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Big Data and Precise Identification Will Be Applied to Public-Private Partnership Projects

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Abstract: Public-Private Partnership (PPP) projects represent a pivotal strategy in addressing infrastructure funding shortages. Originating in the 1980s, the PPP model gained traction globally, with China entering its standardization phase in 2014. However, the extensive scale, prolonged construction periods, and diverse stakeholders involved in PPP projects introduce multifaceted risks. To navigate these challenges, the Ministry of Finance emphasized the need for accurate risk identification in 2019. This paper integrates the "accurate identification" theory with big data technology, providing a theoretical foundation and technical support for precise risk assessment in PPP projects. The 5V characteristics of big data—scale, diversity, low-value density, data validity, and rapid processing—enable cost-effective and efficient risk analysis. Key risks, including financial, government credit, pricing mechanism, force majeure, and approval delays, are identified. The "accurate identification" theory and big data facilitate not only risk identification but also preventive measures. This comprehensive approach aims to enhance decision-making, reduce conflicts, attract social capital, and improve the overall efficiency of PPP projects.

Keywords: The PPP risk, Big data, Accurate identification

1. Introduction

The inception of the Public-Private Partnership (PPP) model traces back to 1982 when the British government introduced it to address infrastructure funding shortages [1]. Its widespread adoption commenced in the 1990s, presenting a novel collaboration between the public and private sectors. In this model, social capital actively participates in public infrastructure construction, fostering benefit-sharing, risk-sharing, and comprehensive cooperation throughout the project lifecycle. China, under the guidance of the State Planning Commission, embraced the PPP model in 1995, progressing to the formal standardization phase in 2014.

However, the extensive number of PPP projects, protracted construction timelines, substantial costs, and involvement of multiple stakeholders introduce a myriad of risks to PPP initiatives. To facilitate the standardized and orderly advancement of PPP projects, it becomes imperative to enhance the identification and control of associated risks. In March 2019, the Ministry of Finance issued the Implementation Opinions on Promoting the Standardized Development of Government-Private Capital Cooperation. This directive emphasizes the need to "resolutely fight the battle to prevent and

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defuse major risks and steadily promote the standardized development of PPP." Consequently, this opinion establishes more stringent requirements for the precise identification of risks inherent in PPP projects [2].

Simultaneously, the rapid evolution of digitalization and big data technology has broadened the avenues for information acquisition. This evolution necessitates government entities and social capital stakeholders to more precisely discern risks within PPP projects from the vast and intricate information landscape. Consequently, accurate risk identification emerges as the linchpin for ensuring the stable operation of PPP projects.

2. Review of Literature

2.1. Exploration of Big Data in Accurate Risk Identification

Zhi Rong's research demonstrated the potential of big data technology in mining data structures and correlations, leading to the discovery of behavioral trajectories and characteristics of individuals and social groups [3]. This approach, applying consistency laws to predict service needs, enhances forward-looking and predictive decision-making, offering valuable insights into risk management. Suying Li and Yu Yang classified project financing risks into six categories and fourteen types, proposing tailored solutions for various magnitudes of risks. Their work contributed significantly to understanding and addressing the diverse spectrum of risks within PPP projects. Couchn et al. emphasized the integration of big data technology into emergency decision-making, enabling precise information collection, scientific predictions through data analysis, and timely solution proposals, thus enhancing the accuracy and scientific foundation of decision-making.

2.2. Underlying Reasons for PPP Project Existence and Domestic Research Landscape

The essence of Public-Private Partnerships (PPP) embodies the collaborative partnership between the government and the private sector, emphasizing "benefit sharing, risk sharing, and whole-process cooperation" in delivering products and services [4]. The optimization of shared risks within PPP projects enhances cooperation efficiency between the government and social capital. In China, the central government actively promotes the PPP model, receiving widespread support from local governments. Presently, despite China's economic development entering a new normal characterized by economic slowdown and structural adjustments, some local governments face severe financial debt burdens, pushing against the government's capacity to bear these obligations. Financial difficulties are also encountered by the public sector.

While research on PPP project risk assessment in China has progressed, the relatively late initiation of this research and limited collaboration among research institutions impact the centrality of results [5]. Furthermore, most domestic scholars have segmented urban and rural areas, studying the feasibility of applying the PPP model separately.

2.3. Synthesis of Current Literature

Research on PPP project risk assessment in China has predominantly featured quantitative analyses, constructing dynamic risk analysis models to elucidate primary risk factors encountered by PPP projects [6]. Qualitative research, though limited, explores specific field situations and trends, shedding light on the current landscape. The integration of big data technology for analyzing and quantifying risks in PPP projects significantly enhances risk cognition and management abilities, grounding the risk identification mechanism in a more scientifically reasonable foundation [7].

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3. Theoretical Foundation

3.1. Big Data

The term "big data," initially introduced by futurologist Toffler in his influential work "The Third Wave" in 1980, represents a fundamental shift in the information industry, succeeding agriculture and industry. This concept entails vast datasets that can be computationally analyzed to unveil concealed patterns, unknown correlations, trends, or anomalies. Initially, in 2001, Meta Group proposed the 3V characteristics of big data, later expanded to 4V. Subsequently, IBM extended this to 5V [8]. The widely accepted 5V characteristics include extensive data scales, diverse data types and sources, low-value density, high validity and reliability of index data, and rapid data acquisition and processing capabilities [9].

Leveraging these 5V characteristics enables cost reduction, efficiency enhancement, acquisition of comprehensive real-time data, and in-depth analysis and mining of data structure and correlations. This capability facilitates the effective and swift identification of risks in PPP projects, supporting the entire process of PPP project risk identification and providing the necessary technical foundation for PPP project risk prediction [10].

3.2. Accurate Identification

The concept of "accurate identification" stems from the broader notion of "precision," initially applied to poverty alleviation in 2013 and later embraced in the realm of social governance. Accurate identification is instrumental for the examination of risk evaluation and sharing in PPP projects, necessitating the selection of an appropriate risk identification methodology [11].

The profound integration of Internet big data background data mining holds significant importance for the development paradigm of PPP projects. Big data and associated processing technologies enable precise risk quantification, aligning with the fundamental principles of accurate identification [12].

4. Main Risk Analysis of PPP Projects

4.1. Financial Risk

PPP projects, characterized by extensive construction scales and prolonged cycles, are susceptible to financial risks stemming from fluctuations in exchange rates and interest rates [13]. These risks can lead to reduced project income or potential corporate bankruptcy, demanding proactive measures and attention to financial strategies by project leaders [14].

4.2. Government Credit Risk

Government credit risk emerges when the government fails to fulfill contractual responsibilities, resulting in project losses [15]. For example, inadequate government-led demolitions can interrupt construction, leading to resource wastage and capital loss, impacting project continuity.

4.3. Risk of Unreasonable Price Formation Mechanism in PPP Projects

Due to the non-excludability and natural monopoly of public utilities, the market-driven approach alone might not establish reasonable pricing [16]. The determination of pricing often requires collaboration between the market and the government, where a lack of clear standard bidding criteria in government-led social capital cooperation can lead to price setting by social capital stakeholders [17].

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4.4. Force Majeure Risk

Force majeure risks, encompassing natural and social risks, require mitigation strategies such as insurance coverage for insurable aspects and clear liability provisions in agreements for uninsurable matters [18].

4.5. Risk of Approval Delay

Complex and lengthy government examination and approval procedures pose significant risks, impacting project efficiency and timely delivery [19]. Divergent requirements from various government departments can consume substantial time and effort for social capital seeking PPP project approval, ultimately impeding standardized project delivery [20].

5. Practical Foundations for Precise Risk Identification in PPP Projects within the Framework of Big Data

5.1. Evolution from Traditional to Data-Driven Risk Identification in PPP Projects

Advancements in big data technology within PPP projects have driven the transformation of risk identification from traditional, experiential methods to data-driven methodologies [21]. This shift toward precision in identifying risks offers substantial potential for bolstering the analytical capabilities of governmental bodies and stakeholders engaged in social capital, thus fostering a more comprehensive understanding of PPP project risks [22].

5.2. Harnessing Big Data Technology for Scientific Risk Quantification in PPP Projects

Big data technology assumes a pivotal role in quantifying risks by meticulously collating and analyzing vast and diverse datasets [23]. This approach fosters a scientifically grounded prediction of risks within PPP projects. Utilizing big data platforms, governmental bodies and social capital stakeholders acquire comprehensive insights into PPP project risks [24]. This entails the collection of pertinent information and thorough mining of PPP project data to extract maximum utility.

5.3. Catalyzing Precise Monitoring and Early Warning Systems with Big Data in PPP Projects

Big data catalyzes precise monitoring of risks within PPP projects, enabling the discernment of risk occurrence patterns [25]. This analytical approach contributes significantly to reducing uncertainty in predicting risks associated with PPP projects. Additionally, it fortifies early warning capabilities, mitigating potential adverse impacts on PPP projects when risks materialize.

6. Constructing and Mitigating Risks

The theory of "accurate identification" provides a robust theoretical foundation for precisely discerning risks within the PPP model [26]. Simultaneously, big data offers formidable technical support for accurately identifying risks within the PPP model. By adhering to the principles of "accurate identification," the utilization of big data technology for data mining and analysis becomes instrumental in pinpointing and preventing risks in PPP projects with precision and timeliness [27].

7. Conclusion

The fusion of the "accurate identification" theory and big data technology establishes a formidable framework for precise risk identification and mitigation in PPP projects [28]. Leveraging the

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analytical capabilities of big data, combined with the precision of accurate identification, allows for a data-driven approach to risk assessment and management. The application of big data not only quantifies risks but also facilitates improved risk prediction and early warning systems, effectively minimizing adverse impacts on PPP projects. Through accurate risk identification and preventive measures, conflicts among stakeholders can be reduced, fostering a more efficient and stable environment for the development of PPP projects [29].

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