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A Review of Research on Big Data Capabilities

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Abstract: ***In the era of digital economy, the importance of big data has become increasingly evident. This paper provides a review of the relevant aspects of big data capability through literature analysis.***

Keywords: Big data, Big data capabilities, Enterprise big data, Big data analysis capabilities**.**

1. Research on the Concept and Implications of Enterprise Big Data Capability

1.1 Big Data

Gobble (2013) defines big data as datasets so large that innovative methods are required for their collection, storage, organization, analysis, and sharing [1]. Sheng et al. [2] reviewed the management research related to big data over the past decade and consider it to be a large volume of structured, semi-structured, and unstructured data continuously generated from multiple sources, which can affect business operations in real-time and influence decision-making through the mining of insightful information. LIN et al. [3] define big data as an information asset composed of vast, rapidly growing, and diverse data. Big data is a massive collection of data that extends the technological capabilities for storage, management, processing, protection, and visualization of data [4].

Compared to traditional databases, the concept of big data is characterized by the "3Vs": Volume, Variety, and Velocity. Volume refers to the large scale and number of variables within the dataset. Velocity is reflected in the real-time dynamic generation of massive data, with extremely fast collection, dissemination, and analysis. Variety arises from the numerous sources of big data, including web clicks, mobile transactions, user-generated content, social media, sensor networks, and commercial transactions (such as sales queries and purchase records). The true challenge of big data lies not only in its vast quantity but also in the diversity of data types, the need for timely responses, and the uncertainties contained within the data [5].

1.2 Big Data Capability

In 2014, Cheng Gang et al. [6] first introduced the term "big data capability" and defined it as the ability of enterprises to collect, store, mine, and utilize big data during its development, management, and application. Xie Weihong et al. [7] were the first to develop a measurement scale for big data capability. Subsequently, the international scholar Lin [3] introduced the term "big data capability" based on dynamic capabilities theory and developed a measurement scale, defining it as the ability of enterprises to identify, collect, store, and analyze various high-velocity data to achieve strategic and operational goals. A review of literature from both domestic and international scholars reveals that perspectives on big data capability mainly include theories on big data technology, big data resources, big data capabilities, and big data pluralism. This paper will summarize and analyze the arguments associated with these different viewpoints.

Big Data Technology Theory. Some scholars believe that big data primarily refers to big data technologies, including storage (preprocessing), data processing, data visualization (postprocessing), big data analysis, and related technologies for constructing decision models and algorithms [8]. It combines massive, complex, and diverse data with emerging information technologies and architectures, fundamentally representing an innovative IT capability [9]. Big data capability is seen as the ability to analyze vast and disparate data in real time, or as the ability of enterprises to acquire, clean, manage, and process large volumes of data within a specific timeframe, providing conveniences for customer management that traditional information systems cannot achieve [10].

Big Data Resource Theory. Yang Shanlin et al. [11] define big data as informational resources reflecting the states and changes of both the material and spiritual worlds. Kwon [9] refines it as an innovative strategic resource resulting from the combination of data with emerging information technologies. Some scholars view big data capability as an organizational resource, equating it with more specific big data analysis capabilities [12,13] or big data management capabilities [14] based on the resource-based view. Gupta and George (2016) categorize its dimensions from the factor-structure-function perspective, defining it as either tangible resources, intangible resources, and human resources [13], or as technical skills, management abilities, and talent skills [12]. Big data capability is defined as a more specific analytical capability. Akter and Wamba [12] define related infrastructure as more specific big data resource management capabilities, involving strategy, investment, coordination, and control in four aspects.

Big Data Capability Theory. From a capability perspective, big data is considered a special ability, including the capability to acquire, analyze, and reconfigure digital resources [15]. Some scholars view big data as an organizational capability, constructing big data capability based on dynamic capabilities theory, and arguing that big data capability is a dynamic capability needed by enterprises to handle explosive data growth. It emphasizes the systematic logic of capabilities involved in acquiring and storing big data resources, mining data using big data technologies and infrastructures, and formulating data-driven strategic decisions [3,7]. Lin (2019) defines big data capability as the ability of enterprises to identify, collect, store, and analyze large volumes of various high-velocity data to support the

achievement of strategic and operational goals [3]. Chen et al. [16] argue that applying big data analysis can build knowledge and create routines in highly dynamic market environments, with these routines being essential components of dynamic capabilities.

Big Data Pluralism Theory. Some scholars view big data capability as a more diversified ability. Zheng Liyuan (2019) defines big data capability as the ability of an enterprise to aggregate, mobilize, allocate, and utilize big data assets and complementary organizational resources to gain valuable insights and make effective decisions. This capability, when integrated with other organizational abilities, transforms insights into actionable outcomes, enhancing the enterprise's ability to cope with environmental ambiguity and uncertainty, thereby helping the enterprise gain a competitive advantage and improve performance [17]. Big data capability refers to the ability guided by big data thinking, with the premise that data is a valuable resource. It involves analyzing the collected big data using organizational mechanisms and digital technologies in a scientific and effective manner. This capability integrates human resources, technological resources, and digital resources to visualize and make data information intuitive [18]. Xie Weihong et al. [7], based on the application of big data in management practices of Chinese enterprises, define big data capability as the dynamic ability to acquire and integrate both internal and external big data resources, deeply analyze and extract potential business value, and continuously adapt to changes in the external environment. From the resource orchestration perspective, which combines the resource-based view with dynamic capabilities, it is argued that in the context of the digital economy, big data has evolved into an indispensable strategic resource. By fully utilizing this resource, enterprises can gradually transform it into a strategic dynamic capability—big data capability.

