Research on Digital Management of the Entire Planning, Investment, and Construction Process

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Abstract. As the socioeconomic landscape shifts toward a digital economy, communication firms must raise the degree of engineering project management digitalization in order to increase their overall competitiveness. This article highlights the need to support the digitization of the entire engineering project management planning, investment, and construction process. It does this by beginning with a situation analysis of the capabilities, coordination mechanisms, and operation modes as they exist today. This article explores how to accomplish full-process digitization by delving deeply into the pressing issues that must be resolved throughout the engineering project management process. It also enumerates the essential skills needed for digital engineering management. This improves the caliber and effectiveness of pertinent engineering management staff throughout the whole engineering project management process by acting as a guide for the technical framework and platform function design in the ensuing support system implementation stage.

Keywords: Engineering Construction; Digitization; Visual Planning; Online Design; Project Management.

1 Introduction

The "14th Five-Year Plan" for the country states that the digital economy, which is currently the dominant economic format, is bringing about significant changes in lifestyles, production techniques, and governance through the digital transformation of all elements and the integrated application of information and communication technologies [1]. The digital transformation of the entire planning, investment, and construction process for engineering management has become an essential trend for communication firms to improve their overall competitiveness. This article begins with the state of the engineering project management process as it currently exists, analyzes the issues that must be resolved in the process management as a whole, concentrates on outlining and examining the essential procedures and technologies for digital planning, investment, and construction, and provides a summary of the solutions for digitalizing the engineering planning, investment, and construction process as a whole. This can help to improve the caliber and effectiveness of the relevant engineering management staff as well as

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the engineering project process overall by directing the technical framework and platform function design in the ensuing stage of support system deployment.

2 Analysis of the Current Situation of Engineering Management Capabilities in Communication Companies

There have been two phases in the growth of engineering management skills in communication firms. Ten years ago, information systems were constructed independently by headquarters and many provinces, with the initial goal of gaining information management capabilities for projects under their authority from project inception to project acceptance. The "cloud transformation and digital transformation" approach has been adopted in recent years, progressively increasing the focus on the development of digital capabilities for engineering management. To improve the delivery capabilities of engineering construction, digital standards and norms for essential components have been developed.

A digital management capabilities system for planning has been initially built in the field of planning management, and it creates partial professional planning support systems by relying on the current MSS (Management Support System). Work support systems for group-intensive planning have been implemented by several professions, including wireless and optical broadband. However, planning management is primarily done offline due to a lack of digital management system capabilities. Rigid control over investment budgets, process tracking of investment progress, and visualization of post-investment evaluations have all been accomplished in the field of investment management through the use of planning and construction systems, data analysis systems, and decision support expert systems. For all professions, a closed-loop investment management system that encompasses the complete process before to, during, and following investing has been originally built. After almost three years of research and development, the field of construction management now has fully traceable key data, including progress, cost, quality, and safety; data quality has been effectively improved; and typical applications are user-friendly and intelligent, encouraging the delivery of construction projects that are high-quality, reliable, safe, and efficient.

Disjointed planning, investment, and construction results from the lack of adequate cross-departmental and cross-professional cooperation mechanisms in the areas of planning, investment, and construction management. Using planning as an example, the current digital auxiliary planning systems are unable to create a completely closed-loop and vertically aligned departmental structure due to the disparate or inconsistent planning goals among various professions [2]. System data gathering is dispersed, making it challenging for departments and professions to work together. There are no centralized intelligent tools or resources to assist with planning activities.

Simultaneously, provincial firms often prioritize or lag behind the group's building system when synchronizing system capabilities because of the "group + provincial company" operational model of communication companies. There are multiple on-site management system platforms at the provincial level, each with varying capabilities,

making it difficult to guarantee the effectiveness of empowerment and lacking in overall planning and intensification. On the one hand, this means that the group's current system capabilities cannot meet the unique needs of each province, leading to insufficient empowerment.

The aforementioned examination of coordination mechanisms, operating models, and management capabilities makes clear that encouraging the digitization of the entire planning, investment, and construction process for engineering management can significantly improve the situation of incomplete engineering management and benefits that are hard to guarantee. Its objectives are to create a uniform management capacity platform for the entire organization, vertically align data across all levels, integrate cross-departmental activities horizontally across the process, and methodically develop digital management skills [3].

3 Immediate Concerns to Resolve in Order to Encourage Complete Project Management

In light of the current circumstances, communication firms have a greater need to uphold network information security and develop a robust network nation, or digital China. Within the domain of communication engineering project management, communication enterprises prioritize "full-process planning, investment, and construction" in order to establish world-class enterprises, foster superior development, and facilitate both internal and external digital transformation. Opportunities and obstacles for development coexist, and "stability, accuracy, and fierceness" must be achieved in implementation. The main issues with production practice that need to be taken into account are listed below.

