Domestic and International Mainstream BIM Software Application and Comparison Study

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Abstract. With the rapid development of science and technology, the construction industry is showing the trend of informatization. BIM has emerged to bring vitality into the construction industry. This paper introduces the application of BIM software in various phases and the mainstream BIM software at home and abroad, and conducts a comparative study on each BIM software from the design phase, construction phase and operation and maintenance phase, analyses the advantages and disadvantages of each software, and helps relevant practitioners to quickly choose the appropriate software according to their needs.

1. Introduction
Internationally, BIM is defined as a computable, arithmetical representation of the physical and functional characteristics of a facility and related project life-cycle information under developed industry standards, thereby providing support for decision-making to better realise the value of the project [1].

With the current changes in the development of construction information technology, BIM is playing an increasingly important role in all phases of construction projects, and a large number of BIM software at home and abroad have come into being, but there are a wide variety of BIM software, and many products of varying levels in each type of BIM software, and it takes a lot of time for relevant practitioners to choose the right software. This paper introduces the characteristics, advantages and disadvantages of mainstream BIM software at home and abroad from the application of BIM software in the whole life cycle of project construction, and selects typical BIM software in the design, construction and operation and maintenance phases respectively for comparison and elaboration, with a view to providing reference for relevant practitioners in selecting BIM software.

2. BIM Software Application in All Phases
BIM is a new technology that uses data from construction projects to build models to support the full lifecycle operation of the project [2]. The design, construction and operation and maintenance phases of construction projects generally suffer from long lead times, low efficiency and inconvenient communication between the various parties involved. BIM has revolutionised the traditional architectural design model, changed the way in which the various parties involved communicate and facilitated the development of the
construction industry in the direction of information technology and integration. The application of BIM in the various phases of the whole life cycle of construction projects is shown in figure 1.

2.1. The Design Phase

Usually, the design phase has a small proportion of investment and a short design cycle, but the design phase is extremely important in the whole life cycle, and the good or bad design drawings of construction projects directly affect the quality of the project, so it is necessary to choose the right tools to apply to the design phase.

2.1.1. Reduce Duplication of Workload. There are more adjustments to project drawings in the design phase, and in the traditional design mode other relevant data will have to be adjusted due to a change in one data. By using BIM software to standardise the design of drawings, other relevant data will be generated automatically, significantly reducing the amount of repetitive workload caused by design changes [3].

2.1.2. Become a Medium of Information Communication. In the design phase, various data and information are provided by different participants, and the information sources are scattered, which is easy to lead to information loss and transmission delay. BIM software changes the transmission mode of data, realizes the mutual and continuous transmission of data in each phase, and becomes an information cloud storage platform.

2.1.3. Collaboration and Efficiency. Before BIM was put into use, the design of building, structure and equipment models needed to be carried out sequentially, and each data could not be reused, resulting in a long design cycle and low efficiency, which affected the overall progress. With the use of BIM software, the design of each profession is carried out at the same time, realising the collaboration of different professions, and forming work standards and templates to achieve the sharing of components and greatly shorten the design cycle.

2.1.4. Improve Design Accuracy. In the design process, due to the limitations of two-dimensional drawings, it is not easy to capture the deviation of details, making the design accuracy and depth of drawings lacking. Using BIM software, the intuitive 3D model is built and the visualisation function helps designers to quickly find problems with the drawings, effectively improving the accuracy and depth of the architectural design.

2.2. The Construction Phase

The success of the implementation of the construction phase directly affects the construction period and budget. If problems are found at the end of construction, the lighter the work is reworked and compensated, the heavier the impact on the lives and property safety of the occupants and users.

2.2.1. Reducing Error Rates. In the traditional construction mode, errors in construction drawings and construction plans are not easily detected; construction site management is complex and prone to unreasonable site layout planning, such as the layout of the stockyard conflicts with the wind direction and the repeated layout of large and heavy machinery. The collision checking function of BIM software can be used to find out the loopholes in drawings or plans and reduce losses; the analysis of each area of the construction site can be carried out to achieve reasonable planning.

2.2.2. Find the Optimal Solution. The selection and optimisation of the construction plan is a major problem in the construction phase. Use BIM software to simulate and compare the construction plans and select the best one; deepen the design plan, supervise and control the construction progress and ensure construction safety [4].
2.2.3. Reduce Waste of Resources. Due to the constraints, the traditional construction mode cannot precisely and finely manage the construction site, resulting in unnecessary waste of resources. Using BIM software, through cloud platform services and simulation demand analysis, the construction process can be finely managed to rationalise the use of resources and save construction costs.

2.3. The Operation and Maintenance Phase (O&M)

The longest-lasting and most costly phase of a building's entire life cycle is the operation and maintenance phase. The investment in the design and construction phases directly affects the expenditure in the O&M phase. Tasks in the O&M phase include space management, facilities management, concealed works management and emergency management[5].

2.3.1. Storage of Management Data Information. The traditional O&M management system has problems such as missing data and poor quality of as-built drawings [6], which makes management difficult. The use of BIM software data platform to achieve the cloud storage of building facilities data, to prevent the loss of information, reduce the difficulty of finding data.

2.3.2. Improve the Efficiency of Operation and Maintenance Management. In the past, O&M management methods were primitive and procedures were cumbersome, resulting in a cumbersome and inefficient management process. The use of BIM software big data platform analysis, upgrade management methods, simplify the management process and improve management efficiency.

2.3.3. Reduce Cost Input. Usually, hidden engineering accidents are not easy to prevent, not easy to solve in time after they occur, and cost a lot of human and material resources. Using BIM software, we can use the functions of maintenance inspection, cleaning and repair, fire escape, etc. to discover and prevent concealed engineering accidents in time, reduce the possibility of accidents and reduce the cost investment caused by concealed accidents.

![Figure 1. Application of BIM in the whole life cycle of construction projects.](image-url)
3. Comparative Analysis of Similar Software

3.1. Analysis of the Advantages and Disadvantages of BIM Software in the Design Phase

There are many BIM software in the design phase at home and abroad, and the specific functions are different. The following table is a simple comparison of the mainstream BIM design software at home and abroad in terms of operability, interface, cost performance, professionalism, etc., to explain the advantages and disadvantages of each software. (See table 1)

The design phase of this paper selects typical Revit software and Bentley software for comparative analysis, both of which are mainstream software at home and abroad. In terms of market share, Revit software is welcomed by the civil construction market for its low learning difficulty, comprehensive functions, high cost performance, abundant information and other characteristics, with a relatively wide range of users and a high market share, while Bentley software is targeted at users who are more demanding in terms of the completeness of construction information but not sensitive to the investment cost of the software, insufficient localisation, high learning difficulty and other reasons. In terms of project support capability, Bentley software only retains the necessary relevance of the profession without unnecessary information, while Revit software has too many internal component relevance and redundant parameters, resulting in too much information, thus Bentley software has better support capability for large projects than Revit software.

3.2. Analysis of the Advantages and Disadvantages of BIM Software in the Construction Phase

The following table analyses the advantages and disadvantages of each software from the aspects of compatibility, operability and rendering effect. (See table 2)

The construction phase of this paper selects the typical Navisworks and Luban software for comparative study, Navisworks software is more used at home and abroad, Luban software is a domestic software, more used in China. Navisworks software has a strong 3D model integration and can import time progress data for four-dimensional simulations. The disadvantage is that it requires high computer configuration, and the process of rendering and adjusting the model is heavy and time-consuming. Luban software has a strong localisation specialisation, does not require high computer hardware configuration, is free and open to download, is easy to learn, enables the integration of model information, project and management collaboration, is fast and stable in the development of new functions, has various output formats and can be directly imported into Lumion, fuzor and other software. The disadvantage is that it is dependent on a third party CAD platform and lacks independence.

3.3. Analysis of the Advantages and Disadvantages of BIM Software in the O&M Phase

There is less domestic software in the operation and maintenance phase, and most of them are foreign software. The following table selects ArchiBUS, Maximo and Ecodomus to analyze the advantages and disadvantages of the software. (See table 3)

The operations and maintenance phase of this paper is a comparative study of the typical ArchiBUS software and Maximo software, which is the FM software with the highest market share and can be connected to BIM. Its main management items include the use of space, various assets, and the operation and maintenance of buildings [8]. ArchiBUS software improves the space utilisation of premises through effective management of space, and keeps the organisation in good financial condition and reduces operating costs through effective management of facilities and equipment. It provides users with the most complete and integrated software solution for the overall scientific management of facilities. Maximo software has the highest market share in the enterprise asset management system market, with MRO software companies changing the traditional reactive maintenance approach to proactive preventive maintenance, and introducing application solutions corresponding to different industries.
is excellent in controlling maintenance costs, improving Maximo software is an excellent solution for controlling maintenance costs, improving efficiency and safety.

| No. | Name of software | Mainstream areas | Advantages | Disadvantages |
|-----|------------------|------------------|------------|---------------|
|     |                  | Domestic | Abroad | simple operation; low application cost; real time update of information; full professional platform; high modeling accuracy | limited capacity for complex modelling; unable to export quantities |
| 1   | Revit            | √        | √      | strong collaboration, interoperability and professionalism; strong data management ability | complicated operation; high application cost; limited number of object libraries; insufficient localization |
| 2   | Bentley          | √        | √      | simple operation; smooth operation; good coordination, interaction and integration; outstanding in construction drawings | insufficient data update and localization; not suitable for modeling of large projects |
| 3   | ArchiCAD         | √        | √      | It is highly specialized in prefabricated buildings and prefabricated component models. | non professional BIM model; insufficient localization |
| 4   | AIIPLAN          | √        | √      | strong in surface, structural analysis, modeling and information management | difficult to learn; costly to apply; inefficient to model |
| 5   | CATIA            | √        | √      | complete modeling functions | complex interface; high application cost |
| 6   | Digital Project  | √        | √      | strong in specialization, detail and modularity | high computer hardware requirements; insufficient localization; large modelling works |
| 7   | Xsteel           | √        | √      | good compatibility, high synergy, good stability; Simple operation; humanized; rich equipment sample library | high application cost |
| 8   | MagiCAD          | √        | √      | low learning cost; wide application range; rich material library | high application costs; difficult to control accuracy |
| 9   | SketchUp         | √        | √      | simple operation; high market share; strong humanization and localization | inconvenient design change; slow update and poor human-computer interaction |
| 10  | PKPM             | √        |        | strong pre-processing, computing functions and core computing functions | Post-processing is relatively weak. |
| 11  | ETABS            |          |        | powerful analysis ability, graphic modeling and post-processing function; strong universality, adaptability and interoperability | Weak statistical analysis functions. |
| 12  | STAAD            | √        |        | localization; supports 3D custom entities | weak independence |
| 13  | TANGENT          |          |        | fast modeling speed and high precision; powerful plug-ins; good stability | poor surface quality; inconvenient to modify models |
| 14  | Rhino            |          |        | high cost performance; powerful 3D cartoon production functions and powerful simulation rendering functions | difficult to get started; slow to render |
| 15  | 3DMax            |          |        | simple operation; complete types of tools; humanization; fast running speed | poor material presentation |
| 16  | TSSD             |          |        | simple operation; quick rendering; many ways of modelling | |
| 17  | Lumion           |          |        |                               | |
### Table 2. BIM software for the construction phase.

| No. | Name of software | Mainstream areas | Advantages | Disadvantages |
|-----|------------------|------------------|------------|---------------|
|     |                  | Domestic | Abroad | | |
| 1   | Navisworks       | √        | √      | good compatibility, strong authenticity, powerful functions of construction simulation, dynamic navigation and roaming | high requirements for computer configuration; low rendering efficiency; inconvenient design change |
| 2   | Civil 3D         | √        | √      | friendly interface and clear system | high computer configuration requirements; slow running speed; imperfect localization; lack of personalisation |
| 3   | YJK              | √        |        | simple operation; strong interoperability; convenient calculation and analysis of complex structures; high quality of results | low market share; high fault tolerance |
| 4   | Quanta BIM5D     | √        |        | simple operation; high cost performance; fine management and high mobility; supports multiple model formats [7] | insufficient stability; poor compatibility |
| 5   | Lubansoft        | √        |        | simple operation; high cost performance; strong localization and specialization | poor independence |
| 6   | THS              | √        |        | highly flexible; Retains original CAD functionality. | poor independence; insufficient stability |
| 7   | Synchro          | √        |        | simple operation; intellectualization; superior construction simulation and schedule management; good compatibility; high quality of results | difficult learning; high application cost |
| 8   | Showcase         | √        |        | real time rendering; low requirements for computer hardware | under-rendered |
| 9   | PMS              | √        |        | simple operation; rich material; wide application range | poor independence |

### Table 3. BIM software for the O&M phase.

| No. | Name of software | Mainstream areas | Advantages | Disadvantages |
|-----|------------------|------------------|------------|---------------|
|     |                  | Domestic | Abroad | | |
| 1   | ArchiBUS         | √        |        | wide application range; strong modularity | Localization and cloud in China are poor. It lacks professional consultants to guide users. |
| 2   | Maximo           | √        |        | strong universality; strong comprehensiveness; high market share | Closed core technology makes it easy to form product dependencies. |
| 3   | Ecodomus         | √        | √      | convenient operation; advanced operation and maintenance mode | The collected project information is not intuitive. |
4. Recommendation for BIM Software Application on Projects

4.1. Clarify the Positioning of Their Role
Different responsible parties have different focus when using BIM software, such as construction units focus on the whole life cycle, the purpose is to make the BIM software play the maximum value; if the learning cost of the software is too high, it will affect the enthusiasm of staff learning; although the design unit is concerned about the software cost, but more focus is on the function of the software and the ability of complex modeling.

4.2. Consider the Cost of Software Input
The cost of software does not only include the cost of purchasing the software, but also the cost of learning the software. The difficulty of the software is directly related to the time spent on learning the software, which affects the motivation of the staff to learn and therefore the efficiency of the work.

4.3. Measuring Software Integration and Interactivity
The level of integration of software directly affects the choice of software, if a software integrates most of the functions required by the user, then the software will be preferred. Of course, any project cannot be completed by a single piece of software alone, but requires the interaction of several pieces of software, so software integration and interactivity becomes an important factor to consider when selecting software.

Therefore, the selection of BIM software should take into account the actual situation and consider the following factors: its own role, the investment cost of the software, the integration and interactivity of the software, the phase of using the software, etc.

Taking into account the above factors and the characteristics of each software, the following recommendations are given: Revit is recommended for the design phase in general, Bentley and CATIA are recommended for complex designs with sufficient budget; Quanta BIM5D and Luban are recommended for the construction phase; ArchiBUS and Maximo are recommended for the operation and maintenance phase.

5. Conclusion
There are many different kinds of BIM software in the market, and the cost, function, application phase and learning difficulty of each software are different. The relevant practitioners are not clear about the positioning and selection of the software, and are prone to blindly follow the trend, so that BIM cannot play its maximum value, and the understanding of BIM is misinterpreted, which then affects the promotion and application of BIM. This paper classifies BIM software from the perspective of the whole life cycle, determines the mainstream areas of application of each software, analyses the advantages and disadvantages of each software, and selects the typical software of each phase for comparison and analysis, suggesting practitioners to choose the appropriate software scientifically and reasonably from the perspectives of cost and function of the software.

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