Proceedings Research on the Path of High-Quality Development of Big Data Industry in Shandong Province

Yu Wang[1,a], Mingle Zhou[2,b,*], Chunjing Wang[3,c], Xingheng Mei[4,d] and Yumei Li[5,e]

{916329405@qq.com[a], zhouml@sdas.org[b], wangchj@sdas.org[c], 412223418@qq.com[d], liym@sdas.org[e]}

Key Laboratory of Computing Power Network and Information Security, Ministry of Education, Shandong Computer Science Center (National Supercomputer Center in Jinan), Qilu University of Technology (Shandong Academy of Sciences), Jinan, China[1, 2, 3, 5]
Shandong Provincial Key Laboratory of Computer Networks, Shandong Fundamental Research Center for Computer Science, Jinan, China[1, 2, 3, 5]
Qilu University of Technology (Shandong Academy of Sciences), Jinan, China[4]

Abstract. The big data industry is a major opportunity to promote the development of the digital economy. This paper analyzes the status quo and problems of the big data industry in Shandong Province, combines the connotation of the big data industry chain, and puts forward countermeasure suggestions for the high-quality development of the big data industry in Shandong Province in four aspects, namely, infrastructure construction, data factor market cultivation, and data application development.

Keywords: Big data industry, Shandong province, Big data industry chain, High-quality development

1 Introduction

Massive amounts of data produced by many sectors throughout the process of production transformation are a national strategic base resource and a key component of production in the digital age [1]. In 2022, China plans to build eight national arithmetic hub nodes and has planned 10 national data center clusters, officially launching a big data strategic project. The project aims to address the imbalance in computing power resources between the east and the west, and to guide the central and western regions to take advantage of their energy resources to build computing power infrastructures that can more adequately support the computing of data in the east.

Currently, major developed countries take data as a basic strategic resource and promote the high-quality development of the digital economy with the big data industry. In China, regional competition in the big data industry is becoming more and more intense. Shandong Province, a major industrial province in eastern China, is in dire need of digital transformation [1, 2]. In this context, this paper puts forward useful opinions for the high-quality development of the big data industry in Shandong Province through an in-depth study of the development status quo and problems of the big data industry in Shandong Province. This paper will promote the development of the big data industry in Shandong Province in the direction of higher quality, efficiency, and sustainability.

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2 Status of big data industry development in Shandong Province

2.1 Overall enhancement of digital infrastructure

First, Shandong Province has opened a total of 162,000 5G base stations, realizing continuous 5G network coverage in urban areas and counties of 16 cities, and the proportion of 5G coverage in townships has reached 100%. Secondly, 12 cities, including Zaozhuang, Jining, and Weihai, were selected as national "gigabit cities,", the second-largest number in China. The number of gigabit users reached 8.116 million, ranking No. 3 in terms of user scale and No. 2 in terms of growth rate. Thirdly, two national Internet backbone connection points in Jinan and Qingdao have been opened and running, making Shandong the only province with two national Internet backbone connection points as a "double hub" in China. A total of 38 secondary nodes for industrial Internet identity resolution have been built and operated, and 21 national top-level nodes have been accessed, with the volume of identity resolution exceeding 36 billion times. Fourth, the computing speed of the National Supercomputing Center Jinan and the Qingdao Ocean Supercomputing Center is at the international advanced level.

2.2 Arithmetic network is gradually improving

At present, Shandong Province has made four key breakthroughs: first, it has realized the first supercomputing interconnection network based on SRv6 technology in China. Secondly, it has broken through the "necklace" technology and realized the 500-kilometer long-distance IB scheduling network interconnection for the first time in China. Third, it built the world's largest IB (infinite broadband technology) and Ethernet parallel networking computing cluster. Fourth, it verified and completed the supercomputing Internet architecture, resource management scheduling, and application testing under the new architecture.

In 2022, according to the China Comprehensive Arithmetic Index, Shandong's Comprehensive Arithmetic Index ranked among the first echelon of the country, coming in at seventh place. In the next step, Shandong Province will further consolidate the base of the arithmetic network and build an arithmetic infrastructure system of storage-computing integration and cloud-side synergy.

2.3 Great potential for industrial development

According to China's Big Data Regional Development Level Assessment Report (2022), Shandong Province's Big Data Assessment Industry Development Index is 46.8, which is located in the head region of big data development, with broad prospects and great potential for the development of the big data industry.

First, the big data industry chain is basically complete, and big data enterprises in Shandong Province are distributed in 12 full-life cycle links such as production, collection, storage, analysis, and application, covering the fields of data resources, basic hardware, general-purpose software, and industry applications. Secondly, the configuration of big data innovation elements is perfect. At present, Shandong Province has cultivated 26 big data development innovation laboratories, 67 big data industry innovation centers, 29 big data innovation service organizations, and 47 big data innovation talent bases, initially forming a reasonable layout of the field, a clear functional level, and a complete innovation chain of the innovation platform system. Thirdly, for the clustered development of the big data industry, in

2021, Shandong added 38 provincial digital economy parks, including 21 digital industrialization parks and 17 industrial digitization parks, and has now cultivated a total of 85 provincial digital economy parks.

