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APPLICATION OF INTELLIGENT ALGORITHMS AND BIM TECHNOLOGY IN THE INTEGRATED DESIGN OF INTELLIGENT MECHANICAL AND ELECTRICAL SYSTEMS IN PUBLIC BUILDINGS

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Abstract. The author conducts research on the application of BIM technology in the mechanical and electrical installation process of large public buildings. Emphasis is placed on the specific application measures of BIM technology in key construction stages. In response to the current problems in application, the author proposes corresponding solutions. Finally, based on a practical case study, a complete three-dimensional information model was constructed through the application of BIM technology during the electromechanical installation process at a certain airport, this model not only guides on-site construction and project management, but also provides accurate engineering data for later operations. During the on-site construction process, the application of BIM technology has achieved the creation, management, sharing, and non-destructive transmission of engineering information, reducing 50-70% of information requests and 20-25% of professional coordination time. By simulating construction progress and optimizing pipelines to guide refined construction, the construction period is shortened, engineering costs are saved, good economic benefits are generated, and management level and efficiency are also improved.

Key words: BIM technology, Public buildings, Integration of intelligent electromechanical systems, application

1. Introduction. Today, with the flourishing development of information technology, BIM technology is leading the rapid transformation in the construction field, and the traditional construction project information management model is gradually unable to catch up with the development situation of the construction industry. BIM technology is an information technology that conforms to the development of the construction industry and can be applied in various stages such as engineering design, construction, and operation, by integrating information through parameter models for information sharing and transmission, applications such as collaborative work and pipeline integration can be achieved, through the association of "BIM+" and extended analysis software such as Energy Plus, research on scheme demonstration and performance analysis can be realized, and the combination of Internet, cloud computing, Big data, VR/AR and other technologies can create an intelligent management platform, it plays an important role in improving project quality, saving costs, improving work efficiency, shortening project duration, reducing rework, increasing publicity effectiveness, and resource waste [1].

With the development of society, mechanical and electrical installation engineering involves various aspects of production and life, building mechanical and electrical installation engineering also involves multiple professions and various types of equipment and materials with the improvement of functional requirements of buildings, it has the characteristics of high integration, high complexity, and high technicality.

Due to the connections between various professions and civil engineering, communication and collaboration among professions all affect the design, construction, and operation quality of buildings. Engineering changes, increments, rework, and other phenomena occur frequently, resulting in difficulties in communication, cooperation, and coordination [2-3]. In the design stage, the traditional design mode is to judge whether the design scheme is reasonable and feasible based on experience, if problems are found after construction and use, it is difficult to take measures to make up for and save them; Each profession operates independently, resulting in low efficiency and personnel waste due to repetitive work, the problem of errors, omissions, collisions, and deficiencies between different professions is serious, requiring design changes and additions, affecting initial investment and project schedule, it is difficult to complete collaborative design of large-scale projects, analysis

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of buildings with complex shapes and green buildings, and other work.

Due to the sharing of BIM model data, BIM technology has coordination and can achieve multidisciplinary collaborative design and pipeline integration, detect and solve problems such as collisions and omissions before construction, and improve work efficiency and design quality. At the same time, the advantages of BIM models in engineering quantity statistics and cost calculation can be utilized to conduct economic analysis of design schemes and control project investment [4]; Through simulation demonstration, qualitative and quantitative analysis of the design scheme, predict whether the design scheme can meet the requirements of safety, function, energy conservation and Thermal comfort. Combining Fluent software to simulate and analyze the airflow organization of the design scheme, it is used to guide the comparison and optimization of the design scheme, and to verify the reasonable feasibility of the design scheme. However, due to the characteristics of mechanical and electrical installation engineering and the limitations of design time, as well as the high cost of hardware, software, manpower, time, training, etc. Required by BIM, the design workload will increase exponentially, resulting in the design of mechanical and electrical systems still being mainly based on two-dimensional design, the application of BIM in the design of electromechanical systems is often limited to establishing a local model of the computer room for pipeline synthesis and collision inspection, as a bonus item in bidding, it fails to truly leverage the advantages of BIM and reduce the number of changes and additions.

