Application of Big Data in Construction Project Management

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Abstract. The construction project has the characteristics of long duration, multi-participation, diverse environment, technical and professional, involving progress, quality, cost, safety and many other aspects. Traditional management methods often have limitations such as insufficient data collection and inaccurate data analysis, which lead to difficult management, many loopholes and great risks. The coming of the era of big data has brought opportunities and provided ways for project scientific management. The purpose of this paper is to discuss the application of big data in the quality, schedule, safety and cost management of engineering projects, so as to comprehensively and systematically promote the improvement of the level of project management.

Keywords: Big DATA · project management · application

1 Introduction

Statistics show that the annual GDP of China in 2022 reached 12,102072 billion yuan, 3% higher than in 2021; the total output of the construction industry was 31.198 billion yuan, marking a 6.5% year-on-year increase. As a pillar of the national economy, the construction industry has a huge scale. A construction project goes through several stages from planning, preparation and implementation to completion, and the management of construction projects, characterized by a long duration of construction, engagement of multiple parties and diverse environments, involves control of progress, quality, cost, safety and many other aspects. With diverse needs of the construction industry and economic swings, project management is facing increasing risks. Big data provides a new way to improve project management, which is worthy of in-depth studies, effective application and promotion [1].

2 Significance of Applying of Big Data Technologies

As science and technology advances with the time, we usher in an era of big data where data penetrate every corner of our life. Examples in this regard are ample: e-commerce systems collect customers' information and recommend products according to their purchasing habits, age, prefer2ences, regions, etc., for customized page display

[2]; and business owners make timely adjustments to their inventory and logistical plans in the light of previous data. In the field of travel transportation, individual travel data are collected through base-station positioning or WiFi + ibeacon to realize targeted security and other deployment to monitor passenger flow control in the stations, airports and on the roads [3]. In the financial sector, insurance companies decide whether the insured person is legitimate to claim the agreed amount of compensations by analyzing the insured person's health conditions, accident records and other information. The bank decides whether to issue a credit card to the applicant and the amount of credit according to the applicant's income, consumption records and credit history… In all aspects of life and sectors of economy, big data have shown its advantages including large data scale, high processing speed, quick updating and low value density. Construction project management has shifted from the traditional management model to the data-based management model, which improves pre-project control, whole-process monitoring, project evaluation, and other aspects.

3   Application of Big Data to Construction Quality Control

Subject to factors such as the construction environment, staff and building materials, traditional project quality control suffers limited efficiency. Big data technologies provide a solution to this problem [4]. For the time being, some government-dominated construction information management platforms are already available abroad. Construction enterprises upload data about the project progress and quality to the platform, and the government performs quality control with the uploaded data, which can reduce quality risks and improve work efficiency. This practice is something that China can take a page from. Moreover, a range of technical models have been established in some foreign countries based on process quality standards and technical specifications. For example, the information of various building components required in construction projects are used to summarize a set of standards for the varieties, specifications, and production of building materials. The quality of construction materials and technologies is monitored in real time according to simulation results, and deviations are identified in time to find countermeasures and hence ensure the project quality. Big data is applied to quality control of construction projects in the following steps: at the engineering design stage, useful data are mined, analyzed and compared so that the data in the design stage can form a flow of information and ensure the initial quality of building products. At the construction preparation stage, all data about the construction and architectural design are recorded, processed and converted into parameters of the construction project; the parameters are the very basis that the construction units rely on to adjust and optimize the construction plans. During the construction process, big data technologies are employed to process data about building materials, historical records, construction management, process product inspection and the results are fed back to the construction unit to make timely adjustments to the construction plan. At the completion stage, big data can be used by the construction unit to prepare after-sales manuals for users and collect additional project information.

