Analysis of Current Situation, Problems and Countermeasures of Big Data in the Field of Engineering Management

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Abstract. Currently, the field of engineering management is experiencing rapid development and has become a significant force in promoting economic and social growth. Due to its complexity, creativity, systematization, and risk characteristics, the field of engineering management presents individuals with significant technical needs and processing difficulties. Big data has achieved significant advancements in the engineering management field due to its characteristics, including large data volumes, various types, and predictability. By utilizing big data, a sizable amount of engineering data can be rapidly analyzed and optimized for design solutions, resulting in improved efficiency and increased accuracy in decision-making while also reducing costs. However, the role of big data in engineering management is limited by issues such as data insecurity, low quality, and a shortage of professionals. This paper proposes solutions to address these challenges, including strengthening data security, enhancing data quality control, and improving personnel training and technological innovation.

Keywords: Big data; engineering management; data; decision-making.

1. Introduction

In the current age of vast information proliferation, rapid advancements in science and technology have enabled big data technology to seep into numerous sectors, garnering widespread attention [1]. With its distinctive features and strengths, big data is revolutionizing the modes of daily lives and occupations. As an integral element of social development, engineering management demands greater efficacy and excellence. Therefore, applying big data to the realm of engineering management holds crucial practical and theoretical importance.

Big data has had impressive accomplishments in the application of the engineering management field due to its characteristics, including large data volumes, numerous data types, and predictability [2-3]. Integrating data and information from crucial components of engineering projects, including personnel, machinery, materials, techniques, and environment, into a cooperative, big data hub for the project, facilitates real-time, thorough, and intelligent engineering project management and monitoring. This operational mode can enhance project efficiency, decrease expenses, ensure project quality, and consequently boost the efficacy and potency of engineering management [4].

However, the practical application of big data in the field of engineering management encounters several problems. For instance, data insecurity, low quality, and a lack of professional talents hinder the role of big data in engineering management. These issues not only impact the effectiveness of big data application, but also restrict the proficiency and productivity of engineering management [5].

In conclusion, the use of big data in the field of engineering management has gained significant attention. However, this paper identifies problems that still require solutions. The current status of big data application in engineering management is analyzed, and targeted solutions addressing the problems are proposed.

2. Current Situation

Construction engineering is a major focus in engineering management and now employs big data technologies. Big data applications are primarily used in the areas of data collection, analysis, and

mining within construction engineering. For instance, Building Information Modeling (BIM) can be utilized to digitally oversee the entire process of architectural design and construction while collecting and analyzing data [6]. Fig. 1 displays the percentage of companies utilizing BIM technology in distinct company types as a proportion of all firms within that category. 85.15% of companies use BIM in public buildings, while 68.37% use it in residential construction. It should be mentioned that BIM usage in infrastructure building and industrial construction has significantly increased to 56.22% and 43.2%, respectively. In 2020, these numbers were 34.24% and 27.75%, correspondingly.