In the bidding and construction stages, the traditional construction mode is for each profession to set their own entry time, schedule, pipeline layout, and other arrangements, operate according to the drawings and construction specifications, and only discuss countermeasures with relevant professionals when encountering problems that were not found in the joint review of drawings, discrepancies between on-site conditions and drawings, and delays in equipment entry time, which may delay the construction period, cause rework, increase investment, etc. The disbursement of progress payments is prone to underpayment and overpayment due to inaccurate accounting and delayed handling of change procedures, leading to dissatisfaction [5]. When dividing the scope of the project in the bidding process, there may be omissions in the project and non professional construction, resulting in rework delays and failure to meet design requirements. For example, the fire linkage control module has not been installed, and the air conditioning supply outlet has been reduced in size and displacement when installed by the decoration unit, increasing resistance, resulting in air flow short circuits and reduced air flow. Visualization using BIM technology can reduce the difficulty of map recognition, avoid map recognition errors, identify issues that require communication, coordination, and change early, and transform post processing into pre control [6,7].

By utilizing the coordination of BIM technology, unified arrangements can be made for the cooperation, processes, progress, technical disclosure, etc. of various disciplines, improving work efficiency, ensuring construction quality, controlling investment, and shortening the construction period. BIM technology can perform 4D and 5D simulations, and in the design phase, based on the simulated construction process of the construction organization, determine a reasonable construction plan to guide construction, measure and allocate progress payments, and achieve cost control, quality control, safety control, and progress control; The optimization of BIM technology can be utilized for pipeline deepening and optimization, collision detection and processing, and guidance for cutting and processing. Due to the high demand for BIM application from construction units, and the efficient BIM technology being able to effectively control construction costs and ensure project schedule, therefore, the current construction stage is the main stage for the application of BIM technology in mechanical and electrical installation engineering, and the main force of application is the construction unit. However, due to the fact that the designed drawings are two-dimensional, the construction unit needs to use CAD drawings to establish a complete electromechanical BIM model, and then use the BIM model for pre embedding and reservation, comprehensive support and hanger, prefabrication processing, deepening design, pipeline comprehensive design, collision inspection, scheme optimization, engineering quantity statistics, construction management, etc.

The construction unit bears some of the workload that should have been completed by the design unit [8]. With the rapid development of the economic market, the process of infrastructure construction and urbanization throughout the country has been accelerating, under the guidance of the ”the Belt and Road Initiative”, foreign contracted projects have grown steadily, the construction industry has become one of China’s important pillar industries, with GDP accounting for about 1/7 of the total. In 2019, the total output value of China’s construction industry has exceeded 24.8 trillion yuan. The traditional project management model of the con-

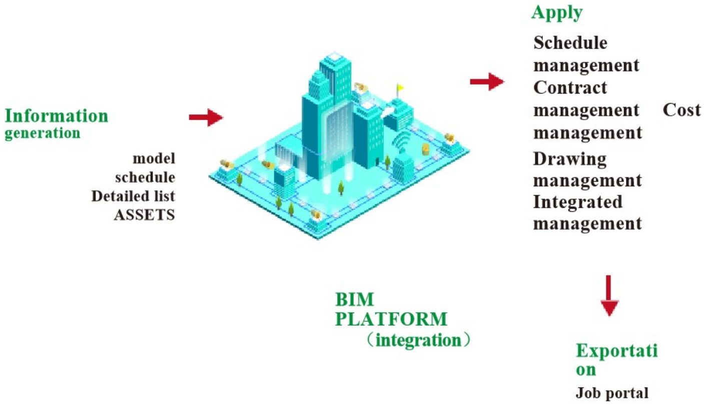

Fig. 1.1: BIM System Framework

struction industry can no longer meet the needs of more and more complex construction projects, the project management model is transforming from a single extensive model to informatization and Digital transformation [9,10].

In the 2016 development outline, the Ministry of Housing and Urban Rural Development clearly proposed to focus on enhancing the ability to integrate and apply information technology such as BIM, and emphasized in the 2020 key work points the need to promote the integrated application of BIM throughout the entire construction process. Through research, it was found that although BIM technology has been applied in the construction field for more than ten years, there are obstacles, limitations, and formalization in the application of BIM in building mechanical and electrical installation engineering, and it has not truly played its role and depth [11] (as shown in Figure 1.1).

2. Methods. In order to solve the problems in the mechanical and electrical installation engineering of large public buildings, the author introduced the application of BIM technology during the construction process. The construction unit will build a BIM application platform, form a team, configure the required software and hardware, then prepare a work plan, develop modeling standards, establish models by discipline, and integrate the models after verification, the key parts such as various systems and computer rooms will be further designed to solve pipeline collisions, and comprehensive support and hanger designs will be carried out. Subsequently, organize various units to review and deepen the design results, and after confirmation by the design party, export the drawings or directly use the models to guide construction. During the installation process, simulate the construction based on the model, determine the installation sequence of pipelines and equipment, and manage the construction site. After the project acceptance is qualified, the BIM model and data information will be handed over to the owner together [12].

