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Original Research Article

Integration and application of intelligent optical cable laying and low voltage electrical engineering from the perspective of environmental sustainability

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Abstract: Environmental sustainability has become a global concern, and the integrated application of intelligent optical cable laying and low voltage electrical engineering technology, as a key link in the construction of modern information and communication infrastructure, is of great significance in promoting the process of social informatization and facilitating green and low-carbon development. This paper deeply explores the connotation and current situation of intelligent optical cable laying technology and low voltage electrical engineering technology, analyzes the main problems and challenges faced by the integrated application of the two, proposes targeted countermeasures, and demonstrates the effectiveness of the integrated application through practical cases. Research shows that the integrated application of intelligent optical cable laying and low voltage electrical engineering technology not only improves construction efficiency and quality, reduces energy consumption and emissions, but also promotes the green development of the information and communication industry, providing strong support for achieving environmental sustainability goals.

Keywords: Environmental sustainability; Optical cable laying; Low voltage electrical engineering technology; Intelligentization; Integrated application

1. Introduction

With the rapid development of information technology, intelligent cable laying and low-voltage engineering technology, as an important part of information and communication infrastructure construction, play a crucial role in promoting the process of social informatization and enhancing the level of urban intelligence 1. However, with rapid development, it also faces challenges such as large resource consumption and serious environmental pollution, which are contrary to the concept of sustainable environmental development. Therefore, how to achieve the integrated application of intelligent cable laying and low-voltage engineering technology from the perspective of environmental sustainability has become an urgent issue to be addressed.

2. Concepts and current situation

2.1. Intelligent optical cable laying technology

Intelligent optical cable laying technology refers to a new type of technology that uses modern information technology means to intelligently control and manage the process of optical cable laying. It combines various advanced technologies such as sensor technology, Internet of Things technology, and big data analysis, achieving precise positioning, real-time monitoring, and efficient management of optical cable laying. Intelligent optical cable laying technology has advantages such as high construction efficiency, reliable quality, and low cost, and is an important support for the construction of modern information and communication infrastructure. Intelligent optical cable laying technology typically includes the following key aspects:

1. Automated path planning: Intelligent systems automatically find the optimal laying path for optical cables, improving laying efficiency.

2. Intelligent monitoring and data management: During the laying process, the status of the optical cables is monitored in real-time, and through the data management system, construction plans can be adjusted and optimized in a timely manner.

3. Efficient construction: Intelligent equipment is used for laying optical cables, reducing the need for manual labor, and improving construction speed and quality.

4. Enhanced safety performance: Intelligent technology can effectively identify and prevent potential safety risks, ensuring construction safety.

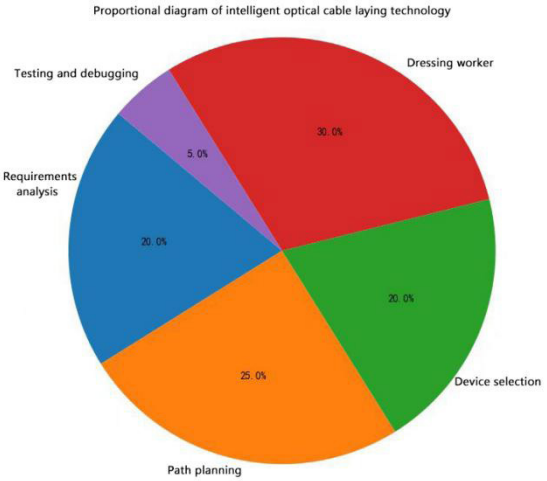

Figure 1. Proportional diagram of intelligent optical cable laying technology.

2.2. Low voltage electrical engineering technology

Low voltage electrical engineering technology refers to electronic information technology involving low voltage and low current, as well as its applications in construction, security, communication, and other fields. This technology encompasses areas such as intelligent building technology, security monitoring, and communication networks. It is an essential part of the information and communication infrastructure construction in modern society. Low voltage electrical engineering technology offers advantages such as fast information transmission speed, large capacity, and high security, providing strong information and communication support for modern society.

2.3. Current status of the integrated application of intelligent optical cable laying and low voltage electrical engineering technology

At present, the integrated application of intelligent optical cable laying and low voltage electrical engineering technology has gradually become the mainstream trend in information and communication infrastructure construction 2. In terms of intelligent optical cable laying, an increasing number of projects are beginning to adopt advanced sensors, Internet of Things, and big data technologies to achieve intelligent control and management of the optical cable laying process. Simultaneously, within the field of low voltage electrical engineering technology, as information technology continues to advance, the functions of systems such as intelligent building technology, security monitoring, and communication networks are constantly being improved, providing a broader application space for intelligent optical cable laying.

