991) [34]
			Auh & Menguc (2005) [6]
			Li & Huang (2013) [28]
Technological innovation	Breakthrough innovation and incremental innovation	TMT integration mechanism Organizational integration mechanism	Benner & Tushman (2002) [8]
			Atuahene-Gima (2005) [5]
			Lin et al. (2017) [30]
			Smith & Tushman (2005) [46]
			Jansen et al. (2009) [21]
Organizational structure	Efficiency and flexibility	Structural duality Situational duality	Tushman & O'Reilly (1996) [49]
			Ebben & Johnson (2005) [14]
			Guo Runping &Cai Li (2017) [19]
			Raisch et al. (2009) [41]
			Wang & Rafiq (2014) [52]
			Gibson & Birkinshaw (2004) [17]
Organizational adaptation	Continuity and change	Regular change	Burgelman (2002) [9]

5. Related Research

5.1 Influence mechanism for ambidextrous innovation

Domestic and foreign scholars have explored the influencing factors of ambidextrous innovation from the organizational level, team level, and manager level.

Firstly, from the organizational level, the influencing factors on the formation mechanism of ambidextrous innovation include: First, organizational structure. Exploratory innovation and exploitative innovation require different organizational structures [4], so multiple departments may help enterprises to realize ambidextrous innovation. Second, organizational culture. The organization can promote the successful implementation of ambidextrous innovation by constructing diversified culture or context [20]. Third, strategic orientation. Enterprises can have an impact on ambidextrous innovation by implementing market-oriented and IT-strategic orientation [54]. Fourth, social capital. Enterprises with social capital can obtain abundant resources and opportunities, which in turn drive enterprises to realize exploitative and exploratory innovation [40]. Fifth, surplus pressure. Under the pressure of surplus, enterprises need to trade off exploratory innovation and exploitative innovation to satisfy short-term interests and ensure the future development of enterprises [24]. Sixth, organizational learning. Organizational learning can drive enterprises to strengthen exploratory innovation and improve the effect of exploitative innovation while constantly developing new products [53].

Secondly, from the team level, the influencing factors on the formation mechanism of ambidextrous innovation include: First, TMT behavioral integration. Lubatkin et al. (2006) argue that TMT behavioral integration reflects the quality of information exchange, collaborative behavior, and joint decision-making of enterprise senior management teams, which helps enterprises better manage the process of contradictory knowledge, thus laying the foundation for the realization of ambidextrous innovation [33]. Second, TMT network characteristics. The formation mechanism of ambidextrous innovation is analyzed from two aspects of TMT network centrality and network sparsity, and it is argued that under the combined effect of centrality and sparsity, enterprises can deepen their understanding of existing knowledge and acquire heterogeneous knowledge, and then carry out exploitative innovation and generate exploratory innovation more efficiently. In addition, social networks will also increase executives' awareness of opportunities to look for opportunities to accelerate the integration of exploration and exploitation [45].

Finally, from the manager level, the influencing factors on the formation mechanism of ambidextrous innovation include: First, leadership style. Existing research explores the influencing factors on ambidextrous innovation from different leadership styles, and different leadership styles have different driving effects on ambidextrous innovation [16] [43]. Second, CEO cognitive flexibility. Cognitive flexibility helps individuals to switch easily among various thinking processes [26]. Therefore, although exploratory innovation and exploitative innovation have different natures and requirements, the high level of CEO cognitive flexibility can carry out the two kinds of innovation activities simultaneously and promote their coordination. the two kinds of innovation activities simultaneously and promote their coordination [23].

5.2 Mediation mechanism for ambidextrous innovation

The mediation mechanism of ambidextrous innovation mainly includes organizational ability change and resource integration processes. First of all, Benner et al. (2003) pointed out that organizational capability is rooted in exploitative innovation and exploratory innovation, that the direct result of ambidextrous innovation activities is a change in organizational capability, and the change of organizational capability can in turn explain the performance differences brought by ambidextrous innovation [7]. Exploitative innovation can continuously optimize the enterprise's existing organizational capability base, while exploratory innovation can promote the generation of new capabilities. As a result, enterprises can take advantage of ambidextrous innovation more quickly and sustainably. Second, the basic premise for ambidextrous innovation to achieve competitive advantage is that enterprises must invest the necessary resources in exploitative and exploratory innovation to achieve a balanced development of both, and also need to integrate and coordinate resources and processes to promote synergy between the two [38]. However, under the condition of limited resources, it may be difficult for enterprises to play the original advantages of ambidextrous innovation activities. Therefore, in the process of transforming ambidextrous innovation into performance, enterprises need to actively acquire valuable resources from outside the organization and allocate and integrate them into internal resources.

5.3 Moderation mechanism of ambidextrous innovation

Previous scholars have explored the boundary conditions of ambidextrous innovation and organizational output from the environmental level and the organizational level respectively.

At the environmental level, existing research on the moderating factors affecting the role of ambidextrous innovation includes: First, competition intensity. The research results on the mechanism of competition intensity on ambidextrous innovation are not consistent: some scholars believe that competition intensity enhances the implementation effect of ambidextrous innovation [6], but some scholars believe that the higher the competition intensity, the more enterprises are trapped in the vicious competition in the market, which in turn negatively affects the implementation effect of ambidextrous innovation. Second, environmental fecundity. Environmental fecundity refers to the extent to which the environment supports the sustainable development of the enterprise. In a permissive environment, the enterprise is more likely to obtain resources from the environment [29], which in turn increases the effectiveness of ambidextrous innovation into performance [10]. Third, environmental dynamics. The environmental dynamics causes the current product or service to be highly susceptible to obsolescence, to reduce the risk and threat of obsolescence, enterprises need to carry out exploratory innovation to introduce new products and meet new demands [22]. Fourth, institutional factors. Institutional elements rooted in cultures such as collectivism and power distance, moderate the relationship between ambidextrous innovation and performance output [38].