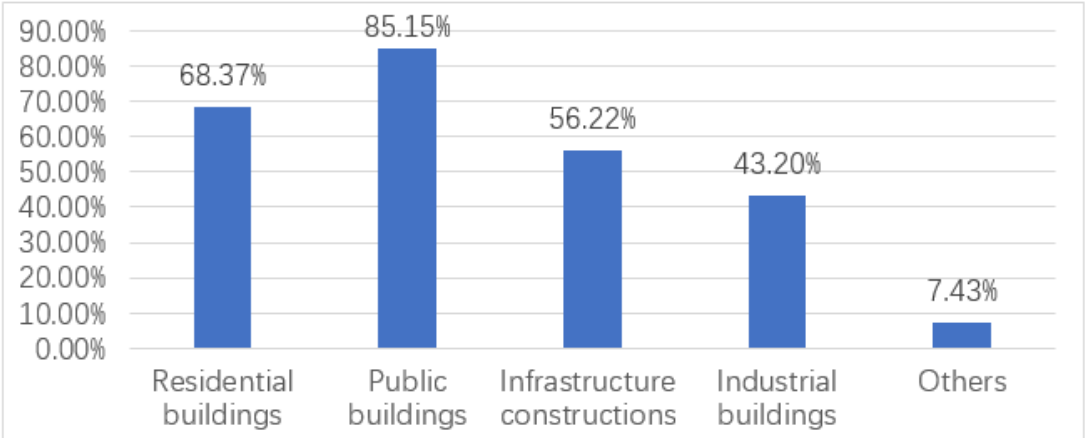

Fig 1. Percentage of companies using BIM technology.

In summary, the use of big data in engineering management is gaining momentum and playing an increasingly crucial role. With ongoing technological advancements, its application in engineering management is expected to become even more extensive and in-depth.

3. Problems

3.1. Data Security

3.1.1. Data privacy leakage

In the realm of big data application, the collection of vast amounts of data - comprising personal, enterprise, engineering, and other sensitive information - is imperative. However, the collection process may give rise to complications such as unlawful data collection and inadequate data desensitization, resulting in the violation of user privacy. Furthermore, during the process of storing and transmitting data, there is a potential for issues such as unprotected data and failure to destroy expired data, resulting in the possibility of hacking, leakage of users' confidential information, and security vulnerabilities [7].

3.1.2. Data tampering and data loss

In addition to the problem of data leakage, the application of big data in the field of engineering management may also face the problem of data tampering and data loss. Both data tampering and data loss can have unpredictable effects on engineering management. Data tampering mainly exists in the two links of data source and data processing, and system failure and human modification of data inaccuracy may occur, affecting the decision-making and implementation of engineering management. Data loss, on the other hand, can be caused by technical failures, human errors or natural disasters, causing immeasurable losses to project management.

3.2. Data Quality

3.2.1. Data sources and integration

In the field of engineering management, there are a variety of data sources, which may come from different departments, projects, suppliers, and so on. Due to the different data sources, the process and specification of data collection and processing are not consistent, and the data format and quality

are also different. Some data may have formatting errors, missing values, outliers, etc., which may affect the results and reliability of data analysis, and at the same time lead to the difficulty of data integration, and it is difficult to realize cross-department and cross-project comprehensive analysis and management.

3.2.2. Data update and analysis

The data in the field of engineering management has high timeliness requirements and needs to be updated and analyzed promptly. However, due to various reasons, such as data processing speed, network transmission speed, etc., it leads to untimely data, which affects the accuracy and timeliness of decision-making. Data processing speed is a major cause of untimely data. In the field of engineering management, the amount of data to be processed is usually very large, including design drawings, construction plans, cost budgets, and so on. If the data processing speed is slow, the data will not be updated and analyzed in time, which will affect the accuracy and timeliness of decision-making [8]. Network transmission speed is also a reason for untimely data. In the field of engineering management, data is usually scattered among different departments, projects, and suppliers. If the network transmission speed is slow, it will result in data not being transmitted and shared promptly, thus affecting the accuracy and timeliness of decision-making.

3.3. Specialized Talents

3.3.1. Talent training system

At present, the application of big data in the field of engineering management is still in its infancy, and the talent training system is not yet sound. First of all, in terms of talent reserves, this field is almost in a blank state. Moreover, due to the lack of systematic curriculum and teaching resources, the talents cultivated cannot meet the actual demand. More importantly, the application of big data in the field of engineering management requires a certain degree of practical ability, including skills in data mining, data analysis, and other aspects. However, at present, many colleges and training institutions still focus on teaching theoretical knowledge, while the construction of practice opportunities and internship bases is relatively lagging, resulting in graduates not being able to effectively apply what they have learned in actual work.

