A Brief Discussion on the Application of Electronic Information in Construction Engineering Management

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Abstract: Against the backdrop of rapid information technology development, electronic information technology is being widely applied across various industries. Its application in the field of construction engineering management can effectively address issues such as lagging information transmission and low collaboration efficiency inherent in traditional management, promoting the large-scale and detailed development of construction projects. This paper analyzes the application value of electronic information in construction engineering management, elaborates on its main application areas, and proposes scientific and rational application strategies. These strategies include building a full-cycle digital management platform, deepening the application of IoT technology in equipment and material management, utilizing big data and AI technologies to optimize decision-making processes, strengthening the system integration guarantee system, and promoting real-time supervision using internet technology. The aim is to provide a valuable reference for the high-quality development of the construction industry.

1. Introduction

Electronic information technology in the era of technology is sweeping across all industries, changing traditional operational models and development patterns. Its application in construction engineering management solves problems of delayed and inaccurate information transmission, ensures project progress, improves project quality, and, supported by technologies like the Internet of Things (IoT), big data, and artificial intelligence (AI), enables construction companies to collect and analyze data quickly. This drives the transformation of the entire construction industry towards high-quality development. Therefore, in-depth exploration of the application strategies of electronic information in construction engineering management holds significant practical importance.

2. Application Value of Electronic Information in Construction Engineering Management

2.1 Enhancing Engineering Management Efficiency

The application of electronic information is key to improving overall management efficiency. Electronic information technology can break down communication barriers between departments, enabling real-time sharing of information such as construction progress and design changes. Furthermore, it allows for precise regulation of resource management (human, material, and financial resources) in construction projects. Companies can dynamically allocate resources based on progress, avoiding shortages or idleness, thereby accelerating construction pace and reducing management costs, fundamentally enhancing project management efficiency [1].

2.2 Beneficial for Strengthening Cost Control

Using electronic information technology in construction engineering management enables efficient collection and integration of cost data. Smart sensors and mobile terminals automatically collect data on material consumption and equipment usage. This data is uploaded in real-time to

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information management systems, where it is integrated to form a comprehensive cost database, providing reliable data support for cost control. With the help of electronic information technology, managers can dynamically monitor costs and quickly issue early warnings upon detecting deviations from the budget, preventing cost overruns from escalating.

2.3 Ensuring Construction Project Quality

The application of electronic information technology is a crucial means of ensuring construction quality. It enables accurate collection and efficient transmission of data during construction. By deploying sensors on-site, data such as structural stress and deformation can be continuously collected. Managers can use this data to promptly identify and eliminate potential quality and safety hazards, avoiding accidents. Additionally, digital management systems built with electronic information technology allow for centralized management of documents like design drawings, construction plans, and material test reports, preventing quality deviations caused by poor information flow.

3. Main Application Areas of Electronic Information in Construction Engineering Management

3.1 Dynamic Supervision of Engineering Progress and Resources

The deep application of electronic information technology is key to enhancing project management effectiveness. Integrated supervision platforms based on BIM and IoT technologies enable real-time perception of construction progress and resource allocation. These platforms, primarily using 3D digital models as carriers, integrate devices like sensor networks and RFID tags. They coordinate with AI algorithms to analyze the health status of construction equipment, providing early fault warnings. Furthermore, electronic information technology can establish dynamic resource databases, creating intelligent matching relationships between material inventory and construction progress. Supported by mobile applications and cloud collaboration, on-site managers can upload process data like progress photos and inspection records in real-time, which the system automatically links to corresponding locations in the BIM model, forming a visual dynamic map of progress and resources. This provides a transparent, traceable information base for multi-party collaborative decision-making. This dynamic supervision model based on electronic information significantly enhances the level of refinement/detail of project management, offering reliable technical support for the digital transformation of the construction industry.

3.2 Engineering Safety and Quality Monitoring

The application of electronic information technology reshapes traditional supervision models. Supported by wireless communication, construction projects can transmit data to cloud platforms, enabling dynamic perception of the project's physical status. The application of edge computing can improve the processing efficiency of project data. Blockchain technology provides strong support for quality traceability by storing key process records, quality inspection reports, and other data on the chain, ensuring data immutability when combined with digital signature technology.

3.3 Engineering Information Collaboration and Decision Support

Electronic information technology is the core carrier for information interaction in construction project management. Through structured data encoding and standardized transmission protocols, it enables cross-regional and cross-disciplinary engineering information sharing and dynamic updates. Companies can leverage BIM's collaborative advantages to integrate multi-dimensional data like mechanical and electrical systems and construction schedules into a single information model. At the decision support level, electronic information technology can address complex engineering problems by building intelligent analysis models. For instance, IT can integrate multi-source heterogeneous data such as geological survey data, environmental monitoring information, and cost budget parameters in large infrastructure projects. Machine learning algorithms can be used for dynamic assessment of construction risks, generating decision tree models with probability distributions. The elastic computing advantages of cloud computing can support parallel simulation and optimization comparison of multiple scenarios, allowing decision-makers to predict the implementation effects of different strategies in a virtual environment.