3 Problems in the construction of big data industry in Shandong Province

3.1 The big data industry is small

As of November 2021, there were a total of 963 big data enterprises in Shandong Province, realizing big data business revenue of 110.43 billion yuan, up 18.5% year-on-year. However, the annual business revenue of the software and information service industry in Beijing's big data industry reached 2.2 trillion yuan in 2021, accounting for 25.7% of the country's share, and the scale of the industry ranked first among all provinces and cities in China. From the point of view of leading enterprises, Shandong has only a few enterprises, such as Wave, Haier, Hisense, etc., that have strong influence and market share in the international and domestic markets. In cloud computing, big data with industry-driven leading enterprises is fewer.

3.2 Small pool of big data talent

According to the Talent Development Research Report of Shandong Province in 2022, high-level talents in Shandong Province are mainly distributed in the fields of modern ocean, new energy and new materials, new generation information technology, medical, and health care. There is a lack of high-level R&D and management teams, as well as composite talents and industry leaders in the field of big data.

In recent years, Shandong Province has focused on the introduction and cultivation of talents in the digital field and will introduce more than 20,000 professionals in the fields of big data, cloud computing, and other digital industries in 2022. The gap between big data talents is narrowing, but there is still a gap compared with advanced regions. From a national perspective, the five major cities of Beijing, Shanghai, Shenzhen, Hangzhou, and Guangzhou have a high level of economic development, good corporate remuneration, and a high degree of aggregation of big data enterprises, attracting and retaining a large number of high-level big data talents and graduates of related professions, with a total of more than 40% of big data talents. In contrast, Shandong Province lacks leading big data enterprises with high salaries and high visibility and is not very attractive to high-level big data talents and teams.

3.3 Application scenarios need to be strengthened

The Assessment Report on the Regional Development Level of China's Big Data (2022) shows that Shandong Province's Big Data Integration and Application Index is 46.9, ranking sixth in the country, which doesn't match Shandong Province's status as a large population, economic, and cultural province. The degree of integration between big data and the real economy needs to be deepened urgently, big data application scenarios need to be further explored, the level of development of the big data industry is unbalanced among different industries and regions, and new data-driven business models need to be broken through.

3.4 The data potential has yet to be activated

At present, the circulation of data elements in Shandong Province and the value of the utilization of the mechanism are not perfect; data rights, data pricing, data transactions, and other norms are not yet sound. The data elements show that market cultivation has greater room for improvement. According to the China Data Factor Market Development Report (2021-2022), during the period from January 1, 2020, to May 15, 2022, there were only nine data factor market investment and financing events in Shandong Province, and the transaction amount of the data factor market was 363 million yuan. On the other hand, Beijing, Shanghai, and Guangdong have 325, 134, and 130 data factor market investment and financing events, respectively, with transaction amounts of 59.577 billion yuan, 16.676 billion yuan, and 11.873 billion yuan, respectively. It can be seen that Shandong Province still needs to accelerate to improve the efficiency of elemental market allocation and fully activate the potential of data elements.

4 Big Data Industry Chain Analysis

The big data industry is a strategic emerging industry focusing on data generation, collection, storage, processing, analysis, and services, including data resource construction, development, sales and leasing activities of big data software and hardware products, and related information technology services. Infrastructure, data services, and convergence applications are intertwined with each other, collaborating to build a complete big data industry chain. In short, the big data industry chain is a comprehensive system that includes multiple links and related industries, covering the entire life cycle of data, so as to maximize the value creation and application of data [3, 4].

The big data industry chain is shown in Figure 1. The core composition of the big data industry chain is divided into three layers: the upstream basic support layer, the midstream data service layer, and the downstream fusion application layer, which covers the entire life cycle of data from generation to application and is committed to maximizing the value of the data and applying it in practical scenarios [5].

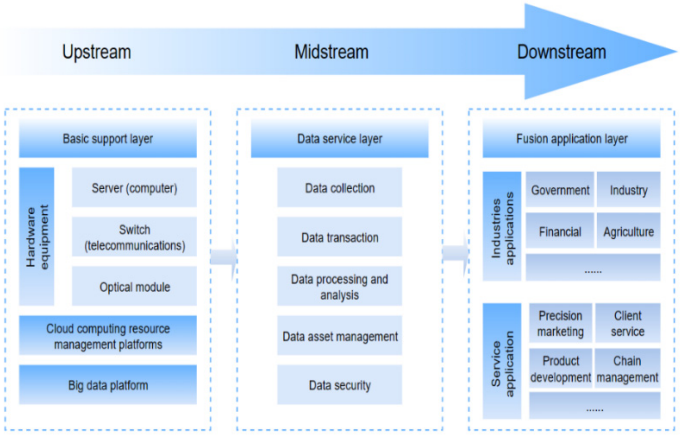

Fig. 1. Big data industry chain.

