

A Research Review on the Impact of Big Data Capability on Enterprise Innovation Performance

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Abstract. In the Internet era, data are generated all the time everyday, and the huge data with exponential explosive growth contains endless information resources. An increasing number of people think that big data will become an important asset of enterprises, which will bring opportunities for innovation and development of enterprises. Data resources are very important to enterprise. Whether the enterprise can seize this opportunity, integrate and analyze the externally generated data, form the data analysis ability, build its own unique competitive advantage, extract the key information resources that are beneficial to the development of the organization, promote the improvement of the enterprise's innovation performance and innovation ability, and truly realize sustainable development. Therefore, how to apply big data capabilities to improve the innovation performance of has become the focus of enterprises' attention. Based on this, this paper analyzes the value of "big data" in general by using the literature research method, investigates the research status of big data capability in the field of enterprise innovation performance, and reveals the relationship between big data capability and innovation performance, which is beneficial for enterprises to explore ways to improve innovation performance by using big data capability, and also has certain reference significance for future research in related fields.

Keywords: Big Data Capability; Innovation Performance; Literature Research.

1. Introduction

Big data, together with cloud computing, artificial intelligence and blockchain, has become one of the main members of the innovation led by the technological trend in the new era of the Internet. Big data resources have also been hailed as the "new oil" in the Internet era, and have become the most valuable assets. The analysis results based on big data are more objective and scientific, and provide data support for the development of enterprise management in the economic field. Big data can be seen everywhere in the current enterprise management. Whether it is the product R&D department's control of user needs, user habits and user psychology, or the front-end sales department's judgment of user source channels and the direction of product promotion, etc., these backgrounds are the result of data accumulation. In enterprise performance management, it is also necessary to use big data for analysis to achieve ideal results.

Big data technology is widely used in all walks of life, and it has been fully proved that it can greatly improve the efficiency of enterprises. It is not only a core resource, but also the core competitiveness of enterprises in the future market competition. The ability to use, mine, sort out, refine and transform big data provides the necessary means and foundation for enterprise competition. Big data capability is also known as the essential core capability of enterprises in the future business competition. It changes the competitive thinking and management mode of enterprises to improve their own value. Therefore, in the general trend of reform and development, enterprises should make a difference, and how to make use of big data capabilities to promote the innovation performance of enterprises is a problem that needs to be considered and actually solved, and it is worthy of in-depth study.

In view of this, on the basis of studying some scholars' literatures, this paper defines the concepts and related theories of big data capability and innovation performance, and explores the relationship between big data capability and innovation performance, which can help enterprises cultivate big data capability and provide an idea for using big data capability to improve their own competitiveness and

innovation performance, and also provide some reference for scholars' future research.

2. Overview of Related Concepts

2.1 The Concept of Big Data Capability

Nowadays, we can fully feel the charm and influence of "big data". The emergence and development of "big data" has triggered a new technological revolution, produced great social changes and created unprecedented economic value. The concept of "big data" first appeared in 1980 and was put forward by the famous futurist alvin toffler in his book *The Third Wave*. "Big data" is a concept formed on the basis of a large amount of data generated by economic and social development. Gartner, a research institution, pointed out that big data is an important information asset with the characteristics of mass, diversification and rapid growth. It has good insight ability, decision-making ability and process optimization ability through new mode processing. McKinsey gives an influential definition of big data, which refers to the data set whose size exceeds the acquisition, storage, management and analysis capabilities of conventional database tools, and its scale is very huge (McKinsey et al., 2011)^[1].

With the deepening research of big data by scholars at home and abroad, they found that the success of big data depends not only on the interaction of data, analysis tools and analysis processes, but also on other factors. In order to solve this problem, the concept of big data capability was put forward by scholars, and the research on the definition of big data capability began to enrich. Big data capability was first mentioned by foreign scholar LaValle et al. in their research, and it was regarded as the ability of enterprises to use big data to make decisions (LaValle et al., 2011)^[2]. Simon thinks that big data ability is a kind of ability that enterprises can provide some convenience in the process of customer service management that traditional information systems can't achieve. By analyzing the data with statistical software, we can predict the development of customers' behavior according to the results, and provide customized services to enhance the brand loyalty of high-value customers (Simon et al., 2013)^[3]. Acito and Khatri believe that big data capability belongs to the scope of "analytical capability", which consists of data analysis theories and tools, including predictive analysis, simulation, regression and optimal solution, so they support description, review, prediction and normative analysis (Acito et al., 2014)^[4]. Gupta et al. defined the big data prediction and analysis capability as the processing capability of enterprises on big data resources, including data collection, integration and reconfiguration (Gupta et al., 2016)^[5].