3. Main issues and challenges

3.1. Inconsistent technical standards

The intelligent optical cable laying and low-voltage engineering technology involve multiple fields and technical systems, and currently, there is no unified technical standard and specification. This leads to poor compatibility and interoperability between different manufacturers and systems in practical applications, making it difficult to achieve true integrated applications. The lack of unified technical standards not only increases the difficulty and cost of project implementation but may also lead to security risks in information communication.

3.2. Difficult construction

The integrated application of intelligent optical cable laying and low-voltage engineering technology involves cross-construction in multiple professional fields. During actual construction, it is necessary to coordinate the cooperation and collaboration between multiple construction teams and various professional trades. However, due to the technical differences and communication barriers between different professions, construction often faces difficulties and slow progress. In addition, intelligent optical cable laying has high requirements for the construction environment, such as temperature, humidity, electromagnetic interference, etc., which can all affect the performance and lifespan of the optical cables. Therefore, ensuring the quality and safety of optical cable laying in complex and ever-changing construction environments is one of the significant challenges currently faced.

3.3. Information security risks

The integrated application of intelligent optical cable laying and low-voltage engineering technology involves a large amount of data transmission and storage, which brings risks to information security. On the one hand, due to the openness and interconnectivity of information communication systems, they are susceptible to external attacks and intrusions; on the other hand, since intelligent optical cable laying and low-voltage engineering systems often involve sensitive information and critical data, any leakage or alteration can severely affect national security and social stability. Therefore, ensuring information security and preventing information leaks and attacks is one of the urgent issues that need to be addressed.

4. Complex operation and maintenance management

The integrated application of intelligent optical cable laying and low-voltage electrical engineering technology involves the integration and collaborative operation of multiple systems and devices. In the actual operation and maintenance process, real-time monitoring, fault diagnosis, and maintenance of each system and device are required. However, due to the technical differences and complexity between different systems and devices, operational and maintenance management is often difficult and costly. In addition, with the continuous advancement of information technology and the continuous upgrading of systems, operation and maintenance personnel need to continuously learn and master the knowledge and skills of new technologies and new equipment to meet the needs of operation and maintenance work. Therefore, how to establish an efficient and convenient operation and maintenance management mechanism, reduce operation and maintenance costs, and improve operation and maintenance efficiency, is one of the important challenges currently faced.

5. Countermeasures

5.1. Formulate unified technical standards and norms

To address the issue of inconsistent technical standards, it is recommended that relevant departments and industry associations accelerate the formulation of technical standards and norms for the integrated application of intelligent optical cable laying and low-voltage electrical engineering technology. By clarifying technical standards, standardizing interface protocols and communication protocols, the compatibility and interoperability between different manufacturers and different systems can be ensured. At the same time, strengthen the promotion and dissemination of technical standards and norms, improve the recognition and acceptance within the industry, and promote the implementation of technical standards.

5.2. Strengthen construction management and coordination

To address the issue of difficult construction, it is recommended to strengthen construction management and coordination work. On the one hand, establish a comprehensive construction management system and process, clarify construction responsibilities, construction standards, and construction requirements; on the other hand, strengthen communication and collaboration between construction teams, establish an effective coordination mechanism and information sharing platform to ensure information sharing and collaborative work during the construction process. In addition, advanced construction management technologies and methods, such as BIM technology, Internet of Things technology, etc., can be introduced to improve the level of intelligence and efficiency of construction management.

5.3. Strengthen information security measures

To address the issue of information security risks, it is recommended to strengthen information security measures. On the one hand, establish a comprehensive information security management system and regulations, clarify information security responsibilities, information security strategies, and information security measures; on the other hand, strengthen the security protection and monitoring of information communication systems, adopt advanced security technologies and methods, such as firewalls, intrusion detection systems, etc., to improve the security and reliability of the system. In addition, strengthen the protection and management of sensitive information and key data, adopt measures such as encryption, backup, etc., to ensure the security and integrity of the data.