2.1. Building a BIM application platform.

(1) Establishment of organizational structure. A well coordinated team is a key factor for project success, and the organizational structure of the BIM team is shown in Figure 2.1.

The BIM manager is responsible for the overall implementation and coordination of the project, team building and management, clarifying the responsibilities and job responsibilities of members, and directly responsible for the quality of BIM deliverables. The position requires familiarity with various professional knowledge on the construction site and a certain understanding of the application process of BIM [13].

The BIM supervisor is responsible for managing the BIM model, supervising the designer to complete the BIM model establishment, performance analysis, drawing, and other work, reporting to the BM manager, and reviewing the model to ensure data quality and compliance with relevant standards for all BIM work. The technical supervisor is responsible for coordinating data and application work. Each professional leader leads the team members to complete the design tasks of their respective profession, conduct 3D design and model modification, extract data from the model, calculate engineering quantities, generate detailed tables, and

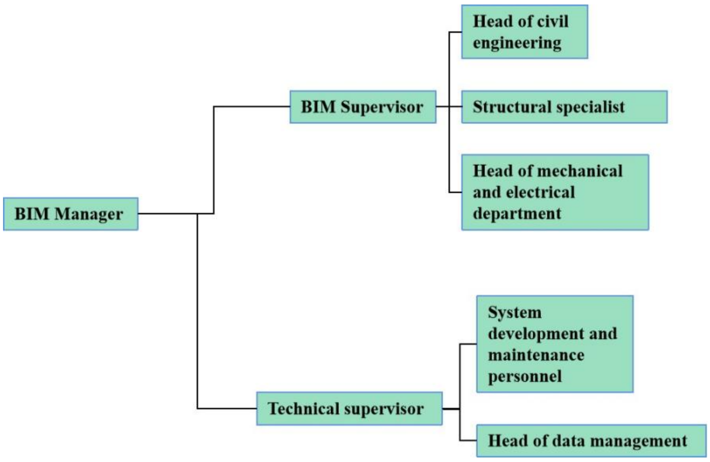

Fig. 2.1: BIM Team Organizational Structure

cooperate with each other to complete the optimization design work. System development and maintenance personnel are responsible for hardware maintenance and system development, providing technical support for software applications. The data management personnel are responsible for collecting information on the construction site and processing the data information of the model, they regularly upload the on-site information to the management system in the form of documents, images, videos, etc., and archive the data and files during the design and construction process [14,15].

(2) Infrastructure requirements. Infrastructure includes software and hardware. The application of BIM technology is achieved through software, there are many factors to consider when selecting software that is suitable for one's own development based on the characteristics of the enterprise. From the perspective of the software itself, it is necessary to consider its popularity, user-friendly interface, and price. In addition, it is also necessary to consider the reputation of the software manufacturer, user reputation, as well as the technical support and user training they can provide. Enterprises need to choose appropriate software based on their own application needs [16].

The commonly used BIM software in the process of mechanical and electrical installation includes the following categories: In the modeling software, Autodesk Revit has complete functions, easy operation, and a wide range of applications. ArchiCAD has powerful functions in the design of mechanical and electrical systems; Collision detection and construction simulation are commonly implemented using Navisworks software, which can interface well with Revit; The display of 3D effects relies on 3D Max, Lumion, and others; Guanglianda has a wide range of applications for engineering quantity calculation and cost software; In terms of construction process management, various enterprises often conduct secondary development on the Revit platform to achieve the management of model versions and project data during the design and construction process [17].

The application of software is closely related to the hardware environment. For BIM applications, the hardware environment mainly includes the following three aspects:

Network environment: In BIM applications, in order to maintain collaborative work, models and related data are generally stored centrally on a central server, members build models and input data on their respective computers, and synchronize with the central file on a regular basis. For large projects, the model contains a large amount of data, and in order to ensure smooth operation, a fast network transmission speed is required. In order to meet project requirements, it is best to connect to a network of over gigabit.

The central server is mainly used to store BIM models and related data information, and has high requirements for computer storage performance. The most important thing is data security. Due to not directly performing calculations, the requirements for processors and graphics cards are not high.