4.1 Basic support layer

The basic support layer is the core of the big data industry. It mainly involves hardware equipment and resource management platforms related to the collection, transmission, and storage processes of data resources, including hardware equipment, cloud computing resource management platforms, and big data platform construction.

4.2 Data service layer

The data service layer is one of the future growth points of the big data market. It mainly focuses on various applications and market demands and provides auxiliary services, including data collection, data transactions, data asset management, data processing and analysis, data security, and data-based IT operation and maintenance.

4.3 Fusion application layer

The fusion application layer is the development focus of the big data industry. The convergence application is a vivid embodiment of the in-depth combination of big data technology and the real economy, and the convergence application layer not only contains general-purpose service applications but also contains overall solutions for various segments that are closely related to the government, industry, agriculture, finance, telecommunication, and other industries.

5 Exploration of high-quality path of big data industry in Shandong Province

To realize the high-quality development of the big data industry in Shandong Province, it is necessary to tightly focus on the whole process of the development of the big data industry chain, consolidate the underlying infrastructure, explore the construction of the data elements market, attack the core technology of big data, and promote the application of industry big data in depth.

5.1 Build a network infrastructure connectivity pattern

Infrastructure is the foundation of industrial development. Shandong Province needs to continue to strengthen the construction of 5G base stations, promote in-depth 5G network coverage, and strive to enhance the depth of network coverage of key scenes and livelihood scenes. Comprehensively promote the deployment of IPv6, strengthen the province's urban areas, townships, and gigabit fiber access capacity. Promoting the province's 16 cities to meet the construction standard of "Gigabit City" and realize "Gigabit Province". It will carry out special actions to enhance the integrated computing network, create a "computing network city" benchmark, and realize a 1-ms delay circle within the city and a 3-ms delay circle in the provincial capital city cluster, Jiaodong city cluster, and Lunan city cluster.

5.2 Accelerating data factor market cultivation

According to the 2022 China Local Government Data Openness Report, Shandong Province ranks first in the national comprehensive ranking of provinces in the Open Digital Forest

Index, and is an Open Digital Forest benchmark province. However, data opening is only a means to an end, and realizing the market-oriented allocation and innovative application of data is the ultimate goal of data opening. Therefore, Shandong Province urgently needs to accelerate the construction of a unified and open data elements market in terms of top-level design, the establishment of data property rights, transaction circulation, security and privacy, and other basic systems, standards, and norms, and improve the regulatory system of the data transaction market at the market level to guide the development of the data asset value assessment, create a more mature data element circulation and transaction model, and assist in the high-quality development of the digital economy [2].

5.3 Deepening the application of big data in the industry

Shandong Province has a complete range of industrial categories and obvious advantages in the development of the real economy, so it is necessary to actively promote the development of the real economy empowered by big data [6]. On the one hand, it organizes and carries out industrial big data application pilots and creates a number of industrial big data benchmark applications. It will build a multi-level industrial Internet platform system, promote the in-depth application of industrial big data, and cultivate specialized and scenario-based big data solutions. On the other hand, taking the pilot demonstration of big data industrial development as a hand, relying on rich digital application scenes, promoting the transformation and upgrading of traditional industries through the application of new technologies such as artificial intelligence and big data to promote high-end, intelligent, and green transformation and upgrading, and continuously giving rise to new business forms and new modes.

5.4 Build an open source and open industry ecology

In the era of big data, software open source and hardware openness have become irreversible trends, and control of open source ecology has become the focus of international industrial competition. In this context, our province needs to break through the "neck" technology in the field of software and strengthen the independent and controllable capability of the big data technology ecology. On the one hand, we should focus on strengthening the foundation, make up for the short board, and strive to create Shandong software "famous products", build a high-end software industry ecology, and enhance the independent basic software and hardware of the underlying support capacity. On the other hand, we should adhere to the open source promotion strategy of "participating and integrating, accumulating momentum, and leading", promote the research and development of independent open source frameworks, components, and tools, and guide the construction of the big data open source community so as to build an independent and controllable open source ecosystem.

6 Conclusions

The paper takes the current state of the big data industry's growth in Shandong Province as its starting point, examines the industry's development issues in great detail, and proposes optimization routes in conjunction with the big data industry chain. Big data is regarded as a new development hotspot. This paper's purpose is to offer useful recommendations for the future growth of the big data sector in Shandong Province and to serve as a resource for other

provinces. Some of the contents are not fully developed due to circumstances and resource limitations, and it is anticipated that future studies will conduct in-depth empirical studies.

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