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Research on BIM Talent Cultivation System for Engineering Management Majors in Financial and Economic Universities Facing Intelligent Construction

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ABSTRACT
Under the background of building industrialization and intelligent construction, it is a general trend to cultivate engineering management talents with BIM skills. Employing the SWOT analysis, this paper examines the strengths, weaknesses, opportunities, and threats faced by financial and economic universities offering engineering management programs. Based on these insights, a distinctive "BIM + Engineering Management" talent cultivation model is proposed. Rooted in the OBE (Outcome-Based Education) philosophy, this model starts from societal needs to establish talent cultivation objectives and requirements, and subsequently designs a curriculum system in accordance with these requirements. To ensure the high quality implementation of the curriculum system, corresponding safeguard measures are put forward from the aspect of teaching reforms, the construction of experimental platforms, and the development of teaching faculties.

KEYWORDS
Financial and Economic Universities; Engineering Management Program; Intelligent Construction; BIM(Building Information Modeling); Curriculum System

1 Introduction

The engineering management major is a comprehensive and interdisciplinary field supported by multiple disciplines such as civil engineering technology, management, economics, law, and information technology. With the advancement of major national strategies such as new urbanization and rural revitalization, the demand for engineering management talents in the construction sector has grown significantly. The rapid development of new-generation information technology and artificial intelligence has accelerated the process of building informatization. Promoting the industrialization of construction towards intelligent construction is the focus and direction of future development in the construction industry, posing new and higher requirements for the cultivation of engineering management talents.

In response to the new development needs of intelligent construction and new industrialization, scholars have conducted extensive discussions on the construction and reform of engineering management majors. It is proposed to build a talent cultivation model for engineering management majors that is oriented towards industry demands [1] and smart construction [2], and there is a consensus on increasing the cultivation of BIM application-oriented talents [4]. It is necessary to focus on "dual competencies" [5], add multi-module interdisciplinary elective courses [6], and build an integrated BIM curriculum system based on the OBE concept and BIM technology [7], while strengthening BIM practical teaching [9]. Scholars have also conducted SWOT analysis and path research on the innovative talent cultivation of engineering management majors in the era of "Internet+ " for financial and economic universities [10], constructed a compound innovative talent cultivation model for undergraduate engineering management majors [11], and carried out research on practical teaching reforms [12].

Financial and economic universities are an essential force in cultivating engineering management talents, renowned for their strengths in economics and management disciplines but with insufficient support in civil engineering technology. Under the new situation of building informatization, industrialization, intelligentization, and high-quality development, how to address the shortcomings in engineering technology, leverage disciplinary advantages, and cultivate high-quality, innovative, and compound application-oriented talents is an urgent issue for financial and economic universities. This paper first applies the SWOT analysis to examine the strengths, weaknesses, opportunities, and threats of offering engineering management majors in financial and economic universities, based on which an innovative curriculum system model is proposed. Then, a BIM curriculum system is constructed according to the OBE educational philosophy. Finally, safeguard measures are proposed to ensure the implementation of the curriculum system.

2 SWOT Analysis of Establishing Engineering Management Majors in Financial and economic universities

Under the backdrop of intelligent construction and new industrialization, it is of great significance for financial and

economic universities to recognize the situations and challenges faced by the professional development in order to leverage their strengths, address weaknesses, seize opportunities, and promote the reform and development of engineering management majors. This paper adopts SWOT analysis for this purpose[10].

2.1 Strengths

Solid foundation in economics and management disciplines. Financial and economic universities boast robust backgrounds and foundations in management, economics, law, and information technology, with strong faculties and well-equipped teaching facilities, providing strong support for the engineering management major. Graduates excel in areas such as project management, cost consulting, investment and financing analysis, and big data analysis and mining.

High policy sensitivity. Engineering management majors in financial and economic universities offer numerous economics, management, and law courses that are closely aligned with national strategic plans and policies, implicitly fostering students' policy sensitivity.

Strong business acumen. Practical components in economics and management courses, coupled with opportunities to participate in related academic competitions, fully exercise students' systematic thinking and business acumen. Graduates are better equipped to enhance project management from a full-life-cycle perspective, thereby improving economic efficiency.

Abundant social resources. The extensive alumni network of financial and economic universities, with close connections and diverse work fields, offers richer social resources for engineering management graduates.

2.2 Weaknesses

Weak technical platform for civil engineering. Most financial and economic universities lack civil engineering majors, with limited engineering courses and resources. The necessary technical platform for engineering management majors is insufficient, resulting in poor laboratory and professional internship conditions that hinder the cultivation of students' engineering practical abilities.