Terminal computer: Team members directly use terminal computers, and model building, information input,

Table 2.1: BIM Model Depth

grade	stage	Model depth
LOD 100	Conceptual design phase can be used for analysis	Basic shape, location, rough size, building volume,of lighting, wind environment, etc
LOD 200	Preliminary design stage	Accurate component information (geometric information such as size, shape, position, direction, and quantity, as well as material and properties): A detailed model of the electromechanical system, including approximate equipment models, which can be used for systematic analysis
LOD 300	Construction drawing design stage	A detailed construction model can produce complete construction drawings for various specialties, enerate engineering quantities and costs, calculate and analyze engineering quantities, and analyze detailed elements and systems through analysis and simulation
LOD 400	Completion stage	Including changes during the construction phase, able to accurately issue final settlement reports and analysis reports on changes in various disciplines
LOD 500	Operation management stage	Regular (short cycle) updated data management model that can be maintained and updated by various disciplines

and data calculation are all completed on terminal devices, therefore, there are high requirements for computer configuration. Generally speaking, computers require an i7 or higher processor, an 8GB or higher installed memory, a 1T hard drive, and a 2G independent graphics card to maintain smooth operation. For the project team, at least one file server, several desktops, one laptop, and one tablet are required to support BIM applications for the entire project (or part of the project) in a collaborative environment.

2.2. Model Establishment. Before establishing the model, it is necessary to configure software and hardware facilities based on project requirements, develop modeling rules, and determine the depth of the model. The American Institute of Architects divides the depth of BIM modeling into the following five levels. As shown in Table 2.1.

When modeling, construction needs need to be considered, and structural beams, floors, columns, etc. should be split according to the construction section to facilitate later construction simulation. At the same time, it should be ensured that the deduction relationship between components is correct and does not affect the calculation of engineering quantities. Under the condition of reaching the specified model depth, improve the model information, such as beam column number, concrete grade, pipeline material, etc. Consider the subsequent model processing requirements in advance and plan the organization of the model. According to the profession, the BIM model is divided into three major parts: architecture, structure, and electromechanical equipment, the electromechanical system is further divided according to needs, and then each subsystem of the electromechanical profession is named and colored according to rules to make it easier to distinguish. In the construction phase, it is necessary to supplement the following content on the basis of the design model: Temporary building houses, temporary water and electricity layout, construction machinery, material stacking planning, safety maintenance components, and other construction models [18].

2.3. Deepening Design.

(1) Collision detection. In the traditional era of two-dimensional drawings, conducting collision detection requires reviewing a large number of drawings and requiring relevant professional engineers to jointly inspect and discuss the collision situation. This collision detection speed is slow, prone to errors and omissions, and the expression is too abstract, making it difficult to fully and accurately record the detection results.

For large public buildings, it is necessary to use BIM software for collision detection in order to ensure the smooth progress of equipment installation engineering. Representing all professional pipelines in the same model according to their true dimensions can reflect some deep-seated issues in traditional drawings. Apply BIM related software, such as Revit Navisworks and others can perform collision detection to detect all pipeline conflicts in the design drawing. Based on the detection results, pipeline optimization can theoretically eliminate all collisions.

The collision detection function of Revit requires high hardware configuration requirements, and for large projects, the computational complexity is high, making it difficult to ensure smooth operation. Therefore, Navisworks is often used in engineering for collision detection. Import Revit models into Navisworks software in different disciplines, select detection conditions based on project requirements, and perform collision detection between different disciplines and between pipeline systems and building structures. The detection results can be saved in various formats such as viewpoint and text, and output as detection reports.