4 Application of Big Data to Construction Project Scheduling

Construction projects generally have a long cycle, the amount of engineering is large, and it is difficult to control the construction duration [5]. For example, traditional construction projects require manual arrangement of people, machines and materials in advance, and any misarrangement will affect the progress of the project [6]. The traditional engineering management methods which are mainly based on technology and experience can no longer be adapted. Practice has proved that the establishment of document and process interface management, through the design drawings, contracts, construction, to form a unified platform for all parties, to improve the project management has far-reaching significance. The big data technologies can be employed to coordinate the varied needs of different parties involved in the project, and optimize various factors in the process of construction management. In the construction process, big data are used to build a control system based on the construction scheme, funds, and construction conditions, coordinate all factors involved in the project, and simulate its progress. Meanwhile, with the support of big data technologies, we can upload information of the construction site to the system and build a construction progress control model through data mining and analysis, design construction plans and progress control systems to realize scientific scheduling and management of the construction site, and optimize the management mechanism, which will improve the construction efficiency and quality, reduce the workload and pressure of the management staff, and make construction project management more systematic and standardized.

5 Application of Big Data to Construction Safety Management

The bottom line of project management is to ensure the safety of construction projects and avoid latent risks. According to the public service portal of the National Project Quality and Safety Supervision Information Platform, there were 549 construction safety accidents and 622 deaths in housing and municipal engineering in China in 2022.Lives and families at stake.

It was reported that among all the casualties in the construction industry in 2022, falls from height accounted for 46.93%, earth excavation collapses accounted for 14.73%, object strikes accounted for 13.24%, lifting machinery injuries accounted for 7.99%, and the others made up 4% [7]… Therefore, it is important to predict the accidents beforehand. However, due to the complex system of construction safety management, data about safety risks collected from relevant departments and enterprises in the construction project are not necessarily reliable as the authenticity cannot be guaranteed, and it costs time and labor to analyze the collected data. As a result, the goal of early-warning and prediction of accidents become unattainable, and the safety management personnel are overoptimistic about the safety conditions at the construction site. Big data provide an effective solution to early warning and prediction of safety risks at the construction site. First, with big data analysis, we can assess the data of safety risks provided by construction enterprises objectively and accurately to avoid data fraud. Besides, a safety big data analysis system can reduce the labor cost and enhance the construction enterprises' attention to safety control; the system can also provide guidance to safety management

personnel in safety control decision-making, and hence reduce latent risks and preclude safety accidents. For example, for management of the construction equipment at the construction stage, sensors can be installed at the key parts of the construction machinery to achieve dynamic monitoring of the equipment so that the key information of the equipment can be collected, problems in operation can be detected timely, and the running state of equipment can be monitored in real time [8]. In this way, the construction unit can maintain and replace the equipment when necessary, which reduces the safety risks in machinery operation and improves the efficiency of construction.

6 Application of Big Data to Cost Management

A construction project, from investment decision-making, design, and construction to completion, involves various issues, among which the cost of the project directly affects the economic benefits of construction enterprises [9]. The use of big data technologies provide reliable data for budgeting and capital investment decision-making based on the estimated scale, funds, and duration of the construction project. For example, in cost management of a construction project, the construction unit can, in light of the actual needs of the project, make use of the big data storage and integration technology to perform centralized analysis of the layout schemes and select the most appropriate materials for construction. Besides, with the support of big data technologies, the construction enterprise can build a comprehensive material procurement platform and warehouse management system to achieve smart management of construction materials during the construction process. Specifically, the ISGP algorithm and BIM technology can be used to identify optimal venues available for storage of materials. Then, the space of the construction site can be allocated, and the transfer of materials should be recorded to realize reasonable procurement of materials. The materials management personnel can log onto the storage management system to check the material inventory to facilitate the construction unit's timely adjustment of procurement plans. To improve construction project cost control, we can also build a cost control database by big data technologies, and by adding the data processing functions to the database, we can create a closed-loop cost management system to process and analyze the massive data in construction projects, strengthen information feedback in cost management, and improve the cost efficiency. The cost database composed of massive data cannot only collect substantive information about the cost of the project, but also accurately process the relevant information by distributed storage technologies to facilitate cost management of future construction projects.

In a short, with the continuous development of information technology, big data have become a mainstream solution to construction project management [10]. It is necessary to strengthen the application and promotion of big data technologies in an all-round and multi-level way, strengthen the training and introduction of big-data professionals, and maximize the ability of data collection and processing in the field of construction project management.

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