Domestic scholars started late in the research of big data capability, and its definition is mainly based on resource integration, analysis and prediction. Zhang Caifeng and other scholars define big data capability as the ability to integrate internal and external big data resources for enterprises, emphasizing that big data capability is a dynamic capability of enterprises (Zhang Caifeng, 2019)^[6]. Based on the concept of dynamic capability, Xie Weihong and others believe that big data capability is the dynamic capability of enterprises to acquire and integrate internal and external big data resources and extract potential business value to adapt to the changes of external environment (Xie Hong et al., 2016)^[7]. After analyzing the financial industry, Ma Liang pointed out that the big data capability of financial enterprises is the ability of enterprises in the industry to develop, manage and utilize big data resources, and the core of big data of financial enterprises is data mining and processing (Ma Liang, 2016)^[8]. Cheng Gang et al. (2014) re-planned the connotation of big data capability from the perspective of big data capability cultivation, and defined it as the big data awareness of enterprises in the process of big data development, management and utilization, including the capabilities of collecting, storing, mining, analyzing, transmitting and using big data resources, of which the mining and analysis of big data is the core (Cheng Gang et al., 2014)^[9]. Based on the resource-based theory and dynamic capability theory, Ma Hongjia et al. regard big data capability as a high-order dynamic capability, and perceive opportunities through data analysis, so as to integrate, establish and reconfigure internal and external big data resources and capabilities to adapt to the rapid changes of the environment (Ma Hongjia et al., 2014)^[10].

Based on the above research, it is generally believed that big data capability is a dynamic capability to extract and sublimate the value of big data resources in the process of enterprise operation and development, and apply it to the operation and management process of enterprises, so as to continuously support the resources and strategic decisions needed by enterprise development, and further help enterprises to obtain sustainable competitive advantages.

2.2 The Concept of Innovation Performance

Innovation was first put forward by Schumpeter. It is the resource reorganization of various factors of production by enterprise doers and one of the effective means to achieve economic growth. At present, the definition of innovation performance in academic circles is mainly based on the output orientation of innovation activities. Hagedoorn believes that in a narrow sense, the degree to which an enterprise puts its inventions and creations into the market is innovation performance; Broadly speaking, the whole process from the generation of innovative thinking, the landing of inventions, and then putting the invented products into the market is innovation performance (Hagedoorn et al., 2003)^[11]. Innovation performance is a comprehensive reflection of the enterprise's innovation achievements and innovation process, and it is a comprehensive evaluation of the whole process of the enterprise's innovation achievements from the input of all resources in the innovation cycle to the end (Chia-hui et al., 2019)^[12]. Bing et al. believe that innovation performance refers to the economic, technological and innovation goals achieved by enterprises through technological progress, efficient enterprise management methods and high R&D capabilities (Bing et al., 2019)^[13].

Some scholars also believe that innovation performance refers to the process mode and performance of individuals in the process of knowledge sharing and transfer, in order to gain their own competitive advantage, maintain their own core competitiveness, and then gain sustained growth momentum and continuously transfer the focus of knowledge (Han Yi et al., 2007)^[14]. It emphasizes that individuals consciously use some innovative ideas, processes or methods in order to effectively improve the innovative results. Domestic scholars Zhou Xiaoyang and Wang Yuyun define innovation performance as the satisfaction of all parties in collaborative innovation. This definition takes the strategic coordination and organizational communication of all parties into the process of innovation from the perspective of enterprise collaborative innovation (Zhou Xiaoyang et al., 2014)^[15].

By reviewing the relevant research at home and abroad, it is found that domestic and foreign scholars have different definitions of innovation performance, and most scholars associate innovation performance with new products, new services, new technologies and new processes. Scholars' research perspectives are also very different. Most researches are based on the organizational level to study the innovation performance of enterprises, while some scholars conduct in-depth research on innovation performance from the perspective of cooperative alliance. The research on the connotation of innovation performance is rich, but no consensus has been reached.