5.4. Establish efficient operation and maintenance management mechanisms

To address the complexity of operation and maintenance management, it is recommended to establish efficient operation and maintenance management mechanisms. On the one hand, establish a comprehensive operation and maintenance management system and process, clarify operation and maintenance responsibilities, operation and maintenance standards, and operation and maintenance requirements; on the other hand, strengthen the training and management of operation and maintenance personnel to improve their professional skills and overall quality level. At the same time, introduce advanced operation and maintenance technologies and methods, such as cloud computing, big data analysis, etc., to improve the level of intelligence and efficiency of operation and maintenance management. In addition, an operation and maintenance service outsourcing mechanism can be established, cooperating with professional operation and maintenance service providers to share the operation and

maintenance work, reduce operation and maintenance costs, and improve operation and maintenance efficiency.

6. Practical cases and analysis

6.1. Smart city construction project

A smart city construction project, which is a key initiative of a municipal government, aims to enhance the level of urban intelligence and service capabilities. The project involves the integrated application of intelligent optical cable laying and low-voltage electrical engineering technology, covering various fields such as building intelligence, security monitoring, and communication networks.

During the implementation process, the project team adopted advanced technology, achieving intelligent control and management of optical cable laying, which improved construction quality and safety. At the same time, through low-voltage electrical engineering technology, intelligent building, security, and communication network systems were constructed, providing efficient services for the city. The project integrated intelligent lighting, security monitoring, and communication networks, achieving building intelligence, enhancing operational efficiency, reducing energy consumption, and improving user experience.

Case analysis shows that the project has achieved significant results in technological innovation, energy conservation and emission reduction, economic benefits, and social benefits. In terms of technological innovation, the project realized precise control of optical cable laying and enhanced the level of intelligence. In terms of energy conservation and emission reduction, the project optimized the optical cable laying path and reduced energy consumption. In terms of economic benefits, the project improved urban service capabilities, attracting investment and talent. In terms of social benefits, the project enhanced the citys security and prevention capabilities, improving the quality of life for residents.

6.2. Intelligent renovation project for an old residential area

The old residential area has long been plagued with outdated security systems and chaotic office communication lines, which not only affected the quality of life of residents but also posed hidden dangers to the safety management of the community. To improve this situation, the renovation project adopted a combination of intelligent optical cable laying and traditional low-voltage electrical engineering technology, specifically addressing the prominent issues of security protection and communication lines in the community.

During the renovation process, the project team applied intelligent optical cable laying technology to key areas such as the perimeter and entrances of the community, building a brand-new security monitoring system. This system upgraded the original analog signal transmission to digital signal transmission, enabling real-time monitoring of the community dynamics and remote monitoring and data storage, effectively enhancing the level of community security protection. At the same time, for the chaotic state of telephone lines and network lines within the community, the project team conducted a comprehensive re-planning. By adopting intelligent optical cables for unified wiring, not only were the communication lines made more tidy and orderly, but signal interference was reduced, and communication stability was improved. In the specific operation of optical cable laying, the project team adopted a new type of cable that can turn and is easy to lay, known as micro-cable. This cable has better flexibility and adaptability, allowing it to be laid without damaging the existing environment of the community.

After the renovation, the communitys security monitoring system had clear images, and the remote monitoring and storage functions were widely praised by residents. The unified planning of communication lines

and the laying of intelligent optical cables not only improved the safety of the community but also enhanced the quality of communication, creating a more comfortable and convenient living environment for residents. The successful implementation of this renovation project provides valuable experience for the intelligent upgrade of other old residential areas.

7. Conclusion

This study delves into the potential and practical effects of integrating intelligent optical cable laying with low-voltage electrical engineering technology, clarifying the significant role of this technology in promoting the process of social informatization and achieving green and low-carbon development goals. Through detailed analysis of specific cases, the study reveals a series of major issues and challenges encountered during the integration process, including the differentiation of technical standards, the complexity of construction processes, and potential risks to information security. In response to these issues, the study proposes practical solutions aimed at promoting the standardization of technology, the smooth progress of construction, and the reinforcement of information security. The results of the case studies indicate that the integration of intelligent optical cable laying with low-voltage electrical engineering technology not only drives innovation at the technological level but also achieves significant results in energy conservation, emission reduction, and efficient resource utilization. It also makes important contributions to enhancing economic and social benefits. These outcomes fully demonstrate the prospects and value of integrated applications. Looking forward, with the continuous advancement of information technology and the ongoing expansion of application fields, the integrated application of intelligent optical cable laying and low-voltage electrical engineering technology will have even broader development prospects. We anticipate that this technology will play a greater role throughout the entire lifecycle, including urban planning, architectural design, construction management, and operation and maintenance services, providing stronger technical support and assurance for promoting environmentally sustainable development. Thus, achieving a harmonious unity of economic, social, and environmental benefits.

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