Insufficient civil engineering technology faculty. Civil engineering is not the mainstream discipline in financial and economic universities, making it difficult to establish research teams in civil engineering, thereby inhibiting innovation enthusiasm and career development of faculty in this field. This leads to a lack of civil engineering faculty, constraining the quality of technical courses in engineering management.

Imperfect curriculum system. Due to weak civil engineering foundations, a lack of engineering faculty and limitations on total teaching hours, some foundational courses cannot be offered with sufficient school hours, increasing the difficulty for students in learning specialized courses and affecting talent cultivation quality.

Insufficient funding for professional development. Most projects in financial and economic universities are humanities and social sciences-oriented, with limited funding. However, the construction of engineering management majors requires substantial investment. Funding based on the standards of general economics and management majors is inadequate, affecting project implementation, external exchanges, and cooperation.

2.3 Opportunities

High demand for professional talents. With the continuous promotion of China's national strategies such as the new urbanization strategy and coordinated regional development, the amount of urban construction and urban renewal projects is huge. Infrastructure construction will be in great demand in the next two or three decades, requiring a large number of engineering management professionals.

Accelerated development of new-type building industrialization. China is deeply promoting the informatization of the construction industry, driving the coordinated development of intelligent construction and building industrialization. It is vigorously promoting BIM technology and accelerating its integrated application in the whole life cycle of construction projects. This process will require a large number of BIM talents.

Abundant online teaching resources. In recent years, online course platforms have developed rapidly, offering rich and high-quality teaching resources. These open course resources greatly facilitate specialized course teaching, avoiding duplication and enabling the selection of suitable resources to optimize teaching design and enhance teaching effectiveness.

New opportunities brought by internationalization. The steady progress of the Belt and Road Initiative (BRI) has created enormous infrastructure construction demands in countries along the route, leading to more international cooperation opportunities in the field of engineering management. This also imposes higher requirements on professionals' technical, economic, management, legal, and English skills.

2.4 Challenges

Intelligent construction requires multidisciplinary integration. The intelligent construction model requires practitioners to not only master traditional construction engineering knowledge but also integrate disciplines such as computer information technology and the Internet of Things to achieve the digitization, networking, and intellectualization of traditional construction engineering. However, current talent cultivation programs in financial and economic universities are insufficient or even lacking in cross-integration with these emerging disciplines.

The digital transformation of the construction industry poses new requirements for talent cultivation. The promotion of informatization in the construction industry, with the integration of relevant information technologies centered on BIM technology and its application throughout the whole life cycle of engineering projects, is the key. Financial and economic universities suffer from a shortage of BIM teachers, backward laboratory construction, imperfect BIM curriculum system, and talent training programs that need to be optimized and updated.

There is a gap between the professional quality of students and the level required by the construction industry. Compared with graduates of civil engineering and other majors, students of engineering management in financial and economic universities lack technical knowledge and practical abilities, resulting in insufficient professional competitiveness. In addition, students lack the integration of various disciplines of knowledge and are unable to apply it in practical engineering.

There is a contradiction between the numerous specialized courses and the compressed class hours. With the rapid development of the construction industry, the content that students need to learn during their university years continues to increase, while the class hours for specialized courses are under pressure to be reduced, posing a significant challenge to the curriculum system of engineering management majors in financial and economic universities.

From the above analysis, it can be seen that the coordinated development of construction industrialization and intelligent construction is the trend of the construction industry, which puts forward new requirements for the cultivation of engineering management talents. BIM technology is the core skill of engineering management talents. For financial and economic universities, it is necessary to comply with the development needs of the industry. The reform of the talent cultivation mode of engineering management majors must take BIM skills as a breakthrough, which can not only make up for the shortcomings of insufficient civil engineering technology through BIM and virtual simulation platforms but also give full play to the advantages of economic management disciplines. Therefore, the innovation in the talent cultivation mode of engineering management majors in financial and economic universities is specifically reflected in the innovation of the curriculum system. Based on this, this study proposes a new curriculum system construction mode: the construction of an engineering management professional curriculum system based on the OBE concept, centered on BIM technology, and oriented to the whole life cycle of engineering projects.

3 Construction of a Professional Curriculum System Centered on BIM Technology

This study, grounded in the OBE (Outcome-Based Education) philosophy, constructs an engineering management curriculum system centered on BIM technology and oriented towards the entire life cycle of engineering projects. The process involves identifying talent cultivation objectives based on social demand, determining graduation requirements based on objectives, and subsequently outlining the curriculum system for talent cultivation based on these requirements.

3.1 Determination of Talent Cultivation Objectives

The logical starting point of the OBE concept is to ascertain the demand for professional talents. This encompasses the needs of the state, society, construction industry, and employers for engineering management talents, as well as the school's positioning and characteristics, student development, and the expectations of faculty and staff.