4 Application Strategies of Electronic Information in Construction Engineering Management

4.1 Building a Full-Cycle Digital Management Platform

The application of electronic information technology requires the construction of a full-cycle digital management platform. In the early planning stage, companies should use GIS technology to collect data on topography and the surrounding environment. Subsequently, big data analytics can be used to evaluate the advantages and disadvantages of different site selection options, providing strong references for rational project planning [2]. Companies can also use BIM technology to create 3D visual models for simulating and analyzing the internal structure and functional layout of buildings, allowing for targeted optimization upon identifying design issues, ensuring planning rationality. During the construction phase, an integrated project management information system should be matched, unifying elements like schedule, quality, and cost within the platform. Various types of sensors should be deployed on-site to comprehensively collect environmental parameters and equipment operational status. In the operation and maintenance phase, intelligent monitoring devices should be installed to predict potential equipment failures, truly implementing preventive maintenance. Companies should use big data and cloud computing technologies to analyze the massive data generated during operation, providing strong decision support for energy management and space optimization, thus improving overall operational efficiency. Additionally, the platform should regularly collect user feedback, promptly optimizing and upgrading its functionalities upon identifying issues to maintain its advanced level and competitive edge.

4.2 Deepening the Application of IoT Technology in Equipment and Material Management

Construction engineering management should emphasize the application of IoT technology in material and equipment management, which is key to promoting digital transformation. Companies should add RFID tags and sensors to materials and equipment, establishing a perception network covering transportation, warehousing, and procurement processes.同时 (At the same time), a digital management platform based on IoT technology should be built during project management, establishing BIM models to map virtual and real scenes. Companies should use big data and AI technologies to deeply mine the collected data, establish standards for IoT device access, and ensure the security of the material and equipment management information system. Furthermore, companies should emphasize the unification of industry standards, achieving standardization of device communication protocols and data interface formats. Regular system security audits should be conducted to avoid impacts on project management due to data leakage risks.

4.3 Utilizing Big Data and AI Technologies to Optimize Decision-Making Processes

The application of electronic information technology should deeply integrate big data and AI technologies to restructure and promote the intelligent transformation of decision-making processes. IoT sensors should be deployed on construction sites to collect data on worker locations and equipment status. This data, combined with unstructured information like BIM models and design drawings, can be processed using natural language processing for important clauses. For example, in concrete pouring, temperature sensors and construction logs can be deployed to accurately identify risk factors affecting quality. At the operational level, machine learning algorithms can mine features from historical project data, using models like LSTM neural networks to dynamically and realistically simulate duration, cost, and quality [3]. At the middle management level, knowledge graph technology can integrate industry standards and process standards, referencing tacit knowledge accumulated in expert systems to form an explainable decision rule library. At the top level, reinforcement learning frameworks can be deployed, allowing the system to optimize resource allocation strategies through trial and error in simulated environments. Companies can also use digital twin technology to create virtual construction sites, where decision-makers can visually assess the impact of different schemes in a 3D visual interface and determine the optimal time window for processes like rebar tying through Monte Carlo simulations. The final decision-making stage should retain manual intervention interfaces, with the system continuously recording correction data and feeding it back to the model training set.

4.4 Strengthening the System Integration Guarantee System

The application of electronic information technology requires a strengthened system integration support framework. Construction engineering management involves different participants and software systems; differences in data formats or interfaces can lead to information silos. Therefore, companies should establish unified data standards, defining format and accuracy requirements, enabling accurate data transfer between different systems. Moreover, interface protocols must be strictly standardized, unifying interface types and data transmission rules to ensure efficient sharing and deep interaction of data across systems. Furthermore, projects should establish a multi-layered security protection system, deploying intrusion detection and firewall systems, regularly scanning for vulnerabilities and updating security patches to enhance the risk resilience of the entire information management system. Additionally, companies should build a comprehensive management platform integrating functions like project management, schedule control, and quality management, consolidating dispersed subsystems. This platform enables centralized data management and analysis, providing comprehensive and accurate basis for decisions. Its collaborative features can enhance communication and coordination among participants, improve work efficiency, and allow field personnel to upload data to mobile terminals in real-time, helping managers grasp project dynamics anytime, anywhere. The management information system should be regularly maintained and upgraded to optimize performance and ensure long-term stable operation. Response measures should be formulated for potential system failures, data loss, etc., to avoid economic losses for the project.

4.5 Promoting Real-Time Supervision Using Internet Technology

The application of electronic information technology is key to enhancing supervision effectiveness. Companies should leverage internet technology to establish real-time supervision platforms, solving issues like information lag and incomplete coverage in traditional supervision, and promoting the transformation of project management towards refinement and intelligence [4]. During this process, companies should establish a multi-source data fusion perception network on-site, using advanced technical means to monitor concrete curing environments and the wearing of safety equipment by personnel. Collected data can be transmitted to cloud systems using 5G technology, enabling supervision departments to understand site dynamics promptly. Automatic alerts should be issued upon detecting abnormal data, avoiding impacts on project decision-making due to information distortion. Companies can also use internet technology to link models with on-site perception devices, achieving bidirectional mapping between virtual and real worlds. Supervisors can access construction progress, quality inspection reports, and safety inspection records for any node through the platform and use big data analysis to predict potential risks. Furthermore, IoT technology can be used to establish information sharing channels between supervision departments, construction units, contractors, and third-party service agencies, breaking down data silos.

5. Conclusion

In summary, the application of electronic information in construction engineering management is a core force driving industry development. Reasonable introduction of electronic information technology can strengthen information transmission and communication between departments, avoiding issues of delay and distortion. Therefore, construction companies should build full-cycle digital management platforms, deepen the application of IoT technology in material and equipment management, leverage the advantages of big data and AI to optimize decision-making processes, strengthen the system integration framework, and conduct real-time supervision of the construction process with internet technology support, providing strong support for the long-term development of the construction industry.

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