2. Research on the Dimensions of Big Data Capabilities in Enterprises

Currently, there is limited research on the measurement of big data capability dimensions. El-Kassar (2019) identifies three dimensions of big data capability: big data adoption, big data normalization, and big data assimilation. Big data adoption refers to the degree to which enterprises recognize and accept big data analysis results; it provides conditions for integrating external data. In uncertain environments, enterprises can leverage big data capabilities to integrate unstructured data from external markets to obtain a comprehensive market view. Existing research indicates that integrating different types of data (customers, government, and suppliers) can enhance an organization's ability to identify potential business opportunities and market needs, and improve product innovation capabilities. Big data normalization highlights the extent of big data capability application within an enterprise, such as whether big data analysis receives budget and professional team support, and whether there are specialized technologies and data analysts. Big data normalization reflects the internal application of big data analysis technology within the enterprise, such as whether there is a foundational technology and a talent team for big data analysis. In high-volume data contexts, matching big data capabilities with technical tools helps organizations perform various tasks, such as generating analytical reports, building predictive models, and interpreting results. Big data assimilation refers to the extent of big data application across different areas of the enterprise, such as whether big data analysis is a key tool for each department, whether decisions are based on big data capabilities, and whether it is applied in management functions. Big data assimilation means integrating big data capabilities across all areas of the organization, which helps the enterprise use a scientific management framework for business decision-making. Big data assimilation starts with the data planning process, which identifies business opportunities and promotes innovation based on established big data models. Additionally, big data collaboration helps enhance cross-functional synchronization within the enterprise, thereby fostering overall business innovation. Lin et al. (2019) categorize big data capabilities as a comprehensive resource capability set, including four subsets: data sets, tool sets, skill sets, and cognitive sets. Among these, the most important is the data set, which contains a vast amount of various types of data scattered across different organizational information systems; it is a prerequisite and a crucial strategic resource for enterprises to extract commercial value in the big data era. The tool set combines hardware, software, and complex information infrastructure in big data practices, aiding in the collection, storage, transformation, and analysis of big data. Additionally, the skill set involves updating and reconfiguring knowledge resources through big data analysis, achieving self-transformation of knowledge, and represents a knowledge-shaping capability. Finally, big data capability is not an isolated technology but a multifaceted toolkit containing interactive elements, requiring a mindset to integrate these elements. Xie Weihong et al., combining the management practices of big data applications in Chinese enterprises, propose that big data capability includes three dimensions: resource acquisition capability, analytical integration capability, and application capability. Resource acquisition capability refers to the enterprise's ability to easily access internal and external data resources, specialized data analysts, technical equipment, and skills, as well as the ability to update data, talent, and technology in a timely manner. Resource acquisition capability is the enterprise's ability to acquire and update big data resources. In the big data era, data is constantly changing daily, with timeliness being a key feature. Resource acquisition capability helps employees obtain the data they need more quickly, providing a resource base for innovation. Analytical integration capability refers to the enterprise's ability to filter and analyze existing raw data to improve data quality, effectively handle diverse and voluminous data, and integrate data from different internal and external departments. Furthermore, analytical integration capability is the enterprise's ability to effectively process and deeply analyze data resources to continuously gain new insights. Initial data is often fragmented and trivial; analytical integration capability processes and synthesizes this raw data to obtain high-quality information. The potential value of data often needs to be analyzed and integrated to be extracted; the insights gained can provide new ideas and directions for employee innovation. Application capability primarily refers to the enterprise's ability to discover potential customer needs or other valuable knowledge through big data analysis, providing strong support for management decision-making. Finally, application capability is the enterprise's ability to

predict the market and support management decisions based on analytical results. Resource acquisition capability, analytical integration capability, and application capability all significantly enhance employee innovation performance.

Existing research suggests that big data is a complex dataset or a static resource collection, requiring multiple dynamic processes such as data identification, collection, storage, and analysis to function effectively [3]. Among these processes, big data analytics is considered the most critical link in transforming general knowledge from the data into product-specific knowledge. MIKALEF formally introduced the concept of big data analytics capability, which refers to an organization's ability to provide new insights for development through data management, infrastructure, and talent, and to convert business into competitive advantage [28]. Big data analytics capability is an organizational dynamic capability related to data analysis [3], enabling enterprises to extract specific cutting-edge knowledge required for their products from complex datasets, and to generate various forms of new products, services, and processes through the knowledge integration process [29]. MIKALEF et al. [30] and LIN et al. [3] found that big data analytics capability enhances organizational dynamic capability by providing cutting-edge knowledge, thereby improving organizational breakthrough innovation capabilities. Alberto Ferraris (2019) identified two dimensions of big data capability (BDAC): the management aspect of big data analytics capability and the technical aspect of big data analytics capability [29]. Gupta and George (2016) developed dimensions of big data analytics capability, established tools for measuring enterprise big data capability, and validated that big data analytics can effectively enhance enterprise performance. Wamba et al. (2017) empirically demonstrated that big data analytics capability has a direct impact on enterprise performance, and also proved that process-oriented dynamic capability has a strong mediating effect on both big data analytics capability and enterprise performance. Based on the literature, big data analytics technology plays a crucial role in optimizing productivity and increasing profits in operational performance. For market share and new markets, new products and services in the market must respond more quickly to competitive advantages than other products and competitors.

3. Evaluation of the Literature on Enterprise Big Data Capability

Through the review and analysis of literature on the concept, connotations, and components of big data capability both domestically and internationally, we find that research on big data capability is still in its nascent stage. Scholars approach the topic from various perspectives, and there is no consensus on the relevant concepts and connotations, nor a unified standard for its dimensional composition. This paper defines big data capability as a dynamic ability to acquire and integrate internal and external big data resources, deeply analyze and extract potential business value, and continuously adapt to changes in the external environment. This capability is not only driven by technology but also incorporates strategic insights, organizational collaboration, and continuous innovation.

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