Once the demands are clarified, talent cultivation objectives can be designed accordingly, specifying the professional and career achievements that students should attain approximately five years after graduation. Addressing the talent demand for intelligent construction and building industrialization, cultivating compound and applied talents with the strengths and characteristics of "BIM + Engineering Management" is an essential component of the professional talent cultivation objectives.

3.2 Determination of Cultivation Requirements

Based on the cultivation objectives, graduation requirements are designed to specify the knowledge, abilities, and qualities that students must possess upon graduation. The graduation requirements for the engineering management major can be determined by referring to documents such as the "Assessment (Accreditation) Document for Engineering

Management Majors in Colleges and Universities" (2020 Edition) and the " Guiding Professional Standards for Undergraduate Education in Engineering Management in Higher Education Institutions," while also incorporating the school's positioning and characteristics. Among them, the cultivation requirements for the BIM-related curriculum system are as follows:

3.2.1 Knowledge Requirements

Master the concepts, characteristics, and value of Building Information Modeling (BIM); understand the development history and trends of BIM technology in the construction industry, as well as domestic and international BIM standards and BIM-related software; understand BIM project management processes, knowledge, and methods of collaborative work. Grasp the basic operation methods of BIM modeling software, modeling processes, and methods for creating and editing architectural entities; master the application methods of BIM technology throughout the entire life cycle of construction project management, as well as multi-disciplinary clash detection methods, rationality analysis methods for construction site layout, and construction process simulation methods; grasp the quantity and pricing methods for construction and installation works, and BIM-based project management methods. Understand the application of BIM technology in the entire process of engineering cost management, proficiently using BIM technology for budgetary estimates, tender and bid budgeting, changes in construction progress, and final settlement, among other stages of quantity and price determination, and be able to prepare engineering cost documents based on BIM technology.

3.2.2 Competency Requirements

Students should possess the awareness to apply BIM technology throughout the entire process of construction project management. They should be able to independently construct a Building Information Model using at least one BIM modeling software. Based on the bill of quantities and quota measurement rules, students should be capable of utilizing BIM models to complete quantity calculations, ultimately acquiring the comprehensive ability to manage the entire life cycle of construction projects using BIM technology. In the process of solving complex modeling problems, students' comprehensive abilities to analyze and solve problems should be cultivated.

3.2.3 Quality Requirements

Through the study of BIM technology, students should understand the future development trends of the construction industry and the application prospects of BIM technology related to the construction engineering management major, comprehensively grasp the new directions of industry development, and possess the desire to continuously learn the latest technologies in the industry. During the teaching process, by completing BIM modeling and applications through group cooperation, students' teamwork spirit should be cultivated. By organizing students to form BIM student clubs, their team operation and management abilities can be further strengthened.

3.3 Establishment of Curriculum System

Identifying which courses support each graduation requirement and integrating them with the school's disciplinary characteristics and market demands forms the curriculum system for professional talent cultivation.

For the talent cultivation program featuring "BIM + Engineering Management," BIM technology encompasses numerous modules, which are embodied in the curriculum system in two ways.

The first is the independently set BIM courses, which systematically explain relevant knowledge of BIM technology, suitable for courses such as BIM Introduction, BIM 3D Modeling Technology, and BIM Modeling Software.

The second is integrating relevant BIM technology modules into existing corresponding courses, including basic professional courses, specialized courses, and practical teaching links. Among them, basic professional courses mainly include Engineering Drawing and Recognition, Engineering Structures, Engineering Materials, Engineering Surveying, and Construction Technology. Specialized core courses include Construction Organization and Management, Engineering Valuation, Bidding and Contract Management, and Project Management. Practical teaching links encompass cognitive internships, course designs for Engineering Drawing and Recognition, Construction Organization and Management, Bidding and Contract Management, professional subject competitions, experiments in Engineering Valuation, Project Management experiments, and graduation design.

This integrated arrangement of BIM technology modules, where BIM modules are integrated into various courses throughout the entire life cycle of construction projects, cultivates students' Internet thinking and BIM thinking. It is more conducive to fostering students' whole-life-cycle BIM technology application mindset, enabling them to better understand and implement the invocation of the same BIM model, information sharing, and work collaboration among

multiple participants in construction projects. Meanwhile, leveraging the 3D, visual, and simulative characteristics of BIM models can address the difficulties in traditional curriculum teaching.

4 Safeguard Measures

After the establishment of the BIM-based curriculum system, to achieve the expected goals during the teaching process, it is necessary to establish and implement a teaching quality assurance system. The construction of safeguard conditions is also of great importance and serves as the foundation for realizing the goal of talent cultivation.