At the organizational level, existing research on the moderating factors affecting the role of ambidextrous innovation includes: First, organizational resources. With different resource bases, enterprises have different knowledge and capability bases in the development and implementation of ambidextrous innovation activities [3], which will affect the effectiveness of the transformation of ambidextrous innovation into performance. Second, organizational capability. Organizational

capability helps enterprises to implement strategic decisions and actions efficiently and with high quality, and thus enterprises with stronger organizational capability benefit more from ambidextrous innovation activities [2]. Third, organizational strategy. Strategy shapes a kind of culture or situation for the organization, which will affect the innovation motivation of the organization members, and then affect the implementation effect of the ambidextrous innovation [36]. Fourth, inter-organizational networks. The inter-firm network structure such as structural holes, network centrality, and network density will promote the ambidextrous innovation to play its role more effectively [11].

5.4 Results of the role of ambidextrous innovation

Domestic and foreign scholars have mainly explored the results of the role of ambidextrous innovation from two perspectives: short-term output and long-term output.

Ambidextrous innovation has a positive impact on an enterprise's short-term output, which can promote enterprises to achieve sustainable development by creating short-term competitive advantages. First, improve the survival and growth of enterprises. Under the action of ambidextrous innovation, the interaction between using existing products and exploring new products can help enterprises to build a unique resource portfolio [15], and further promote enterprises to develop new value-creation opportunities and increase the survival probability [20]. Second, improve financial performance. Although exploratory innovation is difficult to generate profits in the short term, exploitative innovation builds on an organization's existing knowledge, ability, and experience, involves low risks, and its resource intensity is low, so it can achieve output in the short term. The results of innovation not only help to improve the economies of scale of the enterprise, but also positively affect the profitability and operation efficiency of the enterprise, and ultimately improve the financial performance.

In the long run, both exploratory innovation and exploitative innovation are helpful for enterprises to gain competitive advantages and achieve sustainable development. First, improve enterprise innovation performance. The essence of exploratory innovation and exploitative innovation is to change product technology or product markets. Through processes such as technological innovation, the development of new products, and supply chain innovation, enterprises can effectively enhance innovation capability and improve innovation performance. Second, enhance the organization's environmental adaptability. Exploratory innovation focuses on seeking new technology and market opportunities, while exploitative innovation focuses on improving and optimizing products or technologies to improve production efficiency. Engaging in both activities helps enterprises balance efficiency and flexibility [56], and thus cope with and adapt to dynamic market environments. Third, improve the competitive position of the enterprise. Ambidextrous innovation can help enterprises realize leapfrog development while ensuring short-term gains, thus consolidating and enhancing their competitive ability and market position [47], and positively and continuously influencing their competitive advantages.

6. Conclusion and prospect

The development of ambidextrous innovation research is characterized as follows: (1) Scholars interpret the connotation of ambidextrous innovation and explore the relationship between exploratory and exploitative innovation based on the perspectives of competition and opposition, difference and differentiation, integration and integration, balance and combination, and so on; (2) The influence mechanism of ambidextrous innovation is mainly studied from the perspectives of organization level, team level and manager level; (3) The effect of ambidextrous innovation is not only reflected in the long-term competitive advantage, but also reflected in the short-term performance of enterprises; (4) The moderating factors between ambidextrous innovation and outcome variables are gathered at the environmental and organizational levels, and the black box of ambidextrous innovation to performance is opened from the perspective of the mediating role of organizational capability and resource integration process.

Although the research on ambidextrous innovation has made rich achievements, the existing research on ambidextrous innovation is relatively simple in terms of topic and analysis method. Based on this, future research can be carried out from the following aspects.

Firstly, ambidextrous innovation research is conducted based on interdisciplinary perspectives. The current mainstream ambidextrous innovation research perspectives include social network theory, strategic learning theory, strategic choice theory, and so on, but ambidextrous innovation research can be cross-fertilized with multiple research perspectives. In the future, ambidextrous innovation research can be conducted from a theoretical interaction perspective by strengthening the connection between different theories.

Secondly, ambidextrous innovation research is conducted based on multi-level and multi-factor intersection perspectives. Existing studies not only discuss ambidextrous innovation from a single level such as the environmental level and organizational level but also examine the formation of ambidextrous innovation and its role from a single factor. However, organizational-level factors and other-level factors may have linkage effects, but there is no research to explore the formation of ambidextrous innovation and its different influence mechanisms based on the cross-level perspective.

Finally, ambidextrous innovation research is conducted based on multiple research methods. The existing studies mainly use empirical and case methods to carry out ambidextrous innovation research. However, the data of most empirical studies are cross-sectional, which cannot reflect the dynamic changes of ambidextrous innovation; the samples of case studies are also short-established enterprises, which do not consider the changes in macroeconomics and industry turnover. Therefore, future research on ambidextrous innovation can be innovative in terms of research methods: (1) Using dynamic panel data to study ambidextrous innovation, and using window data to show the dynamics of ambidextrous innovation; (2) Making a long-term observation case study to summarize the rules of operation and function of ambidextrous innovation in China's context; (3) Combining empirical research and case analysis to explore the mechanism of ambidextrous innovation in both static and dynamic perspectives.

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