Journal of Architectural Research and Development

Editor-in-Chief

S. Ravi

Anna University, India

BIO-BYWORD SCIENTIFIC PUBLISHING PTY LTD
(619 649 400)
Level 10
50 Clarence Street
SYDNEY NSW 2000

ISSN (ONLINE): 2208-3537
ISSN (PRINT): 2208-3529

Journal of Architectural Research and Development

Focus and Scope

Journal of Architectural Research and Development is an international peer-reviewed and open access journal which is devoted to establishing a bridge between theory and practice in the fields of architectural and design research, urban planning and built environment research.

Topics covered but not limited to:

- Architectural design
- Architectural technology, including new technologies and energy saving technologies
- Architectural practice
- Urban planning
- Impacts of architecture on environment

About Publisher

Bio-Byword Scientific Publishing is a fast-growing, peer-reviewed and open access journal publisher, which is located in Sydney, Australia. As a dependable and credible corporation, it promotes and serves a broad range of subject areas for the benefit of humanity. By informing and educating a global community of scholars, practitioners, researchers and students, it endeavors to be the world's leading independent academic and professional publisher. To realize it, it keeps creative and innovative to meet the range of the authors' needs and publish the best of their work.

By cooperating with University of Sydney, University of New South Wales and other world-famous universities, Bio-Byword Scientific Publishing has established a huge publishing system based on hundreds of academic programs, and with a variety of journals in the subjects of medicine, construction, education and electronics.

Publisher Headquarter

BIO-BYWORD SCIENTIFIC PUBLISHING PTY LTD
Level 10
50 Clarence Street
Sydney NSW 2000
Website: www.bbwpublisher.com
Email: info@bbwpublisher.com

September 2022, Volume 6 Issue 5

Table of Contents

1 **Study on the Carbon Effect of Agricultural Land Remediation Based on the Carbon Peaking and Carbon Neutrality Goals**
Hua Guo, Hongyun Li, Hangzhou Zhang

8 **Analysis on Reformation of Digital Management Education of Prefabricated Construction Project Under the Background of Intelligent Construction**
Juan You

14 **Research on Construction Technology of Prefabricated Structure Based on BIM Technology**
Shan Zhao, Lin Zhang

20 **Risk Management of Large Infrastructure Projects: Risk, Uncertainty, and Complexity**
Zhen Liu, Lijie An, Dong-Joo Kim, Junyou Liu

25 **Research on Construction of Bill of Quantities of Prefabricated Buildings Based on BIM**
Xiangxiang Liu

31 **Research on the Current Situation and Countermeasures of Building a Beautiful Countryside Under the New Urbanization**
Lei Zhang

37 **Analysis of the Degree of Convenience of Xi'an Metro Station**
Baoping Zeng, Yonggang Li, Wanglong Jia, Hengbo Luo

42 **Comparison of Illuminance in Different Environments: A Case Study on Subway Stations**
Tao Wang, Jie Su

Call for papers – Journal of Architectural Research and Development

ISSN (Online): 2208-3537
ISSN (Print): 2208-3529

Submission open for November - 2022

Dear Researchers,

Journal of Architectural Research and Development is an international peer-reviewed and high quality open access journal which is devoted to establish a bridge between theory and practice in the fields of architectural and design research, urban planning and built environment research.

The Journal Publishes in both online and print version. *Journal of Architectural Research and Development* publishes research and review paper in the field of:

- Architectural design
- Architectural technology, including new technologies and energy saving technologies
- Architectural practice
- Urban planning
- Impacts of architecture on environment

The *Journal of Architectural Research and Development* is published by Bio-Byword Scientific Publishing Company, it is a fast growing peer-reviewed and open access journal publisher, which is located in Sydney, Australia. As a dependable and credible corporation, it promotes and serves a broad range of subject areas such as medicine, construction, education and electronics for the benefit of humanity. By informing and educating a global community of scholars, practitioners, researchers and students, it endeavour's to be the world's leading independent academic and professional publisher.

All Bio-Byword journals are free from all access barriers, allowing for the widest possible global dissemination of their manuscripts and highest possible citations. Bio-Byword publisher online submission will go through a rapid peer review and production, making the process of publishing simpler and more efficient, which benefit from its user friendly online submission system that reduces the overall time from submission to publication.

Acceptance Notification: Within 21 days from the date of manuscript submission

Send your manuscript to the editor at: **info@bbwpublisher.com**

With Warm Regards,
Editor in Chief
Dr. Ravi S.
Journal of Architectural Research and Development

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Study on the Carbon Effect of Agricultural Land Remediation Based on the Carbon Peaking and Carbon Neutrality Goals

Hua Guo*, Hongyun Li, Hangzhou Zhang

Weinan Branch of Shaanxi Land Engineering Construction Group Co., Ltd., Weinan 714000, Shaanxi Province, China

****Corresponding author:*** Hua Guo, 865702953@qq.com

Abstract: With the goal of achieving carbon peak and carbon neutrality, this paper studies the carbon effect of agricultural land remediation. In this paper, the carbon effect mechanism and calculation method of land consolidation, the proposed national carbon peaking and carbon neutrality goals, and the requirements put forward by agricultural land consolidation followed were analyzed. Then, the application research on the carbon effect accounting of agricultural land consolidation was conducted. Besides, the application process of carbon effect accounting of land consolidation with the goals of carbon peaking and carbon neutrality. Therefore, we hope this study will play an effective role to advance the carbon effect research in the regulation of agricultural land.

Keywords: Land consolidation; Carbon peaking and carbon neutrality goals; Agricultural land remediation; Carbon effect

Online publication: September 15, 2022

1. Introduction

Climate change caused by greenhouse gas emissions has become a major challenge for human development that needs to be addressed. In September 2020, China has put forward the goals of 2030 carbon peak and 2060 carbon neutralization, and at the same time introduced the carbon peaking and carbon neutrality goals into the overall layout of ecological civilization construction. In order to achieve carbon peaking and carbon neutrality, all sectors of society need to be actively involved, including industry, agriculture, land governance, and so on. Therefore, by exploring the carbon effect from agricultural land remediation, it will be effective in promoting the implementation of the carbon peaking and carbon neutrality goals.

2. Mechanism and accounting method of carbon effect of land remediation

(1) Carbon effect mechanism of land remediation

The carbon effect mechanism of land remediation is to comprehensively improve the area and quality of effective cultivated land and optimize and improve land production conditions by using a series of technologies such as land leveling technology, irrigation technology, drainage technology, field road construction, farmland protection technology and ecological environmental protection [1]. Based on the analysis of the carbon effect mechanism of agricultural land remediation, its carbon effect is mainly reflected in the three dimensions of project implementation, land structure and land use [2]. The implementation of the carbon effect of the project is to change the regional land use structure through effective land remediation, and reduce the disturbance of external factors to the land carbon balance from the perspective of ecosystem [3]. The carbon effect of land structure is based on the regulation of land, which effectively develops a series of low-efficiency land plots in the region, such as wasteland, ridges, barren pits and ponds, effectively adjusts the structural layout and spatial layout of land use, and realizes the transformative carbon effect. The carbon effect of land use is to realize the scale and mechanization of land use through effective regulation according to the land characteristics, promote more mature production conditions, and significantly improve the supporting production functions such as farmland transportation, protection, irrigation and drainage [4].

According to comprehensive analysis, the regulation of agricultural land is based on the regulation of agricultural land. After the project is approved, based on the leveling project, irrigation and drainage project, farmland protection project and road construction, the carbon effect of three dimensions of land structure change, project implementation and land use mode will be finally realized [5].

(2) Carbon effect accounting method.

First of all, for the calculation of the carbon effect of the project implementation, it is necessary to confirm the carbon source nodes in the project implementation stage, that is, the consumption of steel materials and cement materials in the construction stage, and the energy consumed in the construction stage, such as electric energy, water resources, gasoline, diesel, etc. The carbon emission of production materials and energy consumption can be calculated based on the material balance algorithm, that is, the consumption of materials and energy consumption are multiplied by the corresponding carbon emission coefficient, and the calculation expression is as follows:

$$C_p = \sum_{j=1}^{n} E_j * f_j \tag{1}$$

In equation (1), C_p is the carbon emission generated by material consumption and energy consumption during the construction stage of agricultural land remediation project, with the unit of kg. .E_j refers to the usage of different energy and materials, and the unit is kg.Then f_j refers to the carbon emission coefficient during the consumption of various materials and energy

Secondly, in the calculation stage of carbon effect of land structure, the carbon reserves of different land use types can be calculated based on soil carbon reserves and vegetation carbon reserves. The calculation is based on the carbon density of soil and vegetation combined with the area of different land use types. The calculation expression is as follows:

$$C_s = \left(C_{s_{final}} - C_{s_{final}}\right) = \sum_{i=1}^{n} L_i(S_i + P_i) \tag{2}$$

In equation (2), C_s, $C_{s_{final}}$ and $C_{s_{initial}}$ are the changes of total carbon reserves in the project area before and after the regulation respectively. The other reserves in the project area after and before the regulation, both use the unit kg. L_i, S_i and P_i are the area changes of I land use types before and after remediation, soil carbon density and vegetation carbon density of I land use types, respectively. The units are m^2, kg/m^2, kg/m^2

Finally, the carbon effect of land use is calculated mainly based on the economic output of crops, the average economic coefficient and water content of major crops, and then combined with the carbon absorption of crops. The expression is shown in equation (3):

$$C_{i_{absorption}} = (1 - W_i) * \frac{1}{H_i} * f_{i_{absorption}} \tag{3}$$

In equation (3), $C_{i_{absorption}}$ represents the carbon absorption of class I unit crops, in kg/kg, W_i represents the average moisture content of class I unit crops, and the unit is in %. H_i represents the economic coefficient of class I crops, the unit is in %. The carbon emission of crops per unit yield is calculated by equation (4):

$$C_{i_{emission}} = C_{ia} + C_{ib} \tag{4}$$

In equation (4), the carbon emission per unit crop of class I is $C_{i_{emmision}}$, and the unit is kg/kg. C_{ia} and C_{ib} are respectively the carbon emissions of class I unit crop production stage and ecosystem, both in kg/kg. Combined with the above equations 3 and 4, the carbon sequestration and carbon emission per unit output of different crops in agricultural land are calculated. At the same time, based on the annual change value of carbon net sink before and after the land remediation project, the carbon effect after the transformation of the utilization mode of excavated land can be comprehensively reflected. The calculation expression is shown in equation (5):

$$C_g = \sum_{i=1}^{n} Y_i \left(C_{i_{absorption}} + C_{i_{emission}} \right) \tag{5}$$

In equation (5), the change value of annual net carbon sink before and after land remediation is C_g, and the change value of annual economic output of class I crops after land remediation is Y_i, and the unit is kg.

2. Requirements for agricultural land regulation in order to achieve carbon peak and carbon neutrality

(1) The connotation of the carbon peaking and carbon neutrality goals

The "Global Warming Of 1.5°C Special Report" released by Intergovernmental Panel of Climate Change (IPCC) pointed out that if we are unable to control the pace of global warming to 1.5 °C, the climate will continue to deteriorate, at that time, a large amount of natural systems function, structure degradation, will produce a permanent shift after the break through the threshold. However, the current voluntary emission reduction sharing submitted by all countries in the world may not be able to implement the target proposed in the Paris Agreement [6]. Because of this, China has made a commitment to achieve carbon peak and carbon neutrality. In order to effectively and truly contribute to China's efforts in global climate governance, China's relevant functional departments began to rapidly adjust and transform the energy structure and industrial structure, and boost the research and development of low-carbon technologies, in order to achieve carbon peak and carbon neutrality by 2030 and 2060 [7].

(2) Path to achieving "double carbon" goal from the perspective of land regulation

From the perspective of land consolidation, the path to achieve the "double carbon" goal includes four directions: agricultural land consolidation [8], the consolidation of construction land, the protection and restoration of rural ecology, and the protection of rural history and culture [9]. In 2019, the Ministry of natural resources issued the document "Notice on Carrying Out Comprehensive Land Remediation Throughout the Region", which clearly pointed out two "5% requirements," namely: the area of new permanent basic farmland should not be less than 5% of the adjusted area; the area of new cultivated land in the remediation area should not be less than 5% of the original cultivated land area; as well as providing clear guidance on the increase of cultivated land area; and the centralized remediation of fragmented cultivated land [10].

(3) Analysis on the relationship between carbon peaking and carbon neutrality goals and agricultural land regulation.

The special report on global warming of 1.5 °C issued by IPCC points out that agriculture, forestry and other land use activities have played an effective role in achieving global warming below 1.5 °C, slowing land degradation, protecting biodiversity, restoring ecosystem functions and developing sustainable agriculture [11]. In 2018, TNC Nature Conservation Association found in its research that ecosystem restoration and protection for farmland, forests, grasslands and wetlands can effectively achieve the goal of controlling global warming up to 2 °C in the Paris Agreement, and can contribute 37% to the mitigation potential of climate change. Land use and land management greatly affect the emission level of greenhouse gases [12]. Some scholars pointed out that the reduction of cultivated land area and the transformation of a large area of cultivated land into construction land will increase carbon emissions and reduce the carbon sequestration capacity of the ecosystem. Therefore, increasing the area of cultivated land and regulating agricultural land can effectively reduce carbon emissions, improve the soil organic carbon content and carbon sequestration capacity, and increase green carbon sink [13].

3. Research on the application of carbon effect accounting of land remediation under the carbon peak and carbon neutrality goals

(1) Basic data processing of carbon effect calculation of land remediation

During the calculation of the carbon effect of land remediation, it is first necessary to sort out the regional data of the land remediation project, including the collection of engineering materials and energy consumption data in the land remediation project. At the same time, around the project budget, the quantities, energy consumption of machine shifts, and unit price of construction materials are classified item by item, and the carbon emission coefficient of the whole region is calculated based on the calculated materials and energy consumption. After data processing and collection, the carbon effect of project implementation, land structure and land use can be calculated in combination with the carbon effect calculation method of land remediation in **Part 1** of this paper.

(2) Calculation and analysis of carbon effect of project implementation

Combined with the carbon effect c method from the perspective of the implementation of the former cultural and industrial agricultural land remediation project, on the basis of understanding the regional carbon emissions and carbon sinks of the agricultural land remediation and construction project, and mastering whether the agricultural land remediation and construction area is in the state of carbon source, first, it is necessary to calculate the carbon emissions consumed by the construction materials such as cement, steel and wood in the implementation stage of the project, and calculate the carbon emissions caused by the energy consumption of electricity, diesel, gasoline and so on. Secondly, based on formula calculation, it is necessary to analyze the carbon emissions of land leveling, irrigation projects and drainage projects from the dimension of project category, and master the carbon emissions of field road construction projects. Lastly, it is necessary to calculate the carbon sink of farmland protection projects, and analyze the amount of carbon emission offset achieved by farmland protection projects. **Table 2** shows the calculation results of carbon effect from the perspective of project implementation in a certain agricultural land remediation project:

Table 2. Carbon emissions of construction materials and energy consumption of an agricultural land remediation project

Type of work	Material Science	Steel products	Cement	Gasoline	Electric energy	Glass	Diesel oil	Lime
Land leveling	Carbon emissions	0	0	0	0	0	1272	0
Irrigation and drainage work	Carbon emissions	1494	3792	124	432	3	197	50
Field road works	Carbon emissions	0	1144	0	16	0	61	0
Farmland protection	Carbon emissions	0	0	0	0	0	0	
Total carbon emissions		1494	4946	124	448	3	1530	0

As shown in **Table 2**, based on the calculation formula in **Part 1** of this paper, the carbon emissions of construction materials and energy consumption of an agricultural land remediation project are obtained. In this project, irrigation works and drainage works have the highest carbon emissions, and field road works have relatively serious carbon emissions in terms of cement consumption [14].

(3) Calculation and analysis of carbon effect of land structure

The carbon effect of land structure is the impact on the regional carbon balance after the change of land use structure. Based on the calculation method in the first chapter of this paper, we can get the increase of agricultural land, the decrease of construction use, the decrease of water areas dominated by rivers and ponds, and the decrease of unused land under the background of agricultural land remediation projects. Finally, combined with the calculation formula, we can master the increase level of carbon reserves under all land use types, including cultivated land area, irrigated land area, dry land area, farmland roads, ditches, ridges and pond water surface changes in carbon storage caused by changes in grassland area. Generally, the increase of cultivated land area will bring the most significant effect of increasing carbon reserves, while the decline of land use structure such as water area, grassland and unused land will also increase carbon reserves to a certain extent.

(4) Calculation and analysis of carbon effect of land use

After the implementation of the remediation project, the following analysis can be carried out under different land use based on the calculation formula in the first chapter of this paper. At present, under the background of agricultural land regulation, the main land use will be according to different regional climate environments, thus plant different crops to achieve the carbon effect goal, and different land structures will usually adopt different uses. In the middle region of China, the rice ↔ wheat crop rotation form is usually used under the paddy field structure, and the dry field structure and irrigated land structure, which usually uses the wheat ↔ wheat crop rotation form.

Generally speaking, the exertion of carbon effect is not only expressed in terms of carbon sink, but also reflected based on the increase of crop yield. For example, after the remediation of agricultural land in rural areas of a province, the annual net carbon sequestration was 23088 t before the remediation, and after remediation, the annual net carbon sequestration was increased to 28547 t. When rice ↔ wheat rotation was used in paddy field and wheat ↔ rape rotation was used in dry field and irrigated land, the yield of rice, wheat and rape was significantly increased after the remediation, and the yield of rice was increased from 8201kg/hm^2 before the remediation to 8944kg/hm^2 after the remediation. The single yield of wheat increased from 3970kg/hm^2 before the regulation to 5740kg/hm^2 after the regulation, and the single yield of rape increased from 1670kg/hm^2 before the regulation to 2280kg/hm^2 after the regulation, which fully indicates that under the background of agricultural land regulation, reasonable choice of utilization methods will also obtain different carbon effect harvest [15].

4. Conclusion

Irrigation and drainage projects account for relatively high carbon emissions in agricultural land remediation projects, and the use of construction materials such as cement and steel is the main source of carbon emissions. Increasing the area of cultivated land can effectively increase the carbon storage of regional agricultural land and the annual net carbon sink of the region. In addition, different ways of land use after land remediation will produce different carbon effects. Therefore, this paper suggests that our local governments should speed up the process of land remediation in rural areas to effectively to achieve the dual carbon goal.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Cheng YQ, 2020, Research on Carbon Effect Calculation and Decision Optimization of Land Remediation Projects, dissertation, Jiangxi University of Finance and Economics.

[2] Sheng Y, Liu X, Zhang S, 2020, Study on Carbon Benefit of Land Remediation Project in Shache County, Xinjiang. Northeast Agricultural Science, 45(01): 119–128

[3] Zhang Z, Hu B, Zhang S, Wei J, 2019, Analysis and Calculation of Carbon Effect of Temporary Land Reclamation- A Case Study of Guangxi. Journal of Agricultural Resources and Environment, 36(06): 744–756

[4] Li Z, 2016, Study on the Carbon Effect of Agricultural Land Remediation Based on Comprehensive Land Use Characteristics and Engineering Characteristics, dissertation, Nanjing University.

[5] Yu R, Huang X, 2019, Study on Expansion Scale of Construction Land Under Peak Carbon Emission Control. China Population, Resources and Environment, 29(7): 66–72

[6] Yang B, Bai Z, 2019, Study On Low-Carbon Land Use in Open-Pit Coal Mine Area. China Mining, 28 (6): 89–93

[7] Jin Z, Wang J, 2019, Analysis on the Decoupling Relationship Between Land Use Carbon Footprint and Economic Growth in Shandong Province Jiangsu Agricultural Science, 47(6): 310–314

[8] Zhou X, 2019, Analysis of Land Remediation Technology System Integrating Soil Remediation. Low Carbon World, 9(8): 54–55

[9] Guo W, 2019, Research on the Planning of Low-Carbon Ecological Villages in Jiangxi Province-Taking Xialaogang Village, Shuibei Town, Xinyu City as an Example, dissertation, Nanchang University

[10] Wu J, Su M, Su S, et al., 2021, Research on the Path of Comprehensive Land Remediation in the Whole Region Under the Goal of “Double Carbon”. China's Land and Resources Economy, 34(12): 77–83

[11] Li X, Min X, 2022, Research on Carbon Emission Reduction Driving the High-Quality Development of China's Manufacturing Industry Under the “Double Carbon” Goal. Innovation and Technology, 22 (05): 57–70

[12] Song G, Wang Y, Lou Y, 2021, Design of Carbon Emission Control Policy Based on “Double Carbon” Target. China Population, Resources and Environment, 31(9): 55–63

[13] Wang H, Wu C, 2022, Research on the Approach of Rural Ecological Environment Governance Under the Background of "Double Carbon" Goal. Journal of Anhui Vocational and Technical College Of Commerce and Trade, 21(2): 43–48

[14] Zhang N, 2021, Ecological Protection and High-Quality Development Path and Policy Design of the Yellow River Basin Under the Goal of “Double Carbon”– Speech at the 5th Lu Qing Forum "Yellow River Basin Carbon Peak and Carbon Neutralization Path Summit Forum". Journal of Qinghai Normal University: Social Science Edition, 43(4): 13–17

[15] Wang S, Zhu F, 2022, Research on Realizing the Goal of "Double Carbon" Under the Overall Layout of Ecological Civilization Construction. China Residential Facilities, 2022(3): 125–129

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Analysis on Reformation of Digital Management Education of Prefabricated Construction Project Under the Background of Intelligent Construction

Juan You*

Chongqing Institute of Engineering, Chongqing 40056, China

***Corresponding author:** Juan You, baicaoyoyo@163.com

Abstract: Prefabricated building is an important building development mode at present. It can improve the development speed and production efficiency of the construction industry, reduce the labor intensity of construction, play an important role in the development as well as the modernization of the construction industry. Due to the late development of prefabricated buildings, the talent training of prefabricated buildings lags behind, causing the development of prefabricated buildings to not achieve its required target. Therefore, the characteristics of intelligent construction need to be incorporated, the education of prefabricated buildings needs to be reformed, the education regarding digital management of prefabricated buildings should be improved, and more professional talents should be nurtured.

Keywords: Intelligent construction; Prefabricated building projects; Digital management courses; Reformation of education

Online publication: September 15, 2022

1. Introduction

With the development of national economy, science and technology, and the strategic goal of sustainable development, prefabricated building construction has become an important development direction in current architecture. Prefabricated building construction promotes the scientific and mechanized development of construction engineering and provides a greater driving force for the development of the construction industry. Colleges and universities also need to keep pace with the development of the construction industry and improve the training of prefabricated construction talents. Especially in the context of intelligent construction, digital management courses should actively be developed based on prefabricated construction projects according to the latest needs of the current construction industry, so as to provide corresponding talent teams for prefabricated construction projects under intelligent construction.

2. Connotation of digital management of assembly type construction project under the background of intelligent construction

2.1. Intelligent construction

With the proposal of the strategic goal of "made in China", it was proposed the strategy of building a strong country. The construction industry also integrates the latest development of modern technology into construction, make full use of network and digital technology to form intelligent buildings, and change the traditional extensive management mode. Intelligent building refers to the digitalization of all elements in the building. Intelligent building promotes the digitalization of the project through network interaction, modeling and large-scale calculation, and realizes the integrated development of construction project planning, design, construction, operation and maintenance [1]. In this way, it provides green and intelligent building services and building models to the owners.

2.2. Prefabricated construction project

With the development of economy, China's construction industry has entered a new stage of development, which provides a huge driving force for the development of the national economy and also promotes the further development of related ancillary industries. However, with the increase of cost of labor, the deterioration of ecological environment and the increasing pressure of market competition, the traditional extensive construction method cannot meet the current development of the construction industry. In order to enhance the core competitiveness of construction enterprises, the construction industry continues to innovate new construction mode in order to further the development of prefabricated buildings. Prefabricated buildings emphasize the standardization and integration of design, and transfer the construction of basic accessories in traditional buildings to factories for processing. For example, the balconies, floors, stairs, and other parts of the building are assembled and connected after being transported to the construction site. Because the components of prefabricated buildings are processed in factories, the use of standardized equipment can ensure the standardization of component processing and improve the production efficiency of components. Besides, mass production can also reduce processing costs. Therefore, with its own development advantages, prefabricated architecture has become an important form in the current social development. However, there are still some limitations in the application of prefabricated buildings in China. Prefabricated building is the mainstream trend in the current development of the construction industry, which meets the development requirements of the construction industry. With the development of industrialization of construction, prefabricated buildings are gradually becoming popular. However, from the current implementation of prefabricated buildings, industrialization and process development are relatively slow, and the digital management mode has not yet been formed. It is still necessary to further the technical research and effectively solve various problems in the development and application of prefabricated buildings through the development of intelligent buildings [2].

2.3. Digital technology

Digital technology refers to the use of network technology, computer technology and other information processing and computing to ensure the efficiency and accuracy of information analysis. Digital technology can facilitate the transformation of all kinds of information to digitalization and form a digital management model. Digital technology is a type of virtualized program based on computer and network technology. At present, the digital technology of prefabricated buildings mainly focuses on building information modeling (BIM) technology, forming the construction of a full life cycle system, promoting information sharing, and making the prefabricated buildings fully apply the Internet of things (IoT) technology and intelligent technology for improvement. The digital assembly building mainly aims at BIM design, precision measurement and control, mechanical installation, information management and so on.

3. The principle and necessity of digital education of assembled building projects under the background of intelligent construction

3.1. Principles of digital teaching of prefabricated construction projects

In the education of prefabricated building projects, it is necessary to ensure uniformity in the design of syllabus. From the current situation of project-based teaching of prefabricated building construction in China, a systematic project-based teaching will be required, including aspects of project selection, design, participation in implementation and evaluation. At the same time, corresponding standards needs to be set for each lesson to ensure that the teaching of each lesson is factual and based on evidence. Besides fairness and impartiality of teaching needs to be ensured, which will be conducive to the teaching evaluation. Secondly, the project-based teaching of prefabricated building construction needs to ensure the scientificity of the project. The quality of prefabricated construction project teaching directly affects students' theoretical study and development of professional skills. In the prefabricated building project, the rationality of the design needs to be and the relevance of the project to the teaching content need to be ensured, so that students can apply the knowledge in the classroom and expand students' thinking and ability through project participation [3].

3.2. The necessity of digital education of assembled building projects under the background of intelligent construction

Construction industry is an important industry in the development of our national economy, which directly affects the level of national economy and the development of upstream and downstream industries. Through the survey of China's gross national product, the proportion of construction industry is close to 25%, which shows that construction plays a vital role in China's economic development. However, there are still some flaws in the development of China's construction industry, such as outdated construction methods, traditional management concepts and high labor-intensity. At the same time, the construction industry is also a relatively heavy pollution industry in China. Therefore, the construction industry needs to focus on labor intelligence and digitalization, make full use of the development opportunities of the industrial revolution, formulate the development goals of intelligent manufacturing based on the national conditions, improve the traditional production mode of the construction industry, and improve the construction productivity. However, the transformation process from traditional buildings to intelligent construction is difficult, and talents are an important support to promote this transformation. Therefore, intelligent buildings have higher requirements for talents. However, due to the late development of intelligent buildings and prefabricated buildings in China, and the development of various fields are composed of multiple disciplines, including engineering, management, architecture and other disciplines. In recent years, the number of colleges and universities offering Engineering Management Majors in China has been increasing. In light of the development of intelligent buildings, it is also necessary to reform the digital teaching of prefabricated buildings and upgrade classroom teaching systems. With the arrival of intelligent construction era and the development of digital prefabricated buildings, it is necessary to optimize talent training and increase innovation in teaching mode.

4. Education system of digital management of prefabricated construction projects

4.1. Clarify the construction objectives of the teaching system

The digital management of prefabricated construction projects emphasizes that in the construction project management, it is necessary to combine all construction links, make use of network technology, computer technology and other information technology means and teaching methods, improve the construction project management ability, promote the communication between all participants in the construction project, and reasonably control the construction cost. It is necessary to promote the coordinated development of construction project management, so that prefabricated construction projects can achieve efficient, high-quality, green development, and be further popularized. Therefore, in the teaching of prefabricated architecture in colleges and universities, it is necessary to emphasize on developing the students' practical ability. Based on the current situation of assembly teaching in colleges and universities, the focus is mainly on theoretical and conceptual content, which leads to the lack of working ability and innovation of students after graduation. In order to improve the digital management teaching system of prefabricated construction projects, it is necessary to analyze from multiple angles and innovate the integrated, visual and network technology teaching of prefabricated construction projects. It is necessary to effectively solve the problems of design, production, assembly and management in the construction production, and provide multi-dimensional and multi angle data information for the project work. It is necessary to ensure smooth implementation of various management works of the project and the effective implementation of management objectives, strengthen the sharing and transmission of information in project management, and ensure the improvement of assembly construction project management efficiency [4]. In addition, the digital teaching platform can be used as an important auxiliary tool in the digital project teaching of prefabricated buildings. The effective combination of project cases and information tools through visual simulation teaching methods and teaching means is conducive to changing the problems of unscientific teaching methods and non-ideal means of teaching in the traditional prefabricated building teaching. Besides, it stimulates the students' interest in learning, and improves the boring teaching atmosphere in traditional classroom teaching. In addition, it also allows students to carry out on-site operation in practice which was not possible previously.

4.2. Construction of digital management system organization for prefabricated construction projects

4.2.1. Information system

The construction of digital management system of prefabricated construction project includes information system, project display and data interaction system. Firstly, in the construction of prefabricated building management information system, cloud platform and mobile apps are the main information management carriers. In the cloud platform, the project information management is taken as the main reference for the system construction. The system needs to improve the analysis and maintenance of the basic information of the project and the data of construction materials, so as to better connect and integrate the information of each project stage, and optimize information management of the whole construction project process. BIM technology mode is applied to compress and restore data, so that the management mode can achieve lightweight development. Web pages and web browsers can be used to browse and analyze the floors and components of the building model from multiple angles to understand the information content of each component [5]. After completing the production of components, manufacturers should mark each component, so that each component can generate a two-dimensional code as the identification of components, which is conducive to the understanding and positioning of component information by users in all links of components. The teaching reform of this part is conducive to stimulate students' awareness of practical innovation, and can apply modern technical means to strengthen management innovation [6]. At the same time, component subscribers can also view the list and parameters of components through the cloud platform. Component manufacturers can input the production time, specification, completion time and other information of components through the cloud platform. In addition, the BIM model can also be used to visually observe and statistically analyze the progress of the project, display the status of components, and form a visual engineering progress observation system according to the planning requirements of prefabricated construction projects and the actual production progress of components. Through the construction of BIM model, the investment situation, project construction technology, payment amount, etc. in different stages of the project are limited [7]. It is necessary to build a professional knowledge base to collect, sort, classify and index various data of prefabricated building components, so as to form automatic deletion projects and preview and download documents [8]. Personnel, authority, and responsibilities can be allocated accordingly through the information management of institutions, personnel, processes and logs. Combined with the form of enterprise collection management, the branches of enterprise structure can be determined. Besides, the students' understanding of the content of construction enterprise management and the application of modern technical means can be improved.

The construction of mobile app mainly focuses on the application of logistics and warehousing. By scanning the QR code of components, the information of components is directly transmitted to the cloud platform, and other related personnel can query the component information by logging in to the app. After the components are transported to the construction site, the material management personnel need to start the QR code for warehousing scanning, so that the status of components can be known by scanning the QR code in the later component application. After the installation of components is completed, it is necessary to scan the supervision QR code again to confirm that the components have been installed. The construction progress and overall image of the project can be queried through the QR code.

4.2.2. Project display system

The assembled project display system adopts the way of large screen simulation, and operates the system through login account and password. Students can conduct system simulation operations in combination with their assigned roles, and do a good job in data collaboration and data connection in all aspects according to the business development process. According to the requirements of prefabricated buildings, students are divided into different roles such as design department, construction department, component manufacturer, construction unit and transportation unit to carry out the actual operation of the project. Students can simulate the path and set coordinate points by themselves through Baidu map. Then, they can use GPS navigation equipment to simulate and analyze the logistics situation, forming a simulated dynamic tracking system [9].

4.2.3. Data interaction system

In the teaching of digital management of prefabricated construction projects, data exchange can be realized through the construction of cloud platform and related apps. Web service technology can be used to transmit data, and protect data through encryption algorithm to prevent data from being intercepted in the digital management system of prefabricated construction projects. The data interaction includes the data of component production progress, logistics and quality inspection. It is necessary to guide students to find data information through the software platform, and make project planning in combination with the data information [10]. Revit model can be combined with app to convert data format, lighten the model and transfer data. It is displayed on the software and cloud platform for users, so that users can log in to the system anytime and anywhere to view. Different systems and software can also be used through format conversion to avoid affecting the efficiency of information transmission due to incompatibility. It is necessary to use diversified systems and software to expand students' project development ideas.

5. Conclusion

In conclusion, the digital management of prefabricated building projects in the context of intelligent construction provides strong technical support for the development of the construction industry, improves the production efficiency of prefabricated buildings and reduces costs. It can realize the visualization and dynamic management of the project. The teaching of digital management of prefabricated construction projects in colleges and universities should be in line with the current development status of the construction industry, make full use of digital technology, cloud platform, visualization technology and other simulated teaching environment, provide convenience for project-based teaching, and help students master the most advanced construction technology.

Disclosure statement

The author declares no conflict of interest.

References

[1] Ding X, 2021, Research on The Teaching Reform of Assembly Building Construction Technology "Course Ideological and Political". Low Carbon World, 11(10): 175–177

[2] Shi Y, 2022, Teaching Reform and Practice of Prefabricated Building Construction Course Based on BIM Technology. China Residential Facilities, 2022(3): 130–132

[3] Lu H, Liu J, 2021, Teaching Reform of Building Safety Course Under the Trend of Prefabricated Building. Shanxi Architecture, 2021, 47(9): 181–183

[4] Liu W, 2021, Research on Teaching Reform of Prefabricated Architecture Course in Higher Vocational Education Based on BIM Technology. Green Technology, 23(11): 256–259

[5] Jiang X, 2020, Curriculum Reform of Prefabricated Architecture Teaching in Higher Vocational Architectural Engineering Specialty. Building Materials and Decoration, 2020(17): 186 + 189.

[6] Wang C, 2019, Analysis of Curriculum Reform of Prefabricated Architecture Teaching in Higher Vocational Colleges. The Work of Nature, 2019(10): 58.

[7] Wu W, 2021, Curriculum Reform of Prefabricated Architecture Teaching for Construction Engineering Majors in Secondary Vocational Schools. Building Materials Development Orientation (II), 19(4): 32–33.

[8] Wang P, Wang M, 2020, Teaching Reform and Practice of Modular Architecture Under Virtual Simulation. Laboratory Research and Exploration, 39(4): 174–177 + 190

[9] Zhang J, 2021, Research on the Reform Path of Prefabricated Architecture Teaching Curriculum for Construction Engineering Majors in Higher Vocational Colleges Brick and Tile, 2021(8): 67-68

[10] Yang X, 2019, Research on the Application of Virtual Reality Technology (VR) Based on BIM in the Construction of Prefabricated Architecture Teaching Platform Building Materials Development Orientation (I), 17(10): 79.

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Research on Construction Technology of Prefabricated Structure Based on BIM Technology

Shan Zhao[1]*, Lin Zhang[2]

[1]Chongqing Energy College, Chongqing 402260, China

[2]Chongqing Yudi Land Readjustment and Development Co., Ltd., Chongqing 401123, China

Corresponding author: Shan Zhao, zsbaobei0915@163.com

Abstract: Building information modeling (BIM) technology simulates visual information data by integrating the information data of construction projects. The presentation of information parameters allows better collaborative management of the construction process. BIM technology is applied to integrate information data during the construction of prefabricated structures, analyze the source of information data of construction projects, and build a digital information model. BIM technology consists of information integration function, information data simulation, cross-region coordination and more. Therefore, this paper applies it to the process of prefabricated structure design, puts forward relevant technical research strategies, establishes relevant models, ensures the accuracy of drawing, and simulates the final construction effect according to the combination of arranged relevant parameters.

Keywords: BIM technology; Fabricated structure; Construction technique

Online publication: September 15, 2022

1. Introduction

With the implementation of energy protection strategy and environmental protection issues, the overall development requirements of the construction industry are more stringent. The fabricated structure reflects the characteristics of high-quality engineering quality, strict and accurate cost control, which can effectively reduce the energy consumption in the overall construction of the construction industry. It is an environment-friendly building model. With the application and development of fabricated structure, the whole shows certain defects [1]. The issue of long construction period and difficult construction of the project occur frequently. In addition, the project cost has increased significantly, and there has been excessive waste of resources. The traditional construction technology is gradually replaced by the high-quality prefabricated building structure [2]. Based on the above difficulties, applying BIM Technology to the process of prefabricated structures can effectively reduce the original defects of prefabricated structures and increase the quality of prefabricated structures. It is necessary to constantly study the characteristics of BIM technology, enhance the application effect of fabricated structure, reduce material resource waste and pollution, and effectively improve the overall application efficiency [3].

1.1. Introduction of BIM technology

BIM technology is a type of information technology that builds digital information modeling based on building information. Based on the integration of various information and data of the construction project, the information is simulated into visual information data through digital technology, which is combined with three-dimensional model and database to form a comprehensive model. BIM technology presents various building information in the form of parameters through model construction, which is convenient for construction workers to analyze, manage, coordinate and control the construction process, so as to improve the professionalism, reliability and accuracy of construction. As for the construction of fabricated structures, BIM technical data is used to comprehensively control the information of the construction project, optimize the design scheme, construction technology, accessories and facilities, and manage the whole process of the construction site. In addition, by improving the rationality of building indicators, we can improve the quality and efficiency of building construction [4]. Through the application of BIM technology, integrating the data information related to the construction, analyzing various information required for the construction of the construction project, and building the relevant digital information model, the simulation model of the whole construction project can be formed. BIM technology mainly presents the main functions of coordination, simulation and optimization. Based on the overall characteristics of BIM technology, according to the actual construction situation, the layout of construction personnel can be optimized, and the construction of parts prone to collision can be adjusted during the construction process. In addition, the construction method is improved by simulating the construction process. BIM Technology can create drawings and mark key points of building construction to select appropriate building construction methods [5] to conduct risk analysis on the formed building model to ensure the safety and reliability of building construction, prevent possible accidents in building construction and reduce the incidence of emergencies.

2. Application of prefabricated structure construction technology based on BIM technology

(1) The combination of BIM technology and construction simulation.

According to the construction scheme of building structure, we can quickly formulate effective engineering solutions. Before implementing the construction scheme of the prefabricated project, BIM technology can be used to conduct comprehensive dynamic analysis and simulation of the construction process, so as to timely find the possible quality problems in the whole process [6]. It is necessary to use BIM technology to build the prefabricated bridge engineering model system, optimize the specific modeling parameters of the prefabricated bridge engineering components, and simulate the bridge engineering and construction work more accurately. In the simulation of the hoisting construction process of prefabricated bridge components, the whole process of design and construction can be directly simulated in combination with the hoisting process planning. It can formulate and provide reasonable guidance for the implementation of subsequent hoisting construction. In the process of final assembly design, it is necessary to consider the influence of various technical factors such as the rotation of tower crane components, the range of curvature radius, transportation speed, operation route and so on, so as to ensure the perfect connection of various technical factors [7]. By simulating the size and construction work of the main components of the bridge, the process defects in the existing construction plan can be detected the existing plan can be improved. In the construction of hoisting engineering, material transportation, loading and hoisting are important nodes of prefabricated bridge engineering. The radius of rotation of tower crane equipment, the expansion and reinforcement of loading site facilities, and the optimization of material transportation vehicles are important because the transportation route affects the layout and management of the construction site, thereby affecting the overall construction operation [8]. Based on the optimization of these key nodes, the construction links in the whole installation and construction process are closely coupled to ensure efficient installation and construction. The construction unit should utilize BIM technology, quickly establish a scientific and complete construction site model, and conduct a detailed and reasonable quantitative analysis of the data such as the use of construction materials on the project site.

(2) Improve the accuracy of prefabricated parts production.

There are limitations in the conventional design method, which cannot accurately and comprehensively present the information of relevant parts, which subsequently brings inconvenience to the subsequent prefabrication construction and directly affects the installation progress. In order to effectively improve the production quality of prefabricated components of prefabricated buildings, it is necessary to introduce BIM technology, establish BIM model of insulation wallboard, internal reinforcement layout of prefabricated components, prefabricated electromechanical pipelines, prefabricated embedded parts, and more. The optimization of components and the overall accuracy of the design ensure the quality and efficiency of the subsequent processing and production of prefabricated components [9]. In the actual production and processing of prefabricated components, manufacturers can obtain the specific processing information of prefabricated components according to the BIM model of prefabricated buildings, and process and produce according to requirements to ensure the maximum utilization of resources. In the actual development and construction of prefabricated construction projects, a large number of prefabricated components must be processed and manufactured in factories. In the production process of prefabricated components, the corresponding prefabricated components according to the construction progress of prefabricated buildings must be manufactured and produced in time, so as to reduce the cost of prefabricated site therefore reducing construction cost. In order to achieve the expected construction goals, BIM technology should be applied. Besides, with the support of BIM model, the production process of prefabricated parts must be optimized, and the cooperative factories must be guided to strictly implement the production plan. Prefabricated construction projects must use prefabricated components, and they must be processed and manufactured in an orderly manner to ensure overall development. When comparing traditional construction projects with prefabricated construction projects, it can be seen that during the development and construction of prefabricated building projects, prefabricated components are installed in a standardized way. It is also crucial to use professional machinery and equipment in the actual installation stage of prefabricated parts [10]. In order to effectively improve the feasibility and efficiency of the overall development of prefabricated buildings, it is necessary to apply BIM technology, constantly optimize the construction scheme of prefabricated buildings, and effectively improve the overall installation efficiency of prefabricated components.

(3) Coordinate professional designing systems with other professional teams.

BIM technology incorporates digital information technology to generate an analog information system combining water collection, heating and electricity. Professional designers and other professional teams need to be coordinated through the analog information system From the perspective of construction companies, structural engineers, manufacturers, and equipment engineers, BIM technicians have changed the original traditional way of use. With a professional designing system, architectural designers can obtain the relevant required information and add its specific information to the actual work. According to the information prompt of the simulation system, we can work with the same parameters as the basic building model [11]. BIM technology is combined with professionally coordinated design, specific work content, shared work information, therefore increasing the efficiency of work progress. The application of BIM technology is conducive to the rationalization of building structure design, ensures systematic progress of construction plan, and effectively improves the quality of the building. By converting the BIM model, according to the specific location of the internal components, we can select the appropriate number, install the corresponding equipment, and test internally. If there are any abnormalities during the selection of equipment data information, the overall structure of the building can be ensured by debugging the overall design parameters. In practice, BIM technology is used to build the model, plan the data measurement information, adjust the model, control the stability of the building, as well as increasing the structural strength of the building. Through the application of BIM technology, building structure design is combined with various on-site data analysis functions to analyze the overall design process of the model and improve the measurement accuracy of building land and surrounding ecological environment information. When natural disasters occur, we can enter the BIM data information system, and the specific disaster information can clearly appear in the database. When the environment changes rapidly, the BIM data feeds back relevant information, and the basic performance indicators of the model structure meet the expected requirements. BIM technology can effectively strengthen the stability of building structures in the early stage of design. In the process of data testing, in order to make the local climatic and geographical conditions better meet the needs of the building, the safety and service life of the building can be effectively achieved through the coordination performance of BIM technology [12]. Architects combine BIM tools and methods to simulate different structural design situations and make judgments on site conditions. According to the preliminary concepts and standards, the building structure design can better integrate ecological factors. Designers use the relevant performance simulation analysis software to analyze the annual sunshine duration and shadow changes of the construction site, so as to provide the basis for specific construction.

(4) Scientific management of construction progress.

The application of BIM technology in site schedule management can effectively simulate the layout and dynamic adjustment of the site, make the loading and transportation of fabricated components scientific and reasonable, and also ensure the construction safety. The construction period of prefabricated construction is shorter than that of conventional construction projects, and the construction efficiency is high. The application of BIM technology can effectively highlight the construction progress advantages of prefabricated construction projects [13]. This is mainly because BIM technology can improve construction schedule management. In the construction of prefabricated construction projects, BIM technology can effectively formulate the construction progress of each work phase, and relevant personnel can analyze the construction situation scientifically according to BIM model and on-site construction monitoring. Systematic planning the human resources and capital investment of the plant can not only ensure optimization of the installation of components, but also deal with the differences in construction technology [14]. The construction engineer must apply BIM technology to simulate the difficulties in construction, detect existing problems in the project, and ensure the smooth progress of construction. In addition, this method can also effectively prevent the waste of building materials, thereby reducing construction costs. The construction workload of prefabricated construction engineering is large, and it often consumes a lot of building materials. Therefore, this makes it difficult to ensure the timely supply of materials when managing building materials in the traditional way. Any damage of breakage of materials during the construction process will be detrimental the construction progress of the project. In the specific application of BIM technology, the construction process must be comprehensively calculated and analyzed, and based on this technology, the construction materials and construction progress must be scientifically and reasonably managed, so that it can meet the construction needs of the project. The materials can be adjusted to ensure uninterrupted supply. In addition, BIM technology should also be used to find abnormal problems of material loss in time in order to make an effective judgement on material loss, so as to improve and optimize the construction stage.

(5) Optimize the construction technology and arrange the scheme reasonably.

In the process of building construction, the splitting process of columns, beams, slabs and other components is created and transported according to the actual situation. In the process management of prefabricated parts on site, BIM technology can be used to optimize the construction process, and BIM technology model can be used for integrated design. The production, construction, management and installation of prefabricated integral components are effectively connected. The final design and construction can be carried out at the same time by defining the construction period and schedule and presenting the components of the whole building through digital technology simulation. With the help of BIM technology, it can realize the informatization of engineering buildings, ensure the sharing of engineering quantity information and data, ensure the visualization of various assemblies, and facilitate the inspection of each connecting node. BIM technology can effectively simulate site conditions and construction plans, and easily select the best construction site, construction plan and construction procedure [15]. According to the industry standards and technical requirements and the project implementation, we can clarify the construction scheme, design, optimize and determine the construction scheme, and use the BIM model to test the feasibility, reliability and integrity of the scheme, find various construction problems, and provide reference for design drawings.

3. Conclusion

In conclusion, the application of BIM technology in the construction process of fabricated structures gives full play to the advantages of BIM technology, improves the construction efficiency of construction projects, shortens the construction time of construction projects, and optimizes key construction nodes. In construction simulation, parts and equipment, construction management, carrying out construction supervision according to specific models can improve the quality and efficiency of the project. The application of BIM technology promotes the development of prefabricated construction engineering and improves the overall utilization of resources. The application of BIM technology in the construction of prefabricated building structures effectively improves the production quality of components. At the same time, through the simulation of the construction site, a reasonable construction scheme is formulated. Lastly, planning the existing buildings on the construction site provides technical support for the development of the construction industry.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Wei Y, 2021, Application Analysis of BIM Technology in the Construction of Prefabricated Building Structures. Sichuan Building Materials, 47(12): 106–107 + 110

[2] Qin X, 2022, Brief Analysis on the Application of BIM Technology in Prefabricated Bridge Engineering. Low Carbon World, 12(03): 144–146

[3] Guo S, Zeng C, Application of BIM in Prefabricated Building Construction. Housing and Real Estate, 2021(34): 170–171

[4] Zhang S, 2022, Research on Construction Technology of Prefabricated Structure Based on BIM Technology. Soda Industry, 2022(03): 28–31

[5] Li B, 2021, Application of BIM Technology in the Construction of Prefabricated Building Structures. Smart City, 7(22): 145–146

[6] Xiong H, 2021, Discussion on the Application of BIM Technology in the Construction of Prefabricated Building Structures. Building Technology Development, 48(06): 61–62

[7] Wang L, Wang Z, Jiao J, et al., 2019, Comprehensive Research and Application of BIM Technology in the Construction Process of Prefabricated Structures. Architectural Technology, 50(08): 910–912

[8] Yuan Y, 2019, Application of BIM Technology in the Construction of Prefabricated Building Structures. Smart City, 5(14): 163–164

[9] Zhang T, 2019. Key Technical Process of Prefabricated Shear Wall Structure Construction Based on

BIM Technology. Engineering Technology Research, 4(12): 51–52

[10] Li K, 2019, Research on Construction Process of Prefabricated Structure Based on BIM Technology Journal of Sichuan Vocational and Technical College, 29(04): 162–164

[11] Liu G, 2019, Research on the Application of BIM Technology in the Construction of Prefabricated Building Structures. Building Technology Development, 46(09): 1–2

[12] Wang K, 2019, Research on Construction Quality Evaluation of Assembled Monolithic Concrete Building Structure Based on BIM, dissertation, China University of Mining and Technology.

[13] Hu J, 2014, Application of Prefabricated Structure Construction Technology. Jiangsu Building Materials, 2014(02): 34–36

[14] Huang L, 2018, Analysis on the Application of BIM Technology in the Construction of Prefabricated Building Structures. Homestead, 2018(24): 70

[15] Xu H, 2018, Application of BIM Technology in the Construction of Prefabricated Building Structures. Homestead, 2018(22): 86

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Risk Management of Large Infrastructure Projects: Risk, Uncertainty, and Complexity

Zhen Liu[1], Lijie An[1], Dong-Joo Kim[2]*, Junyou Liu[3]

[1]Major of Social Economy, Department of Social Economy and Business Administration, Woosuk University, Wanju-gun 55338, South Korea

[2]Department of Social Economy and Business Administration, Woosuk University, Wanju-gun 55338, South Korea

[3] School of Architecture and Art, Central South University, Changsha 410083, Hunan Province, China

***Corresponding author:** Dong-Joo Kim, ju7055@woosuk.ac.kr

Abstract: The development of large infrastructure projects requires the consideration of many different risks in advance, of which the two common risks are strategic risk and project risk. This study provides an overview of the different relevant literature on risk management of large infrastructure projects. Based on the Hong Kong section of the Guangzhou-Shenzhen-Hong Kong high-speed rail, this study identified the project's main strategic risks and project risks, and provided suggestions for risk management.

Keywords: Transport infrastructure; Risk; Uncertainty; Complexity; Guangzhou-Shenzhen-Hong Kong high-speed rail

Online publication: September 15, 2022

1. Introduction

Large infrastructure projects are infrastructure projects of national importance, and they are complex. Therefore, appropriate management of the risks of such projects is of crucial significance. There are three types of planning uncertainty which are as follows: the uncertainty of the planning environment, the uncertainty of decision-making in the relevant areas of decision-making, and the uncertainty of the environment [1]. Effective risk management ensures that projects develop corporate strategies based on changing opportunities and risks [2], which can increase certainty and reduce exposure to potential chaos.

2. Literature review

2.1. Risk uncertainty and complexity

There are many ways to classify the risks of large infrastructure projects. Strategic risk is regarded by many experts in the field of infrastructure planning and development as one of the important risks for large infrastructure projects which may affect the achievement of corporate objectives during the development of a large infrastructure project [2]. Meanwhile, project risk is another common risk for large infrastructure projects. It stems from varying degrees of uncertainty in all projects, especially during project development process [3]. The focus of risk management is to reduce its uncertainty and impact [2], and risks can be divided into positive risks and negative risks. The former means that positive outcomes are more likely to occur, and vice versa [4,5]. In real life, people are more concerned about negative risks than positive risks. However, positive risks should also be given high priority [1].

Risks stem from varying degrees of uncertainty [3], and the focus of risk management is to reduce its uncertainty and impact [2]. There are four levels of uncertainty which are as follows: a clear enough future, an alternative future, a range of future, and true ambiguity. On the other hand, innovation, discontinuity, abrupt change, rapid change, historical contingency, diversity, pluralism, and heterogeneity all contribute to the complexity of matters [6]. Together, uncertainty and complexity are factors that should be highly valued by project developers as they can cost them a serious loss due to various negative consequences if they do not highlight the importance of risk mitigation.

Firstly, if infrastructure has already been built, it is impossible to change its purpose. Secondly, the benefit of investment is positively correlated with economic growth. This means that if the growth is promising, the project will go well; if the growth is low, the project will perform poorly [7].

2.2. Risk management

Scenario planning is used to explore multiple possible futures [8], which is very beneficial for exploring strategic risks. In addition, it is considered an effective tool in transport planning, supported by reasons as follows [9]: (1) Scenario planning is thought to be effective in negotiation and group decision-making. (2) Scenario planning constrains the scope of possible futures. (3) Scenarios help people explore multiple possible futures. Multi-criteria analysis is thought of as an effective tool for strategic risk management, and has been successfully applied in environmental impact assessment. It is also used to assess risk from different perspectives, that is, different criteria. Some people combined scenario planning and multi-criteria analysis to form a scenario-based multi-criteria analysis method, and this combinatorial method can take full advantage of these methods. More specifically, scenarios provide multiple possible futures, and multi-criteria analysis provides comprehensive analysis based on various criteria [10].

The aforementioned tools are more commonly used in strategic risk management. For project risk management, there are many other commonly used risk management tools [11], such as document review, brainstorming, Delphi techniques, interviews, root cause analysis, checklist analysis, assumption analysis, diagramming techniques, SWOT analysis, and expert judgement [4,12].

Project appraisal is used to explore, review, and evaluate proposed courses of action to determine whether a given proposal is viable, and risk analysis is widely used in project appraisal.

The project risk management methods include steps as follows: 1. Identify project risks. 2. Analyze risks using both qualitative and quantitative methods. 3. Plan risk responses to control risks [4,12]. Risk analysis includes identifying existing controls, possibilities, and consequences, and estimating risk levels. Quantitative analysis and qualitative analysis are important in risk analysis [13].

A risk map is a useful tool for risk management. It requires people to map risk based on impact and probability, as shown in **Figure 1**, where people need to decide which risks are the key risks to consider based on the plotted map.

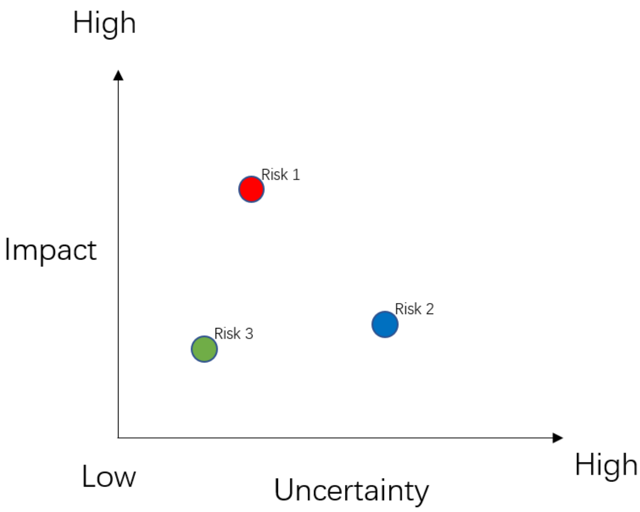


Figure 1. An example of a risk map

Risks can be mitigated by assigning them to those best suited to manage them, and by changing and insuring the project. To manage the risks, the most optimal response plan can also be implemented. Proactive stakeholder management plays an important role in risk management, and assigning risks to the stakeholders best suited to manage them is critical in managing large projects. In addition, the matrix is often used to allocate risks [2,14]. Non-professionals know things that many experts often overlook, contributing to hazard management over the lifecycle of large infrastructure projects. Therefore, a more respectful and balanced relationship between experts and non-professionals is beneficial [15].

3. Case study

3.1. Site selection

The Hong Kong section of the Guangzhou-Shenzhen-Hong Kong high-speed rail (XRL) is a large infrastructure project that can have a significant impact not only on the future development of Hong Kong, but also on that of the Guangdong-Hong Kong-Macao Greater Bay Area. **Figure 2** shows the overview of the area, where the underground high-speed rail line is about 26 kilometers long. The government has invested around £84.42 billion into the project, of which construction began in 2010 and took around eight years to be put into operation. The project aims to improve the connection between Hong Kong and mainland China, and promote Hong Kong's development.

Figure 2. Hong Kong section of Guangzhou-Shenzhen-Hong Kong Express Rail Line

3.2. Risk identification

We used a risk map to identify critical risks. Based on a comprehensive analysis, this study identified three main risks of XRL. Cost overruns are common and important in large projects, and should be identified as they will have a significant negative impact on the construction and operation of the project. Project delays are also common in large projects, which can increase the risk of cost overruns [2,14]. In addition, we identified three main project risks based on the analysis on risk impact and uncertainty matrix, which are tunnel collapse, corruption, and worker injuries [16].

3.3. Stakeholder involvement

Table 1 shows the key stakeholders and their roles in risk management provided in this study. Stakeholder analysis is critical for the risk management of large projects. As different stakeholders have better knowledge of risks than experts, assigning risks to different stakeholders is conducive to risk mitigation.

Table 1. Key stakeholders and their roles in risk management

Stakeholders	Roles
Government	Comprehensive risk management
Mass Transit Corporation (MTR)	Formulate risk management plans
Construction contractors	Manage construction risks with MTR
Communities	As non-professionals who provide suggestions for risk management
Independent board committee	Write reports on various matters

3.4. Suggestions for current risk management practices

One of the government's strategic goals was to complete the project with less than HK$70 billion. However, the final estimate of the cost of the project was £84.4 million, meaning that the project has a significant cost overrun. Scenario planning and multi-criteria analysis can be considered two useful tools for exploring the financial risks of the project [17]. Scenarios may be useful to explore multiple future trends in project costs, while multi-criteria analysis can be used to analyze a large project under different scenarios. This helps in exploring financial risks and adopting some useful strategies in advance.

Project delays are another issue to consider. Some experts had estimated that the project could be delayed, but they did not fully consider assigning the risk to different stakeholders. Project delays are a risk that can be easily influenced by different stakeholders, and in this paper, it is argued that non-professionals know better. In other words, different stakeholders should be involved in the management of this risk.

To explore project risks, an impact and uncertainty matrix was used to explore critical project risks, which is effective since a risk is determined by its impact and possibility. We believe that this matrix is rather beneficial for comprehensively considering all relevant project risks and identifying critical risks.

4. Conclusion

In summary, this paper comprehensively analyzed the risks associated with large projects, which can serve as a reference for those wishing to explore the risks of large projects. This study believes that strategic risk and project risk are two indispensable parts of risk management for large infrastructure projects, and argues that the public can be more involved in the risk management process.

Disclosure statement

The author declares no conflict of interest.

References

[1] Hall P, 1980, Greater Planning Disaster, University of California Press, California, 1–32.

[2] Allport RJ, 2011, Planning Major Projects, Thomas Telford Ltd., London, 158–195.

[3] Perminova-Harikoski O, Gustafsson M, Wikström K, 2008, Defining Uncertainty in Projects–A New Perspective. International Journal of Project Management 26(1): 73–79. https://doi.org/10.1016/j.ijproman.2007.08.005

[4] Project Management Institute, 2013, A Guide to the Project Management Body of Knowledge (PMBOK 325 ® Guide)–Fifth Edition, viewed December 14, 2018, https://anyflip.com/zmbd/cxvl/basic/

[5] Batty M, 2012, Managing Complexity, Reworking Prediction. Environment and Planning B: Planning and Design, 39(4): 607–608

[6] Harvard Business Press, 1999, Harvard Business Review on Managing Uncertainty, Harvard Business School Press, Boston.

[7] Flyvbjerg B, Bruzelius N, Rothengatter, 2010, Megaprojects and Risk: An Anatomy of Ambitions, Cambridge University Press, Cambridge.

[8] Amer M, Daim T, Jetter A, 2013, A Review of Scenario Planning. Future, 46: 23–40. https://doi.org/10.1016/j.futures.2012.10.003

[9] Schroeder M and Lambert J, 2010, Scenario Based Multiple Criteria Analysis for Infrastructure Policy Impacts and Planning. Journal of Risk Research, 14(2): 191–214. https://doi.org/10.1080/13669877.2010.515314

[10] Dimitriou HT, Ward EJ, Dean M, 2016, Presenting the Case for the Application of Multi-Criteria Analysis to Mega Transport Infrastructure Project Appraisal. 58: 7–20 https://doi.org/10.1016/j.retrec.2016.08.002

[11] Glason etc, 2012, Environmental Impact Assessment, Taylor and Francis Group, London.

[12] Kim SD, 2012, Characterizing Unknown Unknowns, Project Management Institute viewed December 17, 2021, https://www.pmi.org/learning/library/characterizing-unknown-unknowns-6077

[13] Australia/New Zealand Standard: Licence, 1999, Risk Management, Standards Australia, viewed December 17, 2021, AS/NZS 4360: 1999 http://www.epsonet.eu/mediapool/72/723588/data/2017/AS_NZS_4360-1999_Risk_management.pdf.

[14] Dieguez A, Cazorla A, and Luque A, 2014, Risk Management in Megaprojects. Procedia - Social and Behavioral Sciences 119: 407–416

[15] Fischhoff B, Slovic P, Lichtenstein S, 1982, Lay Foible and Expert Fables in Judgement about risk. The American Statistician, 36 (3): 240–255.

[16] Flyvbjerg B, Bruzelius N, Rothengatter W, 2010, Megaprojects and Risk, Cambridge University Press, Cambridge.

[17] The Government of Hong Kong Special Administrative Region: Press Releases, 2008, Green Light for Local Section of Express Rail Link, viewed December 21, 2020. https://www.info.gov.hk/gia/general/200804/22/P200804220141.htm

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Research on Construction of Bill of Quantities of Prefabricated Buildings Based on BIM

Xiangxiang Liu*

Chongqing Institute of Engineering, Chongqing 40056, China

***Corresponding author:** Xiangxiang Liu, zz5132008@163.com

Abstract: Building Information Model (BIM) Technology can be widely used in various construction fields. The construction quality and project cost of the prefabricated construction industry based on BIM can be effectively controlled. Based on BIM Technology, the integration of bill of quantities can effectively control the cost of prefabricated construction and improve competitiveness in the bidding process. Based on this, the characteristics and advantages of bill of quantities pricing based on BIM were expounded in this paper. Besides, the structure and content construction of bill of quantities were analyzed, followed by an analysis of pricing control strategy based on BIM were analyzed for assembly building quantities for reference.

Keywords: Building Information Modeling (BIM); Prefabricated building; Bill of quantities

Online publication: September 15, 2022

1. Introduction

As an application system that can be widely used in various construction projects, BIM can integrate all kinds of information in the whole life cycle of the project, so as to well realize the representation of building information and real-time sharing of data, and provide an opportunity for the progress of cost management. In particular, the modeling characteristics of BIM components and the management benefits of information integration are highly consistent with the component-based and integrated concepts of prefabricated building [1-4], indicating that there is a certain coupling between prefabricated building and BIM technology, and it can be highly integrated. Therefore, BIM technology can be applied to the cost control of prefabricated buildings to effectively improve the accuracy and efficiency of cost control. However, because the BIM model only contains some geometric and physical information, it does not have the necessary conditions to implement life cycle cost management, and this problem needs to be further addressed [5-9]. In addition, the importance of data is increasingly emphasized in the era of big data. Cost information resources have important value in project cost management. Making full use of cost information resources and efficiently managing cost information resources are important factors in improving project cost management. Preparing bill of quantities of prefabricated buildings through BIM technology can improve the competitiveness of construction enterprises in the market in the process of project bidding and cost calculation.

2. Characteristics and advantages of bill of quantities pricing based on BIM

2.1 Pricing characteristics of bill of quantities based on BIM

The multi-level bill of quantities of prefabricated buildings based on BIM combines the characteristics of BIM. Based on the characteristics of prefabricated buildings, it has been modified in terms of decomposition structure and pricing rules. The list has the following characteristics:

(1) Starting from the characteristics of prefabricated buildings and BIM componentization, we should give full play to the advantages and economies of scale of modular production of prefabricated buildings to help reduce the construction cost of prefabricated buildings. At the same time, the main advantage of the combination of data-driven BIM is to optimize the project cost management mode of prefabricated buildings [10].

(2) According to the general contract mode of the project, it can meet the cost management needs of the whole life cycle. There are many different pricing methods for a project. Adopting different pricing methods in each stage of project construction not only reduces the pricing accuracy of prefabricated buildings on the whole, but also cannot make full use of the characteristics of each pricing method. The multi-level decomposition structure meets the characteristics of different pricing methods at different stages of the project pricing process, and helps to improve the cost management of prefabricated construction [11].

(3) The new price combination mode is in line with the characteristics of prefabricated building components as well as the factory production mode of prefabricated building, which helps highlight the benefits brought by the production mode of industrial building. By reducing the construction cost of prefabricated buildings, the problem of high cost restricting the active promotion of prefabricated buildings can be well solved.

2.2. Construction advantages of bill of quantities BIM

(1) Improve the efficiency of engineering quantity calculation.

The scientific application of BIM technology in the bill of quantities calculation of prefabricated buildings makes the presentation of information data more efficient, scientific, intelligent and electronic. With the help of visual data platforms, managers can manage the amount of prefabricated construction more scientifically and effectively as well as standardizing it. It effectively makes up for the deficiency of traditional paper information storage and transmission mode, makes information storage more secure, increases the efficiency of engineering quantity management, increase over the control of accuracy of related parameters, and improves overall management efficiency.

(2) BIM technology can complete cost simulation according to the bill of quantities.

BIM technology has the simulation function of simulating the analysis of engineering quantity calculation scheme. It can organically associate the 3D model of building structure with the bill of quantities, and build a 4D spatially assembled building model and a 5D communication technology platform on this basis. In addition, the calculation links of various quantities can be compared with the actual quantities to confirm whether there are omissions. The building information model based on BIM technology can carry out different modeling for various accessories of different types and sizes, so that the supervision department and relevant technicians can fully understand the bill of quantities information, further optimize the assembly building cost, and control the assembly building cost.

(3) The whole process of quantities can be traced.

The scientific application of assembly building based on BIM technology can give full play to the role of the Internet of things and mobile devices, and connect the completion process of the bill of quantities organically. By utilizing cloud storage and other technologies, the construction and pricing of bill of quantities can be remotely controlled, and the calculation process of bill of quantities pricing can be strictly supervised and managed in real time. In addition, the indicators and parameters formed in the construction process of the bill of quantities can be uploaded to the cloud simultaneously, so that the relevant staff can comprehensively, timely and wholly understand the actual situation of the quantities, understand the use of materials more accurately, and achieve supervision and tracking of the whole process of assembly materials use.

3. Structure and content construction of bill of quantities

This paper establishes the bill of quantities according to the construction entity of prefabricated buildings. The specific process is as follows [12-16]:

3.1. Structure establishment of bill of quantities

3.1.1. Research ideas of constructing bill of quantities

In the process of establishing the bill of quantities, in order to perfectly integrate the three contents of the bill of quantities, prefabricated building and BIM technology, it is necessary to compare and analyze the characteristics of the three, then integrate and analyze them, and then decompose the bill of quantities according to different modular theories. The specific decomposition of ideas of the bill of quantities are as shown in **Figure 1**.

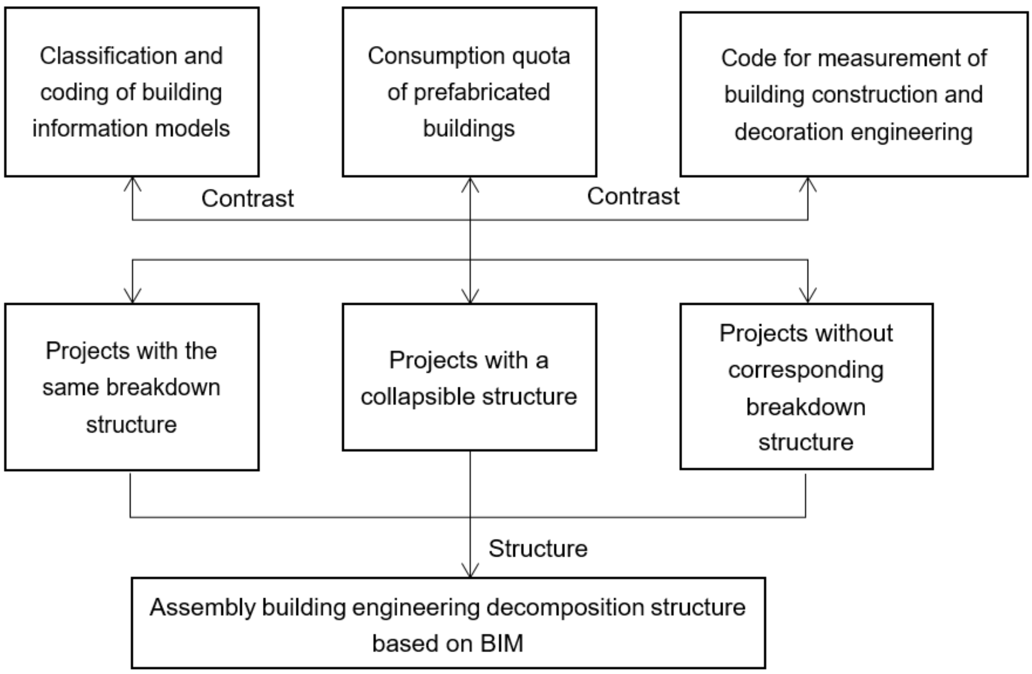


Figure 1. The idea of establishing the prefabricated construction engineering decomposition structure based on BIM

3.2. Application of modular theory

When using BIM technology for modular design of prefabricated buildings, we should first analyze the characteristics of prefabricated buildings. According to its characteristics, the construction projects of prefabricated buildings can be segmented, and the modular analysis of product processing, product structure, product purchase and other contents can be done according to the characteristics of modular list construction. The specific process is as follows:

(1) Modularization of product structure refers to the disassembly of prefabricated buildings according to different functions and production methods. “The unified standard for the application of building engineering information models” includes architecture, structure, electricity, water supply and drainage, heating, ventilation and air conditioning, intellectualization, fire protection, decoration, divisional

quantities, conceptual design, BIM modeling, and project estimation.

(2) The modularization of product manufacturing process includes the processing and manufacturing the components of prefabricated buildings according to various production processes and methods. Among them, the structural module is divided into foundation structure and precast concrete structure. Next, precast concrete structures are divided into precast columns, precast beams, etc. Then, precast columns are divided into precast frame columns and precast shear wall hidden columns.

(3) Products can be manufactured by purchasing, subcontracting or processing. The construction unit determines the capacity of these prefabricated components and outsources them to component contractors, while module suppliers manufacture according to their own design parameters and standards. In other words, the modularity of procurement subcontracting. These prefabricated components can be refurbished, disassembled and manufactured. For example, precast columns require a variety of materials such as steel and concrete, as well as labor and machinery. The process of manufacturing these prefabricated frame columns (sub modules) is modular. Processing and manufacturing, according to the rule of the assembly of multiple sub-modules, is a new product integration.

3.3. Establishment of bill of quantities structure

According to the above construction ideas and modular application theory, taking the structure as an example, this paper constructs the contents of the bill of quantities of prefabricated building structure, and the specific contents are as follows:

(1) The structure of a first level of the list includes architecture, structure, electricity, water supply and drainage, heating, ventilation and air conditioning, intellectualization, fire protection, decoration, divisional quantities, conceptual design, BIM modeling, and project estimation.

(2) As for the second level of the list, the foundation, precast concrete slab, other precast concrete components, precast concrete columns, precast concrete beams, post cast strips, precast concrete walls, concrete beam column joints, structural joints, precast concrete stairs, embedment and rings are all carried out by the components in the primary list. The second level also includes sub item quantities, preliminary design BIM modeling, and design estimates.

(3) In the third level of the list, in addition to the distribution of sub-divisional quantities, BIM modeling of construction drawing design, construction drawing budget and other contents, flat plates, hollow slabs, grooved slabs, grid frames, broken line slabs, ribbed slabs, large plates, trench covers, well covers, well rings, etc. are all carried out by the prefabricated concrete slabs in the two-level list, sleeve grouting, post cast concrete pouring and tamping, post cast concrete reinforcement, post cast concrete formwork are all carried out by the post cast strip, construction joints Anti-seismic joints and contraction joints are developed by structural joints, and iron parts and bolts are developed by embedded and lifting rings.

For prefabricated buildings, other bill of quantities can be further established according to the bill of quantities decomposition model, and finally integrated and summarized by the BIM software platform to complete the final bill of quantities calculation, summary and pricing.

4. Pricing control strategy of bill of quantities of prefabricated construction based on BIM

4.1. Reasonable cost management

In the design stage, we need to have a sense of rationalization of cost control in order to complete the docking of engineering projects. It is necessary to apply reasonable cost management measures, good behavior and more scientific overall design scheme, focus on reducing some unnecessary materials, simplify the architectural design process, and highlight the designer's intention of low cost, high functionality and high cost performance. In general, in order to realize the design intent, we should adhere to practical, scientific and reasonable working methods in the design stage, which will be of great help to cost control.

4.2. Scientific accounting process in the design stage

In terms of process management, scientific process division should be carried out according to the investment quota of construction projects. For example, a preliminary design is made according to the declared quantity in the existing design sheet, and then fine tune the parameters of the drawing in a step-by-step way. In practice, reference information should be strictly implemented in order to reduce costs on the basis of function realization. In addition, we should control the scientificity of the planning, take strict implementation as the measurement basis, understand the process of architectural design, and prevent the construction from exceeding the budget or exceeding the budget settlement. We should avoid technical limitations and inconsistencies of concepts. In terms of kinetic energy distribution, technical schemes should also be formulated to avoid the problem of insufficient total investment and the design concept cannot be completed. The cost management organization can make scientific accounting and implementation plans to insure the project. It is necessary to comprehensively consider uncontrollable factors and uncertainties such as environment, technology and manpower, and improve the feasibility of overall cost management.

4.3. Estimate the design budget scientifically and reasonably

The preparation of design estimate is important mainly because it can provide a basic reference for the preparation of project investment planning and cost management. Based on the approved construction drawings, further cost estimation of the drawings is carried out on this basis. Reverse calculation is carried out according to the design budget after the initial overall estimation of the project. The drawings are within the budgeted cost, so as to reduce the problems of over-budget caused by the design drawings. When reviewing the budget of the design drawings again, the needs of the initial budget can be fully integrated, so as to provide theoretical data support for the later construction and avoid the increase of the overall cost of the construction project.

5. Summary

In conclusion, the construction of the bill of quantities of prefabricated buildings based on BIM can effectively improve the efficiency of the calculation of quantities. BIM technology can complete the cost simulation according to the bill of quantities, realize process traceability of quantities, and ensure the construction quality and cost control of prefabricated construction projects. Taking the prefabricated structure as an example, BIM technology can be applied to build the bill of quantities, which can be operated on the BIM platform to achieve multi-party coordination and drive the development of prefabricated construction companies.

Funding

School level scientific research project of Chongqing Institute of Engineering.

Project No.:2020xskz01.

Disclosure statement

The author declares no conflict of interest.

References

[1] Zhang X, Guo J, Lou N, 2022, Research on Dynamic Pricing Method of Prefabricated Buildings Based on BIM Components. Journal of Engineering Management, 36 (02): 147–152

[2] Liu P, 2021, Analysis of Construction Cost Management Approach Under the Valuation Mode of Bill of Quantities. Real Estate World, 2021(15): 54–55

[3] Jiang Y, 2021, Research on Construction Period Cost Optimization of Prefabricated Buildings Based on BIM, dissertation, Nanjing Forestry University.

[4] Lou N, 2021, Research on Dynamic Valuation Method of Prefabricated Buildings Based on BIM Entity Quantity, dissertation, Beijing Jiaotong University.

[5] Zhang X, 2021, Cost Analysis of Construction and Installation Projects Based on the Valuation Mode of Bill of Quantities. Architecture and Budget, 2021(04): 26–28

[6] Yang F, 2020, Analysis and Research on Modular Pricing Method of Prefabricated Concrete Buildings Based on BIM, dissertation, Hebei University of Science and Technology.

[7] Zhang L, 2020, Analysis of the Practical Application Process of BIM Technology in Prefabricated Construction Projects, dissertation, Anhui University of Architecture.

[8] Han X, 2019, Research on Collaborative Valuation Mode of Assembled Buildings Under DB Mode Based on BIM, dissertation, Northeast University of Finance and Economics.

[9] Tang T, 2019, Research on Measurement and Payment of General Contract of Prefabricated Construction Engineering Based on BIM, dissertation, Southeast University.

[10] Zhang X, 2019, Research on Valuation Mode of Bill of Quantities of Prefabricated Concrete Construction Based on BIM, dissertation, Beijing Jiaotong University, 2019

[11] Zhang Y， 2019， Research on Prefabricated Building Construction Cost Optimization Software with Positive Application of BIM Technology, dissertation, Southeast University.

[12] Han X, Gao P, 2018, Price Mechanism of Assembled Buildings Under the General Contracting Mode Of Design And Construction. Project Management Technology, 16 (11): 64–69

[13] Zhou T, 2018, Research on Project Cost Management Under the Background of Modernization of Construction Industry. South Agricultural Machinery, 49(20): 197 + 221

[14] Wei Y, 2018, Cost Management Analysis of Assembled Buildings Under Bill of Quantities Pricing Mode. Sichuan Building Materials, 44 (03): 218–219

[15] Yu H, 2017, Talking About the Cost Management of Prefabricated Buildings by Using the Valuation Mode of Bill of Quantities. Smart City, 3(06): 229.

[16] Xie S, Chen X, Liang Y, 2017, New Bill of Quantities Based on BIM and Prefabricated Buildings. Journal of Engineering Management, 31(03): 130–135.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Research on the Current Situation and Countermeasures of Building a Beautiful Countryside Under the New Urbanization

Lei Zhang*

Shaanxi Provincial Land Engineering Construction Group Weinan Branch, Weinan 714000, Shaanxi Province, China

***Corresponding author:** Lei Zhang, blackdock@163.com

Abstract: In order to implement the "Rural Revitalization" policy and speed up the construction of beautiful villages, the development of new urbanization must be carried out to promote the coordinated development of rural agricultural modernization and industrial informatization. In order to explore an effective path for the construction of beautiful villages in the context of new urbanization, this study proposes several strategic ways for the construction by analyzing the overall relationship between new urbanization and the construction of beautiful villages as well as the current situation of the construction of beautiful villages in the context of urbanization, hoping to provide reference and guidance for the exploration of the rural revitalization strategy implementation.

Keywords: New urbanization; Beautiful countryside; Construction; Development

Online publication: September 15, 2022

1. Introduction

Comprehensively carrying out rural revitalization and construction is the directional strategic policy for China's rural economic construction that has been put forward by the 19th National Congress of the Communist Party of China, hoping that under the guidance of this policy, China's rural economic construction will improve and reach a higher level. In order to truly realize the strategic goal of rural revitalization and improve the level of rural economy, practical and feasible beautiful rural planning and overall development must be implemented in the process of rural economic construction and development, the transformation of rural economic industrial structure must be promoted, and the goal of rural revitalization and construction must be sought. In view of the rural economic development under the rural revitalization strategy, Kong Xiangfeng pointed out that it is first necessary to clarify the significance of the rural revitalization strategy, make reasonable planning on the premise of analyzing the current situation of rural economic development, clarify the ideas, achieve the integration of industry and village, as well as ensure the orderly promotion of the construction of beautiful villages under the new urbanization [1]. Based on several research results, this paper makes an in-depth analysis of the overall relationship between new urbanization and beautiful rural construction, the current situation and problems of beautiful rural construction under the new urbanization, as well as the effective ways to speed up the construction of beautiful rural areas, hoping to provide reference and guidance for the effective implementation of the rural revitalization strategy.

2. Overall relationship between new urbanization and beautiful rural construction

In order to realize the stable growth of rural economy, it is important to pay attention to the coordinated development of new urbanization and beautiful rural construction. With the continuous progress of urban and rural reform, urbanization is accelerating day by day. However, during this period, existing problems such as the large urban-rural income gap and the uncoordinated urban-rural development are also becoming increasingly prominent, which to some extent are limiting the sustained and stable growth of rural economy. Therefore, in order to maintain the existing achievements of economic development and further improve the quality of urbanization, the overall development of urban and rural areas must be taken into account [2]. In the same way, in order to continuously improve the quality of China's urbanization and maintain the achievements of economic development, the overall development of urban and rural areas must be taken into account. The concept of "new urbanization" first appeared during the 18th CPC National Congress. Compared with traditional urbanization, new urbanization emphasizes the people-oriented scientific concept in development, focuses on making up for the shortcomings of rural development, and uses the achievements of urban economic development to support the development of rural economy. However, rural economic areas should also speed up the adjustment of their own industrial structure, strive to improve agricultural productivity and creativity, as well as refrain from blindly relying on cities and towns to drive their development. The ultimate goal of building a beautiful countryside is to accelerate the development of rural economy, improve the level of rural modernization, and protect the ecological environment of the rural residents [3]. At the same time, the construction of beautiful villages has provided a steady stream of power for the promotion of new urbanization. Therefore, in order to ensure the coordinated and stable development of China's urban and rural economy, it is of utmost importance to pay attention to the planning and construction of beautiful villages under the new urbanization and actively promote the new rural construction model.

3. Current situation and problems of "beautiful" rural construction in the context of new urbanization

3.1. Insufficient scientificity of rural construction planning and design

There are many contents and links involved in the construction of beautiful villages under the new urbanization. Therefore, it is imperative to analyze the contents involved in rural construction from a macro perspective and plan reasonably while considering the actual situation of these villages, so as to promote the stable improvement in the efficiency of the construction of beautiful villages on the basis of ensuring that the rural construction is scientific, reasonable, and feasible. Relevant research results have shown that at this stage, many regions in China are in chaos when carrying out the construction of beautiful villages, resulting in the lack of order and organization in the construction process, especially in the case of emergencies or problems that cannot be dealt with effectively, and ultimately leading to the difficulty in achieving the goal of the construction [4]. Although the ultimate goal of constructing beautiful villages is the same, due to the regional differences, the construction of beautiful villages must be carried out in consideration of their own forms, through scientific planning and design as well as the formulation of practical implementation regulations to ensure that the construction standards meet the expectations [5]. However, some regions have failed to focus on the actual and long-term planning when carrying out the construction, thereby resulting in a disparity among the local conditions, local industrial economy, and rural construction. In some areas, there is a certain "blindness" in the construction of beautiful villages. One cannot build a beautiful countryside by only reproducing the successful experiences of other regions without conducting adequate research and development planning. This does not only bring great damage to the local ecological environment, terrain, and landform, but also violate the basic principle of ecological harmony in the construction of a beautiful countryside.

In addition, due to the lack of scientific planning and design, the ambition of farmers has been seriously disregarded in rural construction, and their homestead and private plots have been severely destroyed, thus affecting their enthusiasm. Their lack of enthusiasm has greatly challenged the implementation of the construction [6].

3.2. Unclear local characteristics

In the context of the new urbanization, the construction of beautiful villages must integrate the cultural history, architectural structure, geographical environment, and ecological environment of each region. The construction of beautiful villages must be integrated with the history and culture of the region. Although most regions have integrated their local characteristics into the construction to fully reflect the cultural connotation of each region, there are still some regions that lack local regional culture and have less distinctive industry and cultural characteristics in the construction [7]. The reason is that the government departments and relevant staff in these regions do not emphasize enough on the construction of beautiful villages. Coupled with the lack of professional rural construction talents, this leads to the single focus of new rural construction on the successful experiences of others, without any innovation in demolishing and transforming old rural buildings. Even when some towns and townships are involved in this work, there is no unified planning and supervision when transforming the houses belonging to farmers, resulting in different architectural styles in the same area and the lack of distinctive regional characteristics. Therefore, relevant personnel must attach more importance to this issue, highlight local characteristics when carrying out the construction of beautiful villages, and promote the orderly development of rural construction under the guidance of scientific and feasible planning and design schemes [8].

3.3. Slow development and transformation of secondary and tertiary industries

The traditional urban and rural construction and development model lacks an ideal supervision mechanism in rural economic construction since its focus is solely on economic development. As a result, environmental pollution is rising. In the early days of reform and opening-up, in order to increase economic income, people began sand mining and forest mining on a massive scale, causing inestimable losses to natural water bodies, mountains, and greeneries [9]. The originally emerald ridges have been turned into ferocious random stone hills due to natural disasters, such as landslides and mudslides; the once-clear river has turned into a muddy "sediment river"; the once-rural scene of smoke curling has turned into a scene of haze covering the sun; and the once-balanced rural ecological environment has been completely destroyed. Moreover, in the process of developing rural economy, some regions have always regarded agriculture as the primary industry despite the fact that the traditional extensive agricultural production mode wastes a significant amount of cultivated land resources. People are only paying attention to crop planting on cultivated lands with slightly higher output; it is difficult to develop scattered planting areas on a large-scale. In terms of agricultural economy, many regions are focusing on the primary industry and the tertiary industry, with a serious lack in the secondary industry that embodies raw material processing and packaging. As a result, there is an excessive dependence of rural economy on the urban economic environment [10].

3. Effective ways to speed up the construction of beautiful villages

3.1. Scientific planning and proper guidance

In order for the construction of beautiful villages to be implemented scientifically, it must be based on sound planning and design. Hence, prior to carrying out rural construction, all regional government departments should conduct a comprehensive survey on the local characteristics, formulate a sound design in line with the results of the survey and the development situation of the current era, make sufficient preparations, and prevent the waste of resources as much as possible [11]. On the one hand, it is necessary to consider and integrate the local terrain, interests, and cultural characteristics into the construction, so as to give full play to the advantages of the region. On the other hand, in line with the basic principle of improving the overall outlook of rural areas and the happiness index of rural residents, the construction of beautiful villages is closely linked with people's lives. The real value of constructing beautiful villages can only be truly reflected by ensuring that these beautiful villages are consistent with people's expectations. From this point of view, building a beautiful village is not a difficult task for the local government and relevant departments, but it requires the villagers to participate and work together with the dream of sustaining the stable growth of rural economic construction. When carrying out the construction of beautiful villages, it is crucial to listen to the opinions of the masses, coordinate with the local residents, and enhance their enthusiasm for participation [12].

3.2. Adjusting measures to local conditions and reflecting local characteristics

Realizing rural revitalization and linking the construction of rural ecological civilization with economic benefits are the fundamental tasks of building a "beautiful countryside."

First of all, it is necessary to improve the rural economic system, adhere to the concept of "beautiful countryside," apply this concept to rural revitalization and construction, adjust measures to local conditions, make overall planning, as well as identify more growth points relating to rural economic interests [13].

Secondly, on the basis of fully understanding the new form of rural economy, targeted and characteristic development strategies should be formulated to assist in the realization of rural revitalization. For example, it is necessary to explore the rural tourism market and increase the added value beyond agriculture. With the increasing desire for spiritual civilization, growing closer to nature and "returning" to nature have become the goal of most people. People are now more willing to visit the countryside and enjoy the pleasure of contentment. Hence, rural planners should make full use of this resource through the planning and construction of organic gardens for picking or shared vegetable plantations, so that the acquaintances of urban residents can experience the joy of picking or planting while improving rural economic benefits [14].

Finally, it is imperative to raise the investment in the secondary industry and realize the industrialization and scale of agricultural products by attracting the investment of large-scale beverage and food processing and production enterprises, so as to form a unique rural economic chain.

3.3. Promoting the transformation and upgrading of agricultural modernization

At all times, agricultural production is the key link in the development of modern rural areas, the indispensable impetus for the development of rural economy, and the core element restricting national economic development. Therefore, based on the rural revitalization strategy, it is crucial to focus on agricultural development, promote agricultural transformation and upgrading, as well as effectively improve the development level of China's agricultural modernization in the optimization of rural economic development. In order to ensure the transformation and upgrading of agricultural modernization, it is necessary to consider the actual situation of each region, formulate an agricultural development strategy that matches the actual situation, so as to promote agricultural construction, adhere to looking at all problems from the perspective of development, and hire professional agricultural technicians to formulate scientific design, so as to maximize economic and social benefits. Secondly, with the help of modern agricultural science and technology and advantageous regional resources, characteristic regional agricultural projects should be designed, and an ideal agricultural processing enterprise should be established to realize the one-stop production chain of supply, production, and marketing, so as to ensure the sustainable development of the region. Finally, making full use of the developed network information resources and adjusting the agricultural industrial structure according to the social development pattern may be beneficial in laying a good foundation for the transformation and upgrading of the agricultural industry [15].

3.4. Realizing the integration of rural natural and cultural heritage with tourism

Many rural areas have rich natural resources and cultural heritage. In order to effectively implement the rural revitalization strategy, it is necessary to integrate rural natural and cultural heritage with tourism, give full play to the advantages of local characteristic resources, and develop the cultural and tourism industry scientifically. On the one hand, promoting the aforementioned integration will not only provide more jobs for local residents and promote the construction of rural infrastructure and public service facilities, but also attract more talents to participate in the construction of rural revitalization. On the other hand, since the cultural and tourism industry has great economic and social value, the development of this industry will not only raise the popularity of rural areas and improve the utilization rate of local ecological resources, but also enhance the rural living standards and cultural quality [16].

3.5. Training talents on demand

In terms of talent training, it is necessary to train on demand and build a three-level talent training system: city, district, and township levels. First of all, the municipal leadership should design a plan to train up leading talents for the revitalization of rural construction, so that they can provide guidance for rural revitalization by using advanced production technologies and mature business philosophies. On the one hand, it is necessary to cultivate and retain high-end talents. On the other hand, it is also necessary to provide various advanced training opportunities or assign relevant personnel to visit the successfully revitalized villages, so as to improve their professional quality and accumulate experiences. With all kinds of top-notch talents available at the grassroots level in districts and towns, the grassroots departments should carry out the classification management of talents from various fields in line with the local situation and entrust them with important tasks, so that they can shine in their fields of expertise and contribute as much as possible to the realization of rural revitalization.

4. Conclusion

Under the new urbanization, the construction of beautiful villages should actively change the traditional inherent concept that man dominates nature and has control over nature to the pursuit of harmony between man and nature. This will not only ensure that the government adheres to the keynote of seeking victory in stability and establishing a solid concept of “green, coordinated, and sustainable development,” but also effectively narrow the gap between urban and rural development, achieve the goal of equalization of public services, as well as ensure that the legitimate rights and interests of farmers are not affected. With the increasing distinctive industries and innovative vitality injected into the construction of beautiful villages, it will certainly lay a good foundation for the realization of the rural revitalization strategy and the urban-rural integration goal.

Disclosure statement

The author declares no conflict of interest.

References

[1] Kong X, 2021, Research on the Optimal Development of Rural Economy Under the Background of Rural Revitalization Strategy. China Market, 2021(4): 35–36

[2] Zhao W, Li Y, 2022, From Beautiful Rural Construction to Rural Revitalization Strategy – A Study on the Evolution of China's Rural Policy in the New Era. Journal of Hubei University of Arts and Sciences, 43(04): 24–30.

[3] Guo D, 2022, Exploration and Reflection on the Construction of Beautiful Villages. New Agriculture, 2022(07): 65–66.

[4] Liu C, 2022, Planning and Construction of Beautiful Countryside from the Perspective of Ecological Civilization: A Review of Rural Ecological Civilization and Beautiful Countryside Construction Introduction. World Forestry Research, 35(02): 136.

[5] Li R, Zheng C, 2022, Research on the Path of Beautiful Rural Construction from the Perspective of Rural Revitalization – Taking Huimin Town of Lancang County as an Example. China's Collective Economy, 2022(08): 1–2.

[6] Tang A, 2022, Research on the Current Situation and Countermeasures of Building Beautiful Villages Under the Background of New Urbanization. Smart Agriculture Guide, 2(05): 107–109.

[7] Gao H, 2022, Research on the Construction of Beautiful Villages in Puyang City Under the Background of Rural Revitalization Strategy. Nanfang Agricultural Machinery, 53(10): 116–118.

[8] Hao Z, Li W, 2022, Research on Countermeasures of Beautiful Rural Construction and Rural Tourism Development Under the Background of Rural Revitalization. Rural Economy and Science and Technology, 33(08): 118–120.

[9] Zhao Y, 2022, Discussion on Rural Industrial Innovation Mode Under the Background of Beautiful Rural Construction. Journal of Heilongjiang Institute of Technology (Comprehensive Edition), 22(04): 98–103.

[10] Wang B, 2022, Research on Rural Landscape Planning and Design Under the Background of Beautiful Rural Construction. Agricultural Economy, 2022(04): 71–73.

[11] Tang A, 2022, Research on the Current Situation and Countermeasures of Building Beautiful Villages Under the Background of New Urbanization. Smart Agriculture Guide, 2(05): 107–109.

[12] Da X, Zuo X, Ma L, et al., 2021, Analysis on the Urban Rural Construction Planning of Jiayuguan City Under the Guidance of the Implementation of Rural Revitalization Strategy. Planner, 37(18): 65–72.

[13] Chen G, Pei S, 2021, Problems and Countermeasures in the Construction of Beautiful Villages in Pu Town, Fanxian County. Rural Science and Technology, 12(06): 11–12.

[14] Zhang Y, 2017, Problems Faced Under the Development of New