3. Review of Related Research

3.1 Research on Big Data Capability

3.1.1 Foreign Related Research

Throughout relevant researches at home and abroad, the influence of big data capability is mostly studied as antecedent variable. Many scholars have found that having the ability of big data can improve the financial performance of enterprises, enhance the performance of high-value businesses and improve the overall performance of enterprises. Huang et al. pointed out that the application of big data analysis can improve the performance of enterprises and enhance the market value (Huang et al., 2018)^[16]. From the perspective of resource-based theory, the ability of big data analysis can realize value creation, improve organizational agility and improve the overall performance of the organization (Ghasemaghaei et al., 2015)^[17]. Bharadwaj et al. think that the application of big data

can improve the market response speed and customer satisfaction, and then bring better performance to enterprises (Bharadwaj et al., 2013)^[18]. Manjui et al. analyzed the investment data of existing big data capacity-building enterprises, and concluded that big data capacity will produce excellent enterprise performance on enterprise performance (Manjui et al., 2016)^[19]. Wamba et al. empirically studied the positive correlation between big data analysis ability and enterprise performance. At the same time, dynamic ability played a certain intermediary role among the players (Wamba et al., 2017)^[20]. Through in-depth interviews with retail enterprises in South Africa, Mney et al. found that the application of big data promotes the information sharing between suppliers and customers, improves the operational efficiency of retail enterprises' procurement, logistics and warehousing processes, and then improves their operational performance (Mneney et al., 2016)^[21]. Based on 152 online questionnaires, Akter et al. put forward a hypothesis on the moderating effect of enterprise strategic positioning between big data capability and enterprise performance, and verified it by empirical research (Akter et al., 2018)^[22].

Many scholars believe that enterprises' ability to use big data can have an impact on business model innovation. Hartmann et al. put forward a data-driven business model through the research of start-ups (Hartmann et al., 2016)^[23]. Davenport(2014) thinks that big data analysis ability can capture business opportunities for enterprises and provide decision support for managers (Davenport et al., 2014)^[24]. Bouman et al. pointed out that in the digital economy era with big data as the core support, digital transformation requires enterprises to rethink and innovate their business models, while more resource allocation and data integration will have an important impact on the design and practice process of business models, thus determining the success or failure of business model innovation, which also requires enterprises to support business model innovation by building and utilizing big data capabilities (Bouman et al., 2019)^[25].

3.1.2 Domestic Related Research

Cha Hongwang makes an empirical analysis on the innovation performance of big data enterprises by DEA method. The results show that the overall level of innovation performance of big data enterprises in China is low, and the low pure technical efficiency is the main inducement (Cha Hongwang et al., 2017)^[26]. Zhang Tie-shan, etc., empirically tested the performance of big data operation and R&D investment intensity. Taking the data of Chinese enterprises from 2012 to 2015 as the research sample, he used factor analysis to show the relationship between each capability factor and R&D investment intensity (Zhang Tie-shan et al., 2016)^[27].

Liu Dan(2014), taking the State Grid as the research object, thinks that big data can influence business model innovation from three aspects: value discovery, value creation and value realization (Liu Dan et al., 2014)^[28]. Hu Zhenya's research based on the innovation mechanism of big data found that the ability of big data can extract the combination of production factors that meet the demand from massive data, and create subversive innovations of new business models through data-driven innovation decisions (Hu Zhenya et al., 2017)^[29]. Li Wen(2020) based on the case study of Xiaomi and Netease YEATION, explained that big data capability drives enterprise business model innovation through customer value, resources and capabilities, and profit model, and built a mechanism model of the influence of big data resource integration capability, big data analysis capability, and big data insight capability on business model innovation (Li Wen et al., 2020)^[30].

In the era of big data, modern enterprises' management and operation concepts, organizational business processes, marketing decisions and other aspects will be greatly affected, which also leads scholars to explore the "black box" research of creating value by big data. Overall, the existing research focuses on the value brought by big data, including the impact of big data capability on enterprise performance, the impact of big data capability on enterprise innovation performance, and the impact of big data capability on business model.