(2) Pipeline integration. Pipeline synthesis is the process of coordinating and arranging the location of pipelines based on the mechanical and electrical system construction drawings completed during the design phase, according to the system, nature, function, and construction requirements of the pipelines. The purpose of pipeline integration is to meet the net height requirements of building space; The second is to meet the installation and maintenance space of pipelines and equipment; Three needs to meet the installation requirements of supports and hangers; Four needs to ensure the accuracy of hole reservation and casing embedding. The mechanical and electrical installation engineering of large public buildings involves multiple specialties, complex pipeline systems, high difficulty in construction organization, and high requirements for installation quality. The comprehensive quality of pipelines directly affects the completion effect. The traditional pipeline synthesis involves overlaying the two-dimensional layout plans of various specialties, which has certain drawbacks. Multiple professional pipelines are stacked together, resulting in messy graphic content. Additionally, the relative positions and elevations of various systems are not expressed clearly and accurately for the parts with a large number of pipelines. Spatial relationships require imagination and rely on two-dimensional drawings, making it difficult to detect all pipeline collisions. The handling of collisions requires local adjustments and cannot achieve global grasp, due to the complexity of spatial and structural systems, although pipeline layout is carried out according to the process requirements of various professions, it often cannot fully meet the design principles and construction requirements. For large public buildings, using BIM technology for pipeline integration of electromechanical systems has obvious advantages. The BIM modeling process is equivalent to a comprehensive drawing review, the model is built according to the actual size and can fully demonstrate the effect after construction, for parts omitted in traditional expressions (such as valve size, pipeline insulation layer, etc.), they can be displayed in the 3D model. Thus, some problems that cannot be seen on the two-dimensional construction drawings but exist in the actual construction process are exposed.

During the installation process of the electromechanical system, due to the deepening design and route adjustment of the pipeline, the length of the pipeline and the number of pipe fittings may change accordingly, which may lead to the system not meeting the original design parameters. After adopting BIM technology, intelligent simulation of system parameters such as energy consumption and flow can be carried out based on the BIM model, providing reference for the selection of equipment parameters. In the initial stage of pipeline integration, the goal is to meet the spatial requirements of the main pipeline, the mechanical and electrical professional model includes the main pipeline, and there are no requirements for the air conditioning terminal branch pipes, water supply and drainage, and fire water pipe branches that enter the room, the air conditioning terminal air supply devices, nozzles, accessories, etc. are left to be further deepened. For the coordination of structures and related specialties, such as the parts where pipelines pass through beams and walls, it is necessary to do well in the design of hole reservation and sleeve embedding [19].

In the mid-term, it is necessary to further improve the model, improve accuracy, determine the elevation and horizontal position of the pipeline, optimize the pipeline layout, and meet the net height requirements. In the initial BIM model, the equipment in the computer room was usually not arranged, or symbolically only large electromechanical equipment was arranged. At this stage, it is necessary to deepen the design of the equipment room, lay out detailed equipment models, determine equipment parameters, and deepen the design of the pipelines inside the equipment room. In the final stage, the BIM team refined the equipment room according to the owner's requirements based on their own construction experience, and constructed a BIM model that was identical in size and appearance to the actual equipment. Improve the details of each system, coordinate all pipeline collisions, and design and arrange supports and hangers. The comprehensive results of pipelines can be directly used in the form of models through mobile terminals (iPads) to guide construction, and two-dimensional drawings can also be exported. The detailed design drawings of each discipline should include a comprehensive pipeline plan, legend, construction instructions, pipeline system diagram, plan, section, equipment room details (including equipment location, installation method, and pipeline layout), reserved and embedded drawings (including the position, precise elevation, and bending radius of openings or embedded parts), and support and hanger layout.

3. Results and Analysis.

3.1. Project Introduction.

(1) Project Overview. This project is the second phase expansion project of an airport, mainly including T2 terminal, transfer center, power center, and information center, with a designed annual passenger throughput of 29 million people. The T2 terminal has a building area of approximately 480000 square meters and a main building height of 38.7 meters. The transfer center has a building area of approximately 270000 square meters and a height of 14.63 meters. It has four underground floors and two above ground floors. The power center has a building area of 8075 square meters and a building height of 6.85 meters, with one floor above ground and one floor below ground. The information center has a building area of 9050 square meters, a building height of 38.3 meters, and eight floors above ground. The mechanical and electrical installation engineering of the airport includes conventional water supply and drainage system, siphon rainwater system, fire water system, ventilation and air conditioning system, power and lighting distribution system, fire power distribution system, automatic control and intelligence system, vertical and escalator system, security system, as well as airport specific flight information display system, broadcasting system, advertising identification system, luggage sorting system, automatic walkway system, etc.

(2) Project difficulties. The airport, as a gateway to the city, places greater emphasis on the design of roofs and exterior design than general public buildings due to its large engineering volume and high installation difficulty, it has high requirements for overall effect and spatial design, resulting in complex structural forms. On the basis of meeting the functional requirements, the electromechanical system also pays attention to aesthetics, greatly increasing the difficulty of design and construction. The installation area of the project is large, and the construction period is tight. It is necessary to ensure construction quality and reduce rework and changes.