3.1 Inadequate Visualization Intelligence and Full-Process Connectivity

Low-efficiency offline labor processes are still present in post-investment evaluation, planning, and other linkages. Inefficient closed-loop information is produced throughout the process due to discontinuities in the processes between investment and construction and between planning and investment. The entire planning, investment, and construction process is not fully integrated with the market at the front and the finance department at the back, and end-to-end processes for new business in digitization and production need to be optimized. The current web protocols for managing construction links are not precise enough, which hinders problem tracing and makes it impossible to reflect real-time construction progress. The accuracy of current AI tools is low and the digital capabilities to assist agile process optimization is insufficient when there are changes in management and business process needs. In domains like investing and planning, intellectual capabilities like modeling and algorithms are lacking.

3.2 Inadequate granular planning and investment, along with the requirement to fortify risk prevention capabilities

Inadequate data-driven planning capabilities lead to risky investment decisions and erroneous plans. For civil engineering projects, there is not much systematic support for risk prediction, warning during the process, and post-event evaluation of construction progress, quality, and safety. During the planning, investment, and construction process, the group and provinces may exchange some data using third-party platforms like WeChat and email, which poses a danger to data security.

3.3 Incomplete and Low-Quality Data Acquisition, Inconsistent Data Standards

Data standards must be standardized in order to enable full-process connectivity. There is currently no single master data standard specification, thus different departments interpret and define the same data in different ways. Expert data, like wireless and cloud, is dispersed among several departments and systems, and cross-departmental MBO domain data is not integrated, leading to inadequate data elements and impairing the precision of investment and planning plans. Inadequate system cleansing and verification techniques, along with the fact that some business data must be filled up by hand, lead to incomplete and erroneous data.

4 Ways to Digitalize the Complete Engineering Planning, Investment, and Construction Process

4.1 Thorough Focus on the Whole Engineering Project Management Process, Creation of Corresponding High-Level Architecture, and Reinforcement of Standards and Norms

We will advance the digital transformation of three major scenarios—planning, investment, and construction—by concentrating on the development of four supporting capabilities, with a focus on the core objective of "comprehensively enhancing cloud network development management capabilities"—actively carrying out data governance, deepening research and application of new technologies, enhancing system platform capabilities, and building a strong digital talent team. By doing this, a two-way drive for management and digital transformation will be achieved, strengthening the self-driving force for managing mode institutional innovation and continuously optimizing business operations. In order to create a cloud network development management capability that spans the entire process horizontally and reaches the bottom of the management hierarchy vertically, we will ensure the iteration of digital norms and increase data security. We will keep promoting norm awareness, creating standards and guidelines for planning, investment, and construction, and directing the development of capability in different provinces.

4.2 Enhancing the Production and Digitalization Integration to Encourage Scientific, Reasonable, and Accurate Investment

Perspective on the development space. We will thoroughly use a variety of investment management models to conduct investment analysis by profession and region based on external data such as economic policy trends, industry development status, and technological development trends combined with internal data such as product market conditions, company financial status, historical investment and evaluation results, and rolling planning results. Using investment modeling to digitally support the suggestion of investment scale, investment structure, and other plans, we will offer investment classification and policy recommendations based on investment limits.

Support for making investment decisions. We will create an indicator database for investment evaluation for various industries and geographical areas, compile historical data to create an annual investment algorithm model, and create an annual investment plan based on business development objectives, strategic directions, and past investment evaluation outcomes. This will help with the rolling scale of investment allocation calculations. To help with pre-investment assessment work at the project level, we will target important projects in key sectors including ICT, cloud, and IDC. For pre-project evaluation, we will employ standardized system templates and indicator systems. The key project database, which will be a crucial foundation for project execution and significantly enhance the scientific nature of project investment decisions while reducing investment risks, will be populated with essential tracking projects that we have identified based on the assessment results.

Extensive process supervision. In order to provide data support for investment management work in various regions and professions, we will be able to obtain real-time data on project-level investment approval, contract signing, project revenue, etc. Comprehensive analysis capabilities for investment progress, investment benefits, etc., will be provided. We will track investments, analyze them, and provide early warnings for projects that involve excessive costs, low resource utilization, strategic investment, and subpar benefits.

Monitoring and assessing effects. We will automatically track and evaluate the overall, professional, and regional investment progress, construction progress, market development, resource utilization, investment benefits [4], investment cost, etc., to create a national and provincial fixed asset portrait. This will be done based on the "fast, good, and economical" investment evaluation system. We will automatically track and evaluate important projects in critical domains like ICT, cloud, and IDC, with an emphasis on project benefits, project objectives, and project management aspects. We intend to enhance the application of investment evaluation results to planning and investment allocation for the upcoming year by offering recommendations for investment strategy optimization in a dynamic manner.

4.3 Realizing Visible Planning to Support Accurate Resource Allocation and Value Improvement

Analysis of Visible Demand. We will make extensive use of technologies like big data, BIM, GIS, etc., based on resource and data infrastructure capabilities, to visually display the current status data of cloud network resource distribution, scale, and carrying capacity, as well as data related to business development demand, like users and revenue, and external environmental analysis, like macroeconomics and competition analysis, in two or three dimensions. In order to provide intelligent demand prioritizing, we will carry out intelligent analysis in areas such cloud network capability, business prediction simulation, and demand auditing. We shall accomplish information exchange and interactive cooperation between several professions during the demand analysis stage.