3.2 Research on Innovation Performance

3.2.1 Foreign Related Research

Scholars at home and abroad are relatively mature in the research of innovation performance, which provides us with a lot of research ideas and inspiration. There are many factors that affect the innovation performance of enterprises, including external factors and internal factors. The external factors include inter-organizational network structure, social network and network capabilities, external technological opportunities, etc. For example, the empirical results of some literatures show that the trust among organizations with high network density, the sharing criteria among members and the common behavior pattern can promote the effective transfer of external knowledge and bring better innovation performance to enterprises (Phelps, 2010)^[31]. Internal factors mainly include R&D investment, enterprise capital, knowledge integration mechanism, absorptive capacity, and enterprise technical capacity. The ability to acquire information resources, enterprise scale and strategy will also affect enterprise innovation performance. R&D investment and capital manpower investment have a significant impact on the innovation performance of enterprises. R&D means investing heavily in technology, which will improve the technological innovation capability of enterprises (Cohen et al., 1990)^[32]. Lai et al. discussed the impact of special resources and relationships among clustered enterprises on innovation performance, and took knowledge management as the intermediary of investigation. The research found that through industrial clusters, knowledge creation and acquisition, knowledge storage and dissemination of enterprises can have a positive impact on the improvement of innovation performance (Lai et al., 2014)^[33]. It is becoming more and more important to study the growth of innovation from the perspective of social network. Muller believes that the growth of innovation in social networks is determined by network structure. Borrowing from the field of industrial organization in economics, this field defines itself as studying the impact of market structure on market performance, and describes this new wave of innovation growth research as the impact of social network structure on innovation performance (Muller et al., 2019)^[34].

Enterprises with high absorptive capacity can effectively identify external information, extract value from it and apply it to innovation activities. Hottenrott et al. believe that R&D cooperation promotes the collection of complementary skills, learning from partners and sharing risks and costs. His research emphasizes the positive correlation between cooperative R&D and innovation performance (Hottenrott et al., 2013)^[35].

3.2.2 Domestic Related Research

Zheng Jianjun and Jin Shenghua, combined with China's national conditions, found that employees' innovation ability has a positive impact on their innovation willingness and results. Employees with strong innovation ability are more confident that they will respond to problems in innovation activities more actively and bring better creativity to enterprises (Zheng Jianjun et al., 2010)^[36]. Ye Ying explored the influence of knowledge integration on alliance cooperation and enterprise innovation performance by taking transnational technology alliance as the research object. Empirical analysis proved that knowledge integration can positively promote enterprise innovation performance of alliance cooperation, and put forward a theoretical model of knowledge integration of transnational technology alliance (Ye Ying Ping, 2014)^[37]. Li Zibiao and others analyzed the data of 503 high-tech enterprises, studied the mechanism and differences of human capital characteristics (education level, overseas background, professional level and R&D experience) on innovation performance of high-tech enterprises, and found that education level has the strongest promoting effect on innovation performance of enterprises. The second is R&D experience, but the influence of professional level characteristics is negative (Li Zibiao et al., 2020)^[38]. Wang Honglue, et al. explored the influence of knowledge reorganization on technological innovation performance, and analyzed the moderating effect of three main knowledge-based relationship characteristics on the relationship between knowledge reorganization and technological innovation performance. The research found that the improvement of R&D's network agglomeration and average path was helpful to enhance the positive effect of the potential possibility of knowledge reorganization on innovation performance.

The increase of the average number of R&D network connections will increase the cost of knowledge reorganization and collaboration, which will have a negative effect on innovation performance; The characteristics of knowledge-based relationship have a significant moderating effect on knowledge reorganization and innovation performance (Wang Honglue et al., 2020)^[39].

Domestic scholars mainly study the factors that affect innovation performance, but how to measure innovation performance still needs to be deepened. In contrast, foreign scholars have done more extensive research on measuring innovation performance, but most of their research results are based on the overall perspective, ignoring the overlap of indicators and the lack of generally accepted indicator models. Therefore, the research on the indicators to measure the innovation performance of enterprises still needs to be deepened.