This project includes a large number of systems, a large number of various pipelines, complex spatial relationships, and numerous mechanical equipment in power centers, air conditioning rooms, and other parts. There are significant difficulties in reviewing two-dimensional drawings, as well as frequent design changes and multiple versions of construction drawings. In order to ensure construction quality and progress, it is necessary to use three-dimensional models to optimize the layout of pipelines. Mechanical and electrical installation engineering requires consideration of many details, and the layout of pipelines can directly affect the construction sequence. Therefore, it is necessary to communicate and communicate with various units at any time during the construction period. However, there are many subcontracting units in this project, making it difficult to coordinate the relationships between all parties.

(3) Application Objectives. Based on the characteristics of the above project, in order to ensure construction quality, save costs, and shorten the construction period, the construction party requires the use of BIM technology to deepen the design of the electromechanical system, and has formulated the following application goals: Utilize 3D models to complete construction drawing review, strengthen coordination between design and construction parties, and reduce collisions and conflicts during construction; Optimize the design plan to achieve a simple pipeline and balanced system, ensuring that the equipment is in the overall optimal operating condition; Conduct construction process and schedule simulation to optimize construction organization; Conduct material statistics to effectively control costs; Combining digital production mode to achieve batch processing of prefabricated components; Combining mobile terminals to achieve construction site management; Realize digital handover and provide complete and accurate engineering information for production and operation.

3.2. Analysis of application conditions.

(1) Application Plan. Develop a project application plan based on the actual situation of the project and the B M application goals. As shown in Table 3.1.

(2) Team composition. Based on the construction site situation and application objectives, a BIM team was jointly established by the general contractor and the design institute that provides BIM services. The team consists of over 40 people, as follows: One BIM general manager, appointed by the project manager,

Table 3.1: BIM Application Scheme

Serial Number	Application content	Completion time and results
1	Team building	Build a BIM team after the project starts
2	Standard development	Refer to internal enterprise modeling and delivery standards
3	Determine the application process	The owner, design institute, construction party, and supervision unit jointly agree on the application depth and approval process
4	Develop a work plan	Within two weeks after the team is formed, divide the work stages and develop a detailed work plan
5	Check drawings	Before establishing the model, check if the design drawings are complete and if there are any omissions. Complete the initial model one month before the start of the electromechanical installation project
6	Model creation and maintenance	One week before the installation starts in a certain area, complete the detailed design of the area and solve the collision detection problem. Complete the model modification within 5 days after receiving the change notice
7	Comprehensive delivery	Complete model integration before acceptance, form a completed model, and hand it over to the general contracting unit

Table 3.2: Software Configuration

Software Name	Software Role
Revit	Modeling for Architecture, Structure, and Mechanical and Electrical Majors
Navisworks	Collision detection, 3D roaming, construction simulation
PKPM	Structural calculation and material statistics
3ds Max Design	Animation production and effect rendering
Showcase	Effect friendly dyeing and design scheme demonstration
Project	Preparation of construction schedule

with 10 years of project management experience, fully responsible for the overall progress of the project; Three BIM coordinators, appointed by the Deputy Project Manager, with over 8 years of project management experience, responsible for personnel management and work progress in each group; More than 30 BIM engineers are responsible for the establishment of architectural, structural, and electromechanical professional models, optimization design of pipelines, integration of various engineering information, and other specific tasks. They also include program developers to provide technical support for software applications.

(3) Software Selection. The software used in this project is shown in Table 3.2. In addition to professional software, this project also applies some plugins developed by a certain design institute, such as Revit based support and hanger generation plugins, material equipment coding plugins, material statistics plugins, and visual comprehensive management platforms.

(4) Hardware configuration. The software used in the project has high requirements for computer configuration. In this project, 25 laptops and 15 desktop computers are used, and the specific parameters as shown in Table 3.3.

3.3. Application Content. The application of this project is divided into three levels, the basic application is implemented using conventional software functions, the deepening application is combined with project characteristics, and the advantages of B M are fully demonstrated using plugins, finally, combined with the engineering data platform, a digital overall handover for the owner is achieved.