Thoughtful planning. Using technologies like big data, AI, GIS, etc., we will progressively build rich planning calculation models or algorithms based on visible demand analysis, professional and scenario characteristics, planning goals, planning principles, and matching construction scale based on benefit and investment constraints to achieve online intelligent planning. Every profession will produce unified digital planning results in accordance with requirements and templates, contributing to later reviews. We will offer online collaboration tools to support the online creation of planning schemes for multi-professional collaborative projects, enhancing the effectiveness and caliber of planning.

Digital evaluation procedure. Realize online review expert matching, electronic plan delivery, and process visualization based on the planning review procedure, authorization requirements, etc.; through the matching of requirements and investments, combined with planning goals, planning standards, and planning results standardization requirements, review the quality of the planning, provide intelligent assistance in the review process, and improve review efficiency; after the review, standardized planning digital results and visualized displays of key content need to be output, and through simulation, BIM, GIS and other technologies, visualize the two-dimensional or three-dimensional effects of key content such as resource capabilities; the planning results after the review serve as the basis for subsequent planning execution evaluation work.

Planning and execution assessment. The system can combine the features of different professions to distinguish between different planning evaluation requirements and evaluation priorities. It can also automatically match key nodes and key data in subsequent design and construction. It can perform automatic, multi-dimensional, and dynamic data analysis. It can comprehensively assess the planning's implementation status, effect, and benefit. It can also generate a digital evaluation report on planning execution and realize the capability of digitally evaluating the planning process's overall planning preparation and execution quality on a closed-loop and dynamic basis. Finally, it can

provide a visual and timely understanding of the planning preparation and execution effect.

4.4 Highlight online collaborative multidisciplinary design and construction process management

Digitization of process management. Taking the design process in the construction field as the entry point, management is carried out through digital means according to professional characteristics and management requirements. To display the design process in real time, intelligent management is applied to manage design materials and related data at several nodes. Demand information can be cooperatively and transparently shared throughout professions. Key indicators, including procurement requirements, progress, and cost, may be dynamically and multidimensionally assessed, displayed, and warned about. This helps professionals at all levels of management make decisions and achieves precise management of the design process.

Design tool digitization. For on-site inquiry, scheme preparation, and other work processes, digital tools are supplied based on the notion of multidisciplinary collaborative design. During the stage of on-site investigation, new technical tools such as image recognition, BIM [5], GIS [6], and others are integrated to support the coordinated resource inspections, real-time recording and feedback of on-site investigation information, and a visual display of the network's resources. Auxiliary generation of equipment/main material lists, auxiliary generation of budgets, online design scheme drawing, and auxiliary preparation of design texts are examples of digital support capabilities that are offered during the design preparation stage. These capabilities offer digital guidance for subsequent design collaboration, procurement collaboration, construction process management, cost control, and other links.

Review of intelligent design. For design reviews, online expert matching, scheme push, and process visualization are accomplished in accordance with the review procedure and review criteria. A multi-dimensional review model is built by combining professional traits with cutting-edge technological tools like big data, BIM, and artificial intelligence. This allows for an intelligent assessment of the scheme's rationality from a variety of angles, including progress, investment, cost, network architecture, and security. This creates uniform review results, serves as a useful reference for the review process, and offers digital direction for the design scheme's finalization and change.

The process of digitizing design results. It makes it possible for design schemes that use cloud network capabilities to be efficiently maintained and presented on a single GIS map [7]. Corresponding capability cost data for the project is generated and automatically docked with the MSS system approval process during the project handover, design approval, and acceptance stages, enhancing process efficiency. Contribute to the creation of material information lists, connecting the material pick-up management and

material purchase order issuing. The engineering quality and safety features are combined with the evaluated design workload to give systematic direction for the requirements for data gathering during the construction phase.

5 Conclusion

The current main tasks for the development of the digital economy include progressively constructing an intelligent and efficient integrated infrastructure, optimizing and updating existing infrastructure, and raising the bar for infrastructure networking, intelligence, service, and collaboration. Thus, based on the understanding of the overall solution presented in the previous chapter, it is imperative to enhance the system construction mindset, make full use of new tools and technologies like artificial intelligence, and methodically apply digital management capabilities to the entire engineering planning, investment, and construction process. Prioritize risk control, build digital support capabilities for supporting systems, prevent and manage known risks, and promptly identify and appropriately address unexpected risks. At the same time, plan and execute a reasonable path to eventually achieve data-wide circulation, cross-domain resource sharing, and intensive reuse of capabilities. Second, achieve centralized resource management and cross-domain sharing, data circulation and data governance, continuous data updating, and continuous operation. Third, ensure appropriate reservations and connections for other engineering project processes; thoroughly evaluate each management link's circulation and data flow control; concentrate on the connections between project approval and design stages, between design and later construction stages, and between visual planning and project approval stages; make prudent investments throughout the entire process; and foster the growth of enterprise digital transformation by implementing the digitization of the entire planning, investment, and construction process.

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