4. Research on Big Data Capability and Innovation Performance

Hooi used structural equation modeling technology to analyze the relationship between big data analysis capability and product innovation performance, and believed that big data capability has high operational and strategic potential, which has a positive impact on improving enterprise innovation performance (Hooi et al., 2018)^[40]. Vassakis et al. believe that with the help of big data capabilities, enterprises can form their products and actions through better forecasting and wiser decisions to meet the needs of customers and innovate against competitors, so as to improve innovation performance (Vassakis et al., 2017)^[41]. Hao et al. developed a model based on the resource-based view and organizational inertia theory to study how big data and big data analysis capabilities affect the sustainable innovation performance of enterprises. In the case of insufficient big data resources, improving big data capabilities can increase sales growth and gross profit margin to some extent, and developing big data capabilities beyond this may actually inhibit innovation performance (Hao et al., 2019)^[42]. Javdan et al. use organizational learning theory to study the influence of big data characteristics on innovation performance mediated by market-driven capabilities, which helps enterprises improve innovation performance through novelty of new products and services and more effective processes and activities (Javdan et al., 2019)^[43]. Muhammad et al. investigated the big data analysis capability (BDAC) model based on the theory of resources (RBT) and the dimensions of big data analysis (management, technology and talents) that affect the company's innovation performance, and found that big data analysis capability has a statistically positive impact on the company's innovation performance (Muhammad et al., 2021)^[44].

The core competence theory and dynamic competence theory of enterprises explain that the dynamic competence of enterprises is the source of innovative performance. Therefore, more scholars are keen to study the influence mechanism of big data capability on enterprise innovation performance. On the basis of the existing research results, Li Shuli made an empirical analysis with the Internet industry as the research object, and constructed a conceptual model of the influence of big data analysis ability on the innovation performance of knowledge-based enterprises. She believed that big data analysis ability can promote the innovation of knowledge-based enterprises and has a significant positive impact on the innovation performance of knowledge-based enterprises (Li Shuli, 2015)^[45]. Ren Nan et al. constructed a conceptual model of the relationship among big data analysis capability, collaborative innovation capability and collaborative innovation performance. Empirical analysis showed that big data analysis capability indirectly affected collaborative innovation performance through collaborative innovation capability, while collaborative innovation capability had a significant positive impact on collaborative innovation performance (Ren Nan et al., 2018)^[46]. Based on the resource-based theory and IT capability theory, Xu Fang et al. think that the big data application capability composed of infrastructure capability, project management capability and human resource capability has a significant positive impact on supply chain collaboration and enterprise innovation performance (Xu Fang et al., 2020)^[47]. Based on the dynamic capability theory and contingency theory, Zhang Zhengang et al. found that big data capability has a positive promoting effect on innovation performance, among which environmental dynamics has a positive U-shaped

regulating effect on the relationship between big data capability and innovation performance, while environmental competitiveness has an inverted U-shaped regulating effect on the relationship between big data capability and innovation performance (Zhang Zhengang et al., 2021)^[48]. Around the dynamic capability theory, Liu Nian and others think that big data analysis capability not only positively affects the service innovation performance of manufacturing enterprises, but also positively affects resource patchwork and organizational agility, and resource patchwork and organizational agility play a part of intermediary role in the relationship between big data analysis capability and service innovation performance of manufacturing enterprises. Therefore, manufacturing enterprises should pay attention to the investment in big data analysis, and achieve high resource patchwork, high organizational agility and new service performance by improving big data analysis capability (Liu Nian et al., 2021)^[49].

According to the existing research, the related research on the mechanism of big data capability on enterprise innovation performance has been gradually carried out, and many achievements have been obtained. From the perspective of management, the existing research is based on enterprise resource theory, dynamic capability theory, core capability theory and knowledge-based theory, and puts forward relevant research directions for the theoretical mechanism of the value mechanism of big data capability.

5. Research Summary

By reviewing the existing literature, we find that the research of big data capability has become more and more in-depth and has become a hot focus in academia. Scholars have gradually formed the foundation of big data capability theory from the initial research on big data capability based on the reference and extension of IT capability. Foreign scholars have made great efforts in government support, technological innovation of enterprises and the integration of big data technology by enterprises themselves. Most of the research samples are international enterprises in a single industry, and the number of research results of foreign scholars is higher than that of domestic scholars. Domestic scholars' research samples are few, and their conclusions are not comprehensive enough. However, the adaptability of foreign conclusions to domestic enterprises needs to be confirmed. Therefore, it is necessary and feasible to carry out research in line with China's national conditions for data collection of domestic industries.