(1) Basic Applications. Based on the two-dimensional design drawings, apply Revit software to establish the initial model of the entire project by profession, and input component information. Due to the large volume of this project, in order to ensure smooth software operation, the drawings are divided into several areas and

Table 3.3: Hardware Configuration

Parts	Desktop parameters	Notebook parameters
motherboard	Ivytown DM2 - Intel X79 PCH	EnazerY50-70
processor	Inte1Xeon E5-2620v2 @2.10GHz Six core	Intel Core i7-4710HQ @2 5GHz GHz
Memory	32GB (DDR3 1333MHz)	8GB (DDR3L 1600MHz)
Graphics card	AMD FirePro V 4900	NVIDIA GeForceGTX860M
display	DELDOSA DELLS2340M (23.1 inch)	15.6 inch

modeled separately. Based on the same elevation and grid, the accuracy of the relative position of the model can be guaranteed. Verify whether the spatial relationship of the original design is reasonable and whether there are any errors or omissions in the pipeline through the integrated 3D model. Intuitive forms of expression are also conducive to coordination and communication between the design and construction parties.

After the model is built, collision detection is performed using Navisworks software. Collisions can be divided into two categories: hard collision and gap collision. The former refers to the cross collision between entities, while the latter refers to the non cross collision between entities, but the spacing does not meet the construction and installation requirements. Combine the disciplines of building structure, water supply and drainage, HVAC, electrical, intelligence, and information technology to conduct hard collision and gap collision detection, and generate detection reports. Classify and analyze the test results, propose modification suggestions, provide feedback to various professional designers, and coordinate the modifications together.

Based on the results of collision detection, the system pipeline must be optimized while meeting the requirements of construction and maintenance space. The optimization model must meet the requirements of design specifications and construction acceptance specifications. A comprehensive pipeline system developed based on the Revit platform can complete layout scheme comparison, installation space detection, and pipeline position and elevation adjustment in the same graphical interface. In the project, the first step is to deepen the design of key areas with a large number of pipelines and equipment. There are many pipelines in the corridor of the terminal building, and there are local automatic walkways with lowering boards. The design heights of suspended ceilings in different areas are different, and installation space and net height requirements need to be considered when arranging pipelines. In the design, conflicts are eliminated by changing the size of air ducts and cable trays or moving pipeline positions reasonably to meet spatial requirements.

The process in the baggage sorting area is complex, and the steel platforms and brackets supporting the baggage equipment are relatively dense. The suspension rods are long, and the suspension rod brackets have a lot of diagonal tension. Each suspension rod has been calculated, and the embedded parts that have taken root have been completed. The position cannot be changed, and there are many cross collisions between pipelines, steel platforms, and suspension rods. Through mold assembly, optimization and adjustment of mechanical and electrical pipelines, as well as simulation, a plan for segmented positioning and installation of mechanical and electrical pipelines, with local reserved coordination space, has been developed to achieve coordination between installation accuracy and on-site variables. The air conditioning room and power center have a high floor height, a large number of equipment, dense and large-sized pipelines, and complex pipeline support arrangements, which affect the layout of other pipelines and cause frequent cross collisions. When installing, it is necessary to consider the form of supports and hangers for pipelines and equipment, leaving sufficient space for equipment inspection. Import the Revit support model into PKPM for calculation and analysis, determine the support form and steel type, adjust the pipeline position and elevation based on the support and hanger form, reduce construction difficulty, and enhance stability.

In this project, a Revit platform based plugin developed by a certain design institute has been applied, which can identify the parts of the pipeline that pass through the wall in the model and automatically generate openings. This ensures that the position, quantity, and size of reserved openings meet the design standards and later construction requirements, and there are no omissions or errors. According to the model and construction drawings, it is possible to do a good job of opening reservation and casing embedding during the main construction. Due to the high accuracy of the models provided in the basic application stage of BIM, the accuracy of pre embedding and reservation in engineering has been significantly improved, reducing secondary excavation and improving construction efficiency. In traditional two-dimensional design, there is often a problem where the spatial positions represented by the plan and profile do not correspond, resulting in engineering change visas caused by modifying the drawings, which affects the construction progress. By applying BIM technology, drawings from all angles are generated by 3D models, fundamentally solving this problem and making up for the shortcomings of 2D design space representation. After pipeline optimization, generation of reserved openings, support and hanger design, and process simulation, the quality of the designed products has been greatly improved, and the drawings can be directly used to guide construction.

(2) Deepen application.

Support and hanger design: Utilize plugins developed based on the Revit platform for comprehensive support and hanger design. After specifying constraint relationships, the software can automatically extract pipeline loads for structural stress calculation, determine the type and size of steel profiles, generate support and hanger calculation instructions, and generate parameterized support and hanger model diagrams in the project. Pipeline prefabrication processing: Based on the comprehensive pipeline model, intelligently segment the pipeline system, by using a detailed list to calculate the length of pipe sections and the number of pipe fittings, complex pipe fittings can be digitally processed by generating part cutting diagrams in the model in advance. The air conditioning system of this project has a large amount of air ducts and a large number of pipe fittings. Based on BIM model data, a brand new plasma cutting machine is used for digital batch production, saving a lot of manpower and time, and improving production efficiency.