3.3.2. Incentive mechanism

At present, there seems to be a lack of effective introduction channels and incentives to attract more excellent talents to enter the field. In addition, the application of big data in the field of engineering management is still under investigation, and the value and potential are still not well understood. As a result, some potential talents lack interest and confidence in the field and are reluctant to engage in it.

4. Countermeasures

4.1. Strengthen Data Security

4.1.1. Security management system

Before formulating a data security management system, it is necessary to clarify the objectives and principles of data security management. For example, it is necessary to protect the confidentiality, integrity, availability, and traceability of data, and to ensure compliance, legality, and fairness of data. Next, the scope of data security management and who is responsible must be clarified. This includes the collection, storage, use, transfer and destruction of data. At the same time, the responsibilities and authorities of various departments and positions are determined to ensure the effective implementation of data security management. Next, data classification and grading standards should be formulated. According to the actual situation in the field of technical management, formulate data classification and grading standards, and develop different protection measures for different types and levels of data. For example, data should be classified into different levels, such as confidential,

secret, internal, and public, and appropriate protection measures should be taken. Finally, the data security management system should also be regularly evaluated and updated, and adjusted and improved according to the actual situation. At the same time, relevant laws, regulations and standard requirements should be followed promptly to ensure the compliance and effectiveness of the information security management system.

4.1.2. Data encryption and access control

First, data encryption and transmission security should be strengthened. Sensitive data should be encrypted and stored to ensure that the data cannot be stolen or tampered with during transmission and storage [9]. At the same time, data transmission security is strengthened, and secure communication protocols and encryption algorithms are used to ensure the confidentiality and integrity of data transmission. On this basis, it is also necessary to establish a perfect data backup and recovery mechanism to ensure that data can be recovered in a timely manner after an attack or accidental loss, so as to avoid irreparable losses caused by data leakage. At the same time, regular data backup and recovery tests will be conducted to ensure the integrity and recoverability of the backup. Finally, strengthen the training and evaluation of relevant personnel operations, and develop a strict system to improve the staff's awareness of data security and skill level, in order to reduce the likelihood of human error, resulting in data errors changing similar events. A perfect data access control mechanism can also be established to strictly control and manage the access and use of data. This includes user authentication, authorization control, and operational auditing to ensure the accuracy and confidentiality of data.

4.2. Strengthen Data Quality Control

4.2.1. Harmonize data and enhance integrability

When faced with a wide variety of data, the first step is to standardize the data so that it is consistently formatted and coded. This improves the readability and usability of the data and facilitates subsequent data integration and analysis. For example, data integration tools such as extract, transform, and load (ETL) are used to extract, transform, and load data from disparate data sources into a unified data warehouse. These tools can help process data from disparate sources, perform data format standardization, field mapping, and data cleansing to ensure data consistency and accuracy. By establishing such a data integration platform, data integration and sharing between different departments can be realized. This can reduce the problem of data from a variety of sources that are difficult to integrate, and improve the accuracy and timeliness of decision-making.

4.2.2. Enhancing the timeliness

To solve the problem of slow data processing, more efficient data processing techniques and algorithms can be used to establish an early warning mechanism to optimize the data processing process. By setting alert lines and thresholds, alerts are issued and action is taken when it is determined that data is not being updated and analyzed in a timely manner. In this way, the data processing process can be optimized and the speed of data processing can be increased, thus reducing the problem of untimely data.

At the same time, the problem of untimely data can be reduced by strengthening the network construction and improving the network transmission speed. This problem can be effectively reduced by using the QoS mechanism. QoS (Quality of Service) mechanism is a technique for managing and optimizing network traffic, which can provide different quality of service guarantees according to different service requirements. The core principle of the mechanism is to classify network traffic into different categories and assign different tags to each category. These tags can include priority, service type, application, etc. Based on the categorization and tagging, network traffic is scheduled and resources are allocated. That is, the classification process sets different priorities and resource allocation policies based on different types of service requirements (e.g., voice, video, data, etc.). Then, network traffic is managed and scheduled according to these classifications and policies to ensure that the requirements of different types of services are met [10]. For example, the QoS