According to the existing research, the related research on the mechanism of big data capability on enterprise innovation performance has been gradually carried out, and many achievements have been obtained. The existing research on the value creation mechanism of big data capability is still in the primary stage, and most of the research is from the perspectives of organization, economy, process and management. From the perspective of management, the existing research is based on enterprise resource theory, dynamic capability theory, core capability theory and knowledge-based theory, and puts forward relevant research directions for the theoretical mechanism of the value mechanism of big data capability. Although some studies have verified the relationship between big data capability and enterprise innovation performance through empirical research. However, the number of studies is not enough to support the extensive explanation, especially the localization data of the studies based on Chinese enterprises are not enough to support the existing conclusions. It is generally believed that the influence of big data capability on the innovation performance of enterprises is multidimensional, and there is not only a direct correlation, but also a common effect through intermediary influences. These multi-level related functions cooperate with each other to create core competitive advantages for enterprises.

As can be seen from the above literature review, most scholars believe that big data capability has a positive impact on enterprise innovation performance, and the higher the level of big data capability, the higher the level of enterprise innovation performance. There are also many factors that play a regulatory or intermediary role, such as knowledge integration, knowledge sharing, organizational learning, external network relations, etc., and scholars have done research on them and achieved

certain research results.

6. Research Prospect

Through combing the current literature, most of the current researches mainly focus on the definition and characteristics of big data itself, while there are few researches on enterprise's big data capability, and there are also relatively few researches on enterprise's big data capability and innovation performance. Although some studies have verified the relationship between big data capability and enterprise innovation performance through empirical research, the number of studies is not enough to support the extensive explanation. Therefore, there is still much room for development in the research on big data capability and enterprise innovation performance.

First of all, the definition of big data capability is constantly changing and evolving with the development of big data technology and industry, and the big data capability of enterprises is also changing dynamically with the passage of time. The impact of big data capability on enterprise innovation performance is a time-series process, so it is necessary to conduct longitudinal research on the role and impact of big data capability on innovation performance, which can reveal the interactive relationship between big data capability and enterprise innovation performance more effectively and further improve the reliability of research results.

Secondly, from the perspective of the value chain of the big data industry, enterprises can be divided into data resource type, technology-owned type and application-oriented type. Different types of enterprises have different requirements for big data capabilities, and the emphasis that needs to be cultivated should also be different. Therefore, aiming at different types of enterprises, the research on big data capability and enterprise innovation performance, as well as the corresponding ways to improve big data capability, will make the research more targeted.

Thirdly, Identify the antecedents that affect big data capabilities. The existing research basically focuses on the meaning, measurement dimension and value mechanism of big data capability, and seldom involves the exploration of antecedent variables. Exploring the antecedents of big data capability is a rich supplement to the research of big data capability, and on the other hand, it can fully understand the internal mechanism of the formation of big data capability, and provide practical advice for enterprises to cultivate and improve their own big data capability.

Fourthly, Further explore the theoretical mechanism of big data capability. The cultivation and promotion of enterprise's big data capability is a long-term and complicated work, which will be affected by the unique resources of the organization and various internal and external environmental factors. At present, the empirical research on big data capability theory is mainly from the perspectives of dynamic capability, enterprise strategic positioning and enterprise psychological contract. In the future, we can also consider other factors, such as organizational practices, internal and external environment, and explore whether there will be a correlation between these factors.

Finally, scholars have introduced moderating variables and mediating variables such as knowledge integration, knowledge sharing, organizational learning, external network relations into the related research of big data and enterprise innovation performance. In the future research, it is still appropriate to broaden the research scope, select another new research angle, and consider the moderating or mediating effects of other variables. The research on independent variable-big data capability-should not only be limited to the influence of big data on other factors of the organization, but may also have an impact on other aspects of the enterprise, such as the investment in enterprise's digital strategy transformation. A more comprehensive research will help organizations to understand and utilize big data capability more deeply to promote the innovation performance of enterprises.

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