4.1 Reform the Teaching Methods

The BIM-based curriculum system incorporates significantly more content than traditional curricula. Given the fixed total hours in the talent cultivation program, resolving the contradiction between the increased content and relatively limited course hours is crucial to ensuring the program's effectiveness. The development of modern educational technology, particularly the rapid growth of online courses and the proliferation of online course resources in recent years, provides a solution to this problem. The most effective approach is to adopt a blended learning model combining online and offline teaching. This involves designing teaching plans and organizing courses in three stages: pre-class, in-class, and post-class. Before class, students preview designated course content with the help of online course resources and complete corresponding assignments. During class, teachers and students fully interact, checking students' pre-class learning outcomes and addressing the key and difficult points of the course. After class, students review and consolidate their learning. This blended learning model makes effective use of students' after-school time to complete learning tasks, stimulating their subjective initiative and fostering their learning abilities. It dedicates classroom hours primarily to teaching the key and difficult points of the course, resolving the issue of limited hours. Incorporating teaching methods such as heuristic, project-based, cooperative group learning, and flipped classrooms, along with comprehensive course assessment throughout the process, will further enhance teaching effectiveness.

4.2 Establish a Comprehensive BIM Experimental Platform

Most BIM-related courses involve software operation and the software realization of constructed BIM models, necessitating the support of an experimental environment. The establishment of a BIM laboratory requires high standards, including specific venues, the selection and purchase of BIM software systems relevant to the curriculum, and the procurement of computers that meet software operational requirements. Additionally, an artificial intelligence (AI) and virtual reality (VR) simulation platform can be established. During practical teaching, teachers can create a fully immersive simulated practical teaching environment for students. Through the platform, teachers can present the knowledge requiring practical guidance and allow students to conduct experiments independently, consolidating learned knowledge through teacher guidance and practice. Currently, there are multiple BIM software vendors, with high acquisition costs and ongoing annual investments. The construction and maintenance of a comprehensive BIM experimental platform are costly, posing challenges for financial and economic universities. One effective way to address these issues is to deepen school-enterprise cooperation and establish a mutually beneficial partnership. By assisting universities in creating BIM laboratories, enterprises can cultivate potential customer groups, while universities' innovative capabilities can help enterprises improve BIM products. In turn, universities can leverage enterprises' abundant hardware and software resources, mature BIM problem-solving solutions, and professional software operators to establish BIM laboratories.

4.3 Strengthen BIM Faculty Development

The key to cultivating BIM talents lies in the quality of faculty. However, engineering management faculty members in financial and economic universities generally have weak BIM knowledge and skills. Teachers who joined the profession earlier have rarely received BIM-related education, while newly recruited teachers lack experience in the construction industry and construction enterprises, resulting in insufficient control over BIM applications throughout the entire lifecycle of engineering projects. Therefore, the development of BIM faculty is urgent and important, requiring multiple measures to address this issue. First, mature BIM faculty should be recruited. Priority should be given to hiring teachers with BIM application experience among new candidates or directly recruiting BIM professionals with practical experience in society. Second, existing teachers should be trained in BIM skills. This can be achieved by organizing a series of BIM technology training sessions and lectures to enable engineering management teachers to undergo professional and systematic learning of BIM-related content. Alternatively, selected backbone teachers can be sent out for specialized BIM

skill training. Third, partnerships should be established with BIM-related enterprises or software companies. Professional teachers can take up positions in enterprises or participate in engineering practices to cultivate and enhance their BIM practical abilities in actual projects. Meanwhile, BIM backbone personnel from enterprises can also undertake some teaching tasks related to BIM technology applications and jointly participate in BIM-related academic competitions and BIM graduation design guidance. This can not only overcome the short-term shortage of faculty in universities but also promote in-depth exchanges between university teachers and enterprise technicians, thereby facilitating the employment of students in this major.

5 Conclusion

This paper proposes a BIM-centered curriculum system construction model for engineering management programs in financial and economic universities through SWOT analysis. Based on the OBE concept, it clarifies the process and outcomes of BIM curriculum system construction. Furthermore, it outlines safeguard measures to ensure the effective implementation of the curriculum system, including curriculum teaching reform, experimental platform construction, and faculty development. It is important to note that BIM technology is constantly evolving, and BIM-related courses also need to be dynamically updated to reflect the latest BIM developments. With the rapid development of new-generation information technology and artificial intelligence, attention should also be paid to the integrated development of BIM and other information technologies and their applications throughout the entire lifecycle of construction projects. As smart construction emerges as a future trend in the construction industry, it requires interdisciplinary integration, which cannot be achieved by a single engineering management major or college in one go. Instead, it necessitates a top-down design for professional development at the university level, comprehensive planning, and the coordinated allocation of university resources. This is a long-term task.

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