Construction simulation: Import the progress plan into Navisworks for simulation, and the intuitive and visual animation effect is conducive to coordination and communication among all parties, determining the production plan, and effectively reducing the loss of construction period caused by overlapping construction periods. For areas with complex pipelines and multiple disciplines involved, simulate the construction process for the installation of various professional pipelines, select the optimal construction plan, determine the construction sequence, and avoid rework problems caused by rush work between construction teams.

On site management: Strictly follow the comprehensively optimized drawings for construction on site, ensure project quality, and track project progress in real time. Compare with the progress plan and analyze the reasons for early or delayed construction period. For parts that require special recording, such as key nodes and concealed projects, on-site personnel record the information through mobile devices in the form of documents, photos, etc., and associate it with the model through the network, enabling engineering management personnel to have a deep understanding of the on-site situation.

3.4. Application effect. BIM technology has achieved good application results in this project. Compared to traditional two-dimensional comprehensive pipeline layout, the accuracy of the deepening design is improved by about 20%, and the deepening design time is reduced by 10%.

Relevant software is used for three-dimensional comprehensive pipeline layout, and areas with multiple pipeline intersections and narrow ceiling space are reasonably arranged to meet the design height of the ceiling. Integrating luggage sorting models, optimizing mechanical and electrical pipelines, ensuring process functionality, detecting and resolving over 200000 professional collisions in advance, avoiding extensive dismantling and modification in the later stage; The accuracy of hole reservation is significantly improved to avoid secondary excavation in the later stage. The mechanical and electrical installation is strictly carried out in accordance with the BIM comprehensive pipeline design drawings and models, reducing complexity to simplicity, enabling the project to be quickly and smoothly implemented, ensuring installation quality and being neat and beautiful; Unified planning, design, prefabrication, and installation of supports and hangers; Through three-dimensional construction simulation, the orderly progress of simultaneous and cross construction in various areas has been achieved, without any delay in the construction period. The construction efficiency has been improved by 15%, effectively shortening the project construction cycle. In this project, the BM application intervened after the completion of the construction drawing design and built the model according to the two-dimensional drawings. The modeling personnel were unable to fully understand the design intent and needed to communicate with the design personnel multiple times, resulting in a significant investment in manpower, material resources, and time. Directly conducting 3D design requires investing a lot of effort and funds in the early stages of the project to configure hardware facilities and train personnel. During the design process, project information needs to be added, which inevitably leads to an extension of the design cycle. But overall, 3D design does not require secondary processing. After the design is completed, it is directly applied in the form of a model, with high design quality and obvious advantages. In the domestic design industry, due to high initial investment, insufficient foreign software to fully meet design needs, and insufficient intuitive economic benefits, there is still a long way to go for the application of BIM from mold flipping to true 3D design.

During the electromechanical installation process at a certain airport, a complete three-dimensional information model was constructed through the application of BIM technology, which not only guides on-site construction and project management, but also provides accurate engineering data for later operations. During the on-site construction process, the application of BIM technology has achieved the creation, management, sharing, and non-destructive transmission of engineering information, reducing 50-70% of information requests and 20-25% of professional coordination time. By simulating construction progress and optimizing pipelines to guide refined construction, the construction period is shortened, engineering costs are saved, good economic benefits are generated, and management level and efficiency are also improved [20].

4. Conclusion. At present, there are problems in the construction and installation industry, such as outdated technology, insufficient information technology, and difficulties in communication and coordination. In order to improve construction efficiency and management level, the application of BIM technology is introduced. The author conducts research on the application of BIM technology in large-scale public building mechanical and electrical installation engineering, and verifies the application value of BIM technology in project mechanical and electrical installation engineering through case studies. By utilizing BIM technology for deepening design, the pipeline layout plan can be reasonably optimized, and through collaborative work, the deepening design time can be effectively shortened; Through collision detection, pipeline crossings and collisions can be reduced, design changes and rework can be avoided, and construction efficiency can be improved; Through construction simulation, the construction plan and schedule can be optimized, and the construction technology and on-site management level can be improved.

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