mechanism automatically increases the allocation of resources to high-priority service traffic when it requires more resources. The mechanism also controls the packet loss rate when the network is congested to ensure that high-priority service traffic receives a better quality of service. In practice, the QoS mechanism can be implemented by configuring network devices (such as routers, switches, etc.). For example, different priorities and resource allocation policies are set on the interfaces of network devices to categorize and schedule different service traffic. In addition, the QoS mechanism can also be implemented by configuring applications, for example, by setting different parameters such as priority and service type in the applications.

In this way, it is possible to ensure that the network is able to provide reliable, efficient, and well-organized services for various services, thereby addressing the problem of data not being updated and analyzed in a timely manner.

4.3. Strengthen Talent Training

4.3.1. Improve the talent training system

First, a multi-level training system should be established to meet the needs of talents at different levels. For primary talents, focus on cultivating basic knowledge and skills, such as data collection, processing and analysis skills. For example, in response to the characteristics of the big data field, colleges and training institutions should increase the number of big data-related specialties and courses, strengthen the construction of teaching staff, expand the scale of enrollment, innovate teaching methods and approaches, and adopt methods such as case analysis, project practice and group discussion to improve students' initiative and participation. Meanwhile, online education, virtual laboratories and other means can be used to expand the scope of training and improve the efficiency of training. For middle and senior talents, emphasis is placed on cultivating comprehensive ability and innovative thinking, such as data mining, data visualization, decision support and other aspects. For example, school-enterprise cooperation can be carried out as a way to strengthen cooperation between universities and enterprises to jointly carry out talent training programs. Enterprises can provide practice opportunities and internships, such as the establishment of practice bases, internship bases, laboratories, etc., to provide real practice scenarios and data, so that students can master the skills and apply the knowledge in real operations. Colleges and universities can provide theoretical knowledge and teaching support to realize resource-sharing and complementary advantages.

4.3.2. Create an effective incentive mechanism

First, policy support and incentives should be strengthened. The government can introduce relevant policies to support and incentivize the cultivation of professional talents in the field of engineering management with big data. For example, financial support, tax incentives, and other measures are provided to encourage enterprises and institutions to participate in talent training programs. At the same time, a sound and scientific talent incentive mechanism should be established. Appropriate evaluation standards and methods can be formulated to comprehensively evaluate the knowledge and ability of talents. Through evaluation, deficiencies can be found and improvements can be made to improve the quality and effectiveness of talent training. At the same time, excellent talents are given incentives and promotion opportunities to stimulate the enthusiasm and creativity of talents.

5. Conclusion

In the field of engineering management, the application of big data is gradually gaining popularity, which brings a lot of opportunities and challenges. By utilizing the characteristics of big data technology, such as large amounts of data, many types, predictability, etc., the project progress can be better grasped, the cost can be better controlled and the quality can be better guaranteed, so as to improve the efficiency and effectiveness of engineering management. However, in practical

application, there are some problems with big data in the field of project management, such as insecure data, low quality, lack of experts, and so on. These problems limit the role of big data in project management. To solve these problems, this paper puts forward the following countermeasures: first, a security management system should be established and strengthen data encryption and access control to establish data security; second, the data should be unified and data updating should be strengthened to strengthen data quality control; finally, the talent training system should be improved and an effective incentive mechanism should be established to strengthen talent training and improve the application level of big data in the field of engineering management.

However, there are still some shortcomings in this study. First of all, the study mainly focuses on literature review and current situation analysis, while there are relatively few specific application cases and empirical studies on big data in engineering management. Meanwhile, although this paper has proposed some possible solutions, the analysis and validation of these answers are relatively limited. Therefore, it is necessary to conduct more detailed and in-depth analyses in the future research to find more effective solutions and provide better technical support for engineering construction and management.

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