AUTOMATION ENVIRONMENT IN OFFICE BUILDING

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Abstract

The ultimate human requisite is a working environment that allows employees to work in a conducive workspace. Some work environments or rather an office spaces have deficiencies in air and lighting that cause discomfort to employees, affecting their productivity. Building automation systems(BAS) is a transformative idea that will give sustainable and temporal solutions to companies in their work environment. This concept helps to deal with the issues surrounding employee welfare, increase the consumption of energy, and utilize more funds to replace the existing system to meet users' needs. The automation systems are efficient and effective in providing comfort in the designs. Technological advancements, especially in designs, are changing the narrative in economic activities and information handling. Most of the workspace and especially offices in industry, private individuals, and governments, are becoming automated.

Automation of offices is not only the replacement of old technology such as typewriters, bookkeeping records, but it is an all-inclusive process of installing hardware’s, dynamic and complex electronic systems, restructuring duties and responsibilities, adjusting the flow of work, organizational culture to fit into the new building automation systems. The automation of offices is being driven by advancements in technology and the exponential growth of office-based work. In contemporary society, technology has given the much-needed boost for automation in various areas that have produced a mixture of results. Systems have failed from time to time to meet the expectations of the end-users. This failure is attributed to a lack of proper planning.

At the planning stage, in most cases, designs are always relegated to the peripheral; this assumption of good designs has resulted in challenges such as thermal, acoustic environment, visual and thermal challenges in the office. The impact caused by these challenges in most cases is damaging, and the best solution is automation. Office automation, management, and designing experts have alluded to the fact that any work environment's quality is vital in increasing performance and employee comfortability. Building automation is only effective in an electronic office space that works to eliminate office work's impersonality and the adjustments in scarce interactions with

work mates in the office. These are the key things to be considered while developing design policies and guidelines for automated offices. To improve the automation environment's impact on office buildings, the communication system must be automated; the building should be converted into an intelligent outfit. Energy efficiency should also be automated. Automation of the building automation system will contribute positively to work output, bolster security measures, cut down on operating costs and regulatory documents.

Keywords. Automation of the Building, BIM system, Building Pipeline, Automatic Layout

1. Introduction: (Research context and motivations)

In recent years, as people spend more and more time in the office, the office environment has attracted more and more attention. At the same time, in the architectural design industry, the layout and design of office environment is also very important. However, there are many factors affecting the office environment, such as architectural space layout, building height and interior design. This paper takes the office environment in architectural design as the breakthrough point, trying to find the relationship between office environment and pipeline layout. At the same time, combined with the automation of architectural design, combined with BIM Technology in the intelligent building environment, explore the impact of BIM Technology in the automatic pipeline layout on the office environment.

BIM Technology in the pipeline comprehensive application effect is remarkable, through the virtual construction of the pipeline before construction, using the advantages of BIM Technology visualization and collaborative work, the collision pipeline is optimized and adjusted, and the possible collision problems in the later construction are solved in advance, which greatly reduces the engineering rework phenomenon and improves the construction efficiency. However, the current pipeline comprehensive optimization schemes are determined by qualitative analysis, and lack of quantitative calculation of optimization schemes.

In this paper, through the study of BIM pipeline comprehensive scheme, real-time calculation of each layout scheme is carried out to verify the feasibility of each layout scheme. Through the establishment of pipeline comprehensive evaluation system, the layout scheme is comprehensively evaluated, so as to select the best pipeline construction scheme. This paper first summarizes the current situation of Pipeline Comprehensive Application of BIM at home and abroad, and finds that there is a lack of specific research on pipeline comprehensive optimization scheme of BIM. Therefore, it puts forward the research of pipeline comprehensive scheme based on BIM, and determines the technical route and main research content of this paper. Secondly, it introduces the application of BIM in pipeline synthesis, compares and analyzes the differences between traditional pipeline comprehensive design and BIM based pipeline comprehensive work, and puts forward the limitations of traditional pipeline comprehensive design and the pipeline comprehensive advantages of BIM.

Thirdly, establish the BIM based pipeline comprehensive design workflow, clarify the basic work points, establish various professional models, carry out collision inspection, determine the pipeline optimization area and propose a variety of pipeline layout schemes. Through the hydraulic calculation of the pipeline, check whether each layout scheme meets the original design requirements, and provide data support for verifying the feasibility of the layout scheme. Thirdly, from the pipeline engineering quantity, pipe section pressure loss, construction difficulty and the overall effect of pipeline layout scheme, the evaluation index system of pipeline comprehensive scheme is constructed, and the fuzzy comprehensive evaluation method is used to compare and select the layout scheme. Then, improve the overall methodology of the whole BIM applied to pipeline design, provide a variety of pipeline layout schemes,

apply the established scheme evaluation index system, and use the fuzzy comprehensive evaluation method to select the best pipeline construction scheme.

Finally, this paper puts forward the shortcomings of this paper, and provides the direction for the next research.

2. Research Aims

1.Figure out a methodology that could automatically generate the best option of pipe design in buildings.
2. Buildup a guideline for the pipelines design and office environment.

3. Research Question(s)

Revise the research question submitted from Assignment 1b: How do we improve the impact of the automation environment on office buildings?

Based on the issues outlined in the introduction and the derived aims, the question the research this project investigates is:

*How could we realize the automation of pipe design? *

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4. Methodology

Architectural designs in today's world rely heavily on delivering quality work for their clients. Buildings are expected to adhere to certain lighting aspects, security systems, and access control factors. Heating, ventilation, and air conditioning (HVAC) have to be in-cooperated in the building automation system (BAS). Furthermore, it was installed to increase an occupant's comfort, security, accessibility, operation, and control. These factors ensure efficient operation within the building, boost security measures, and reduce operating costs and documents on the pros and cons.
The project seeks to explain and predict using scientific methods why an automated building is a crucial subject in construction. To improve the automation in office buildings, factors such as risk, plural structure, reflexive, dialectic critique, and theory and transformation should be considered. Action research should contribute to people's real concerns presented with an immediate problem. The research aims to

identify risks that may affect the construction process. The building management system can improve risks by using and taking photographs. This ensures that every detail is caught on camera and is dealt with accordingly through review and documentation. For example, buildings with dark allies highlight major lighting issues. A clear photo of this issue may prompt its adjustment.

The collaborative research principle should be heavily practiced. Every participant should be heard. Dismissing claims of participants may cost the process heavily. Each opinion is important because it gives fresh insights into different viewpoints. Striving to avoid being bias and lack of credibility. For instance, certain participants may argue on the issue of installing cameras in public convenience facilities. It may be viewed as high security, but some may feel it's an invasion of one's privacy.

Research methods depend on your goal, and the subject one wants to study. Methods likely to be used in this project are observation and experimentation, to mention a few. Observation will help in identifying the challenges the participants are faced with. Naturally, studying will ensure that data isn't distorted in any means. They are cost-effective and derive credible results. The drawing board is therefore repositioned, rectified, or changed to solve identified problems. Observation will help in identifying the advantages of automation in office buildings. Issues of complaints by workers because of extreme light conditions may help adjust the light concentration.

The experimentation approach will help the researcher identify the cause and effects of a certain problem; obtain accurate results since each variable can be controlled on its own or combined. For example, an air conditioning problem can be identified when the participants get involved in the exercise. The researcher and participants can gauge their first-hand experience on the underlying issue hence can fix the matter.

In conclusion, action research provides in-depth knowledge about the problem in question. The research uses both action and research, and practicability is key; the method is applied to improve specific outcomes. This method is applicable and effective in deriving qualitative and quantitative data. It is also facilitated when the researcher works collaboratively with participants in diagnosing the problem. Furthermore, it is based on the evaluation, critical analysis, and improving research problem through the data obtained.

5. Background Research/Literature review

Introduction

With the advent of technology, the built environment is in the middle of a revolutionary transformation. Some of the elements of the improved technology such as artificial intelligence, the Internet of Things, robotics, among other technologies, have proved instrumental in the realization of the automation process and creation of new rules in architecture and the real estate industry at large (Park, Pobil & Kwon 2018). Automation has many opportunities for organizations because it helps business organizations improve their productivity and identify more comfortable operationalizing businesses (Park, Pobil & Kwon 2018). Improving the impacts of the

automation environment on office buildings is significantly influenced by the complex and sophisticated tasks such as the integration of front office and back-end systems. Again, various types of automation are applicable in different business industries worldwide; therefore, improvement in automation impacts is much dependent on the kind of organization and the most suitable automaton system of the business. Automation enhancing automation's implications in organizations can help achieve optimal office operations, thus helping save on time, money, and human resource. Therefore, traditional office buildings need to adopt automation systems within their office spaces and working environments.

Automation for energy efficiency

"If a change occurs such as to produce discomfort, people react in ways which tend to restore their comfort" (Mousavi et al. 2014). Most office and residential buildings have a thermal comfort system to provide an indoor climate that is favorable to the building (Peeters et al. 2009). However, office buildings are way different from residential because energy use is dependent on the workflows, which significantly determines the amount of energy used in a building. Thus, office buildings need to have energy-efficient building automation systems that consider business processes' dynamic and unpredictable nature. This paper is important because it proposes models that can help enhance energy efficiency through a meeting room scheduling scenario where equipment is combined. Energy use has been measured to improve the efficient service of energy. According to Noailly (2012), energy efficiency as a result of the office environment's automation can be instrumental in bringing down the cost of business operations and enhancing workers' well-being. Omar (2018) further notes that automating the energy systems in a building is not entirely assured that energy efficiency will be achieved because office occupants' behavior directly impacts energy consumption in a building. This is in line with the observation that carelessness and ignorance account for over one-third of buildings' energy costs (WBCSD, 2009). Therefore, there is more to attaining energy efficiency than just automating the system since human behavior also plays a significant role in complementing the automation process.

Intelligent Buildings

"Intelligent buildings provide effective, sensitive, and conducive environments where organizations are able to meet their objectives (Himanen 2004)." Hiamanen also notes that buildings have profound effects on people because they can hence work effectively. Brown (2020) also observes that buildings present various stimuli for people to react to. Therefore, technology needs to formulate highly responsive structures that facilitate significant building and space management and business

management systems. This research contributes to understanding the aspects of office buildings that can be enhanced to positively impact the organizations' workers while having minimal adverse effects on the environment and the people who use the facility. All in all, Omar's (2018) view of intelligent buildings are predominantly aligned to energy efficiency and the low cost of business operations that come with energy-efficient buildings, unlike Himanem (2004), whose idea of intelligent buildings encompasses the well-being of persons and the environment. All in all, smart buildings are an advancement of the traditional office buildings that did not pay attention to the user's space and the office space's sensitiveness to the worker's productivity. According to Omar (2018), building intelligent buildings is not enough, but rather, users need to promote smart use of the buildings

Automation of Communication systems

Building automation systems play an integral role in controlling the conditions within the indoor environments (Kastner et al. 2005). Kiwimagi et al. (2005) highlight that is building automation systems is predominantly used in the automation of heating, ventilation, and air-conditioning systems within large buildings. However, developments in technology have made it possible to use building automation systems in all kinds of information systems within a building. This paper expounds on building automation and looks into how the systems and communication systems that can be integrated into the building automation system to enhance its effectiveness. Zanoli et al. (2015) observe that user comfort is the primary motive of the building automation systems. However, apart from improving users' convenience, improvements of the communication systems can help bring down costs of operations (Wang 2009), putting in mind that businesses in today's world rely on communicating systems to stay competitive (Stacho et al. 2019).

6. Case Study (Your Project work)

The pipeline network in intelligent building is very complex, such as electrical pipeline, water supply and drainage pipeline, gas pipeline and so on. It is easy to cross in the process of installation and laying of various pipelines. For intelligent buildings, it is necessary to design the pipeline network scientifically and reasonably, so as to continuously improve the rationality of building pipeline network and ensure the normal operation of various infrastructures in intelligent buildings. In the intelligent building, due to the large number of pipelines, it will occupy more space in the design process, especially the pipeline network laying range of some large projects is relatively wide. If the pipeline is not designed reasonably, it will occupy more space, and may also lead to the cross influence between different types of work, and affect the normal operation of various infrastructure. In this regard, in the process of intelligent building design, the pipeline should be designed and arranged comprehensively according to the architectural design standards and requirements. On the premise of ensuring the basic functions of each kind of pipeline, space should be saved as much as possible to create a good and comfortable living environment for people, and also save costs. Pipeline integration generally includes building equipment, water supply and drainage, electrical, fire protection, heating and

ventilation, etc. its purpose is to combine different types, specifications and functions of equipment, pipes, air ducts and bridges in the building to carry out reasonable spatial layout. On the premise of meeting the functional requirements of the building and the needs of customers, the overall space occupied by the pipeline is compressed and increased The clearance height of the building, so as to win a larger space for the building.

In summary, the application of BIM technology in pipeline synthesis can be summarized as follows:

1. Drawing problem check. The process of basic modeling using BIM technology is also a process of drawing review. In the process of modeling, using the three-dimensional visualization of BIM model, design errors and unreasonable pipeline layout in the drawings can be sorted out. Using the three-dimensional model to check the design drawings for errors, omissions and defects, on the one hand, optimizes the drawing information, on the other hand, improves the construction efficiency, and reduces the occurrence of Engineering rework.

2. Collision check and optimal design. Using the characteristics of three-dimensional visualization of BIM technology, check whether there are collision points between pipelines and building structures, analyze the causes of collision, communicate with the designer, and propose solutions to avoid engineering rework in the construction process.

3. Net height check. After the model of pipeline and building structure is created, net height check simulation is carried out to list the areas with insufficient net height, analyze the reasons for the unsatisfactory net height, communicate and negotiate with the designer to determine the solution for a good look and feel.

4. Pass sexual examination. By three-dimensional roaming and referring to the designed transportation path, the process of entering the field of equipment is simulated, and the equipment passability is checked. Provides the basis for the transportation path reserved for the equipment to enter the installation location, and avoids the rework of the project.

Taking the layout of air conditioning wind duct as an example, this paper studies the pipeline automatic layout in BIM Technology Based on Revit.

The purpose of air duct system design is to reasonably organize the air flow, and reasonably determine the structure, size and layout of the air duct on the premise of ensuring the use effect (i.e. distributing the air volume according to the requirements). The purpose of hydraulic calculation of air system is to determine the section size of

each pipe section and calculate the resistance along the pipe section and the local resistance according to the air volume, the size and position of the air supply and return outlets of each system, the selected wind speed of the pipe section and the room air volume determined according to the functional requirements of the room. According to the total pressure loss of the most unfavorable loop pipe section, the residual pressure outside the fan can be determined, which provides data support for the later selection of fan and other equipment models. The duct cross-section area is related to the air volume and wind speed passing through the duct: duct interface area = wind speed / air volume.

It can be seen that under the condition of certain air volume, increasing the wind speed can reduce the cross-section size of the air duct, thus reducing the amount of duct work. However, from the use function, it is not the greater the wind speed, the better, because the increase of wind speed will correspondingly increase the pipeline noise in the pipeline. If the noise exceeds the indoor noise standard, it will seriously interfere with people's work, study and life. In order to eliminate the influence of noise, the operation cost of pipeline will be increased correspondingly. Therefore, it is better to keep the wind speed in the range of economic velocity.

When the HVAC module of BIM hydraulic calculation software carries out the hydraulic calculation of the air duct, it mainly uses the assumed velocity method to calculate the hydraulic pressure of the air system. The software can directly read the model data from the Revit model, extract the information of the wind system, and calculate the whole system. The software can automatically calculate the local resistance coefficient of tee, cross, reducer and elbow, and then calculate the local pressure loss. By reading the size information, velocity and length of the duct, the pressure loss along the system can be calculated automatically. The total pressure loss of the system is calculated. After the calculation is completed, the calculation sheet in Excel format can be exported to facilitate later editing and modification. The calculation function of the software can solve the problem of real-time hydraulic calculation of the wind system in the process of pipeline comprehensive optimization, check whether the optimized wind system meets the design requirements, and provides strong data support for the implementation of the optimization scheme of the wind system. The specific operation steps of wind system hydraulic calculation of BIM hydraulic calculation software are as follows:

1. Check whether the system pipelines of the pipe in the Revit model are connected completely. It is mainly to check whether the main pipe, branch pipe, pipe fittings and pipe accessories of air duct are connected into a system. This is very important for the hydraulic calculation of the extraction wind system in the later stage. If the complete system cannot be extracted, the hydraulic calculation can not be carried out.

2. Open the plan view of the floor air duct system to be calculated, and click the "duct hydraulic calculation" command on the property bar to enter the duct calculation mode.

3. According to the command line prompt: "select the distal end of the first segment of pipe to calculate the branch". After selecting the duct to be calculated, the following window pops up, as shown in Figure 1. It is found that the values of "local resistance

coefficient" and "local resistance" in the table are zero. This is because the software has not yet calculated

4. Click "parameter setting" under the "Settings" menu to set "fluid parameters", "velocity settings" and "calculation parameters". For different building types, the recommended wind speed of main pipe and branch pipe will be different. As shown in Figure 2.

5. The design calculation is based on the air volume, and the software will automatically calculate and select the appropriate duct size, and optimize the pipe segment according to the optimization parameters in the duct settings. Design and calculate the air duct. The software will assign the modified pipe diameter information back to the original model, and automatically modify the pipe segment size in the model. As shown in Figure 3. The software can automatically calculate the pressure loss of each loop of the air system when it carries out the hydraulic calculation of the air duct. The software can view the calculation results of the longest branch, the most unfavorable branch, the most unbalanced branch, and all branches respectively. As shown in Figure 4.

In the current research, only the relevant BIM application and calculation test are carried out on the wind air conditioning pipeline, and there is a lack of research on other aspects of pipeline, such as water supply and drainage pipeline, power pipeline, etc. This is the missing part of this research project. In addition, the volume collision test of pipes in Revit will generate more invalid collision points. These points need to be manually searched, which is also a limited point in this study.

7. Discussion (evaluation and significance)

After the above research and experiment, the automatic pipeline calculation and evaluation system or methodology based on the technology of Revit and BIM is preliminarily formed. The main body of this paper mainly introduces the research of pipeline comprehensive scheme based on BIM. The overall calculation and design process include the basic points of pipeline comprehensive design of BIM, including the basic layout principle, avoidance principle and optimization principle of pipeline comprehensive layout; the basic form of pipeline comprehensive layout and the related basic theoretical research of basic steps. The preliminary preparation of the model, the process of each professional model establishment, the model checking and collision checking. Finally, the paper introduces the hydraulic calculation of water supply, drainage and spray in the wind system and water supply and drainage

system of pipeline integration, analyzes the purpose of hydraulic calculation of each system, the calculation process of each system and the significance of calculation data. Through the hydraulic calculation of each system, the feasibility of the optimized pipeline scheme is checked. The current research results answer some questions raised in the early stage of the research, that is, how to generate pipelines automatically through relevant algorithms or theoretical constraints and control parameters.

However, the current calculation logic process is not well connected with the office environment. Therefore, we can't answer the question of how to optimize the office environment of automation, which is also the initial research goal. There are many factors in the optimization of office environment. At first, the author hopes to take the pipeline layout as the breakthrough point. Through the optimization of the pipeline, to improve the office environment. But in the actual research process, there are some deviations. Therefore, in the follow-up study, we should combine the pipeline layout with the office environment. In the process of assessment, the pipeline layout should be combined with the improvement or improvement of the office environment, but due to the limited time, this part of the content has not been added to my research. At the same time, there are some limitations or improvements in the existing research

1. The current BIM work is based on two-dimensional drawings, so the quality of drawings will greatly affect the workload of model creation and the accuracy of the model. Due to the poor quality of drawings, most of the modelers will have some problems in the process of model creation. Due to the understanding deviation, the model needs to be adjusted constantly, which greatly increases the workload of the modeling personnel.

2. At present, the number of family libraries in Revit is limited. With the increasing demand for model refinement, the existing family libraries can not meet the actual project requirements. Therefore, a large number of new families are needed to meet the growing design requirements. However, the establishment of a new clan is a very complicated thing, which requires a lot of time and energy to conceive in the early stage, and to study and practice continuously in the later stage.

3. At present, in the pipeline collision inspection, most of the collision points detected by the software are invalid ones, which need to be checked manually to screen out the effective collision points. It's also a lot of work. Therefore, the accuracy of the model should be ensured as much as possible in the process of modeling.

Figures: Each figure is numbered and inserted in the text after the first reference to it with one blank line before and after. Figure captions are in 10 pt Times, 11 pt leading, placed below the figure, centered and have the following style:

[FIGURE]

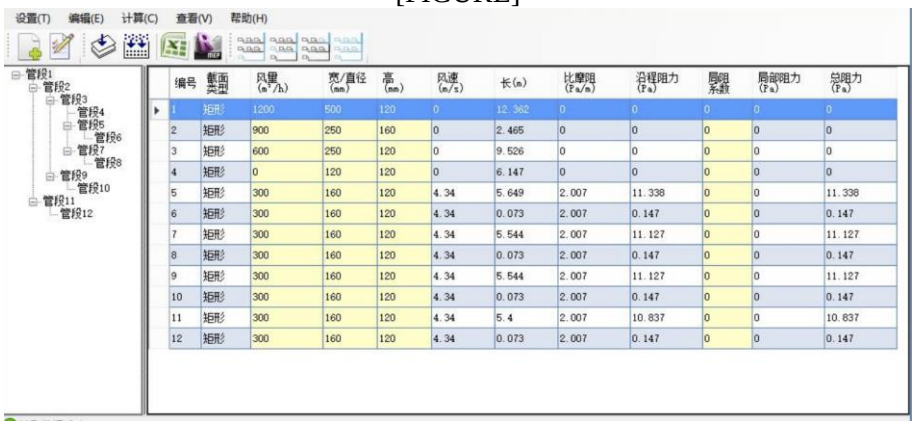

Figure 1. Air duct hydraulic calculation interface

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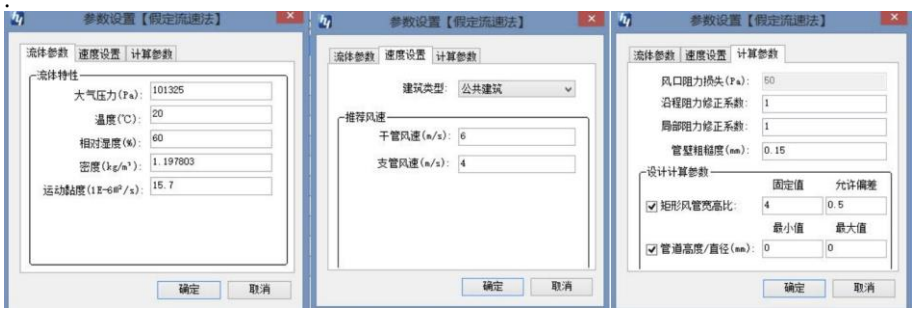

Figure 2. Parameter setting interface

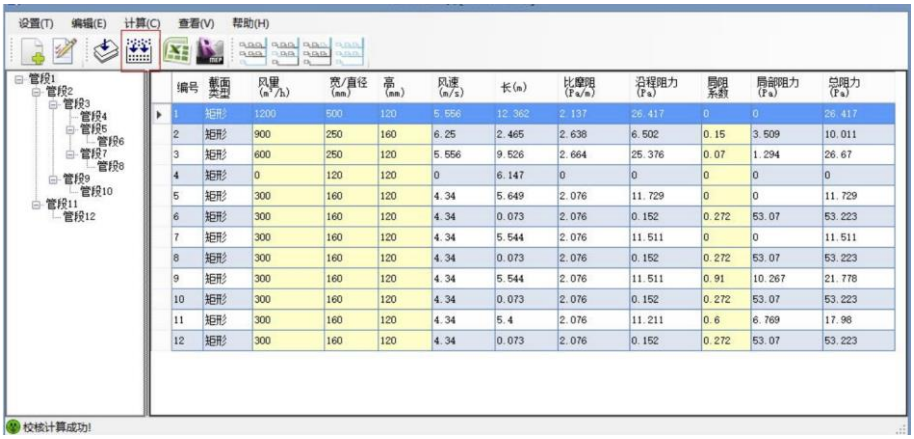

Figure 3. Check design interface

Figure 4. View the calculation results interface of each branch

8. Conclusion

In this paper, the BIM Technology for the determination of the pipeline layout scheme is combed, and the basis, basic form and steps of the pipeline comprehensive arrangement are studied, which provides a theoretical basis for the optimization and adjustment of the pipeline comprehensive in the actual project. Through the software, the hydraulic calculation of each system is carried out to check whether the design parameters of the pipeline meet the design requirements, which provides data support for the feasibility of comprehensive pipeline layout.

Based on the fuzzy comprehensive evaluation method, the comparison and selection of pipeline layout schemes are carried out. The BIM Technology is used to arrange the pipelines in the areas that need to be optimized and adjusted. The comprehensive evaluation index system of pipeline is established from four aspects of pipeline engineering quantity, scheme feasibility, construction difficulty and overall effect of pipeline layout. Through qualitative or quantitative analysis and determination of each evaluation index, the value of each evaluation index is determined, and the evaluation matrix is established. The fuzzy comprehensive evaluation method is applied to comprehensively evaluate the pipeline scheme, and the best pipeline comprehensive engineering construction scheme is finally selected.

Due to the limited personal ability, there are still many deficiencies in this study, which need to be further studied and improved. There are mainly two aspects as follows:

1. The refinement degree of pipeline comprehensive model needs to be improved. At present, in the establishment of pipeline comprehensive model, there is no entity modeling for the cable, piping and wiring in the electrical specialty. When the engineering quantity is counted, the engineering quantity of this part can not be counted in real time. It is necessary to strengthen the research of this part.

2. The evaluation index system of pipeline scheme established in this paper is not perfect, and it needs further study to supplement and improve each evaluation index, so as to form a more reasonable and scientific evaluation index system. Moreover, the current evaluation index system is lack of evaluation standards and data reference, which makes the evaluation results subjective and not objective.

TABLE 1. Table caption.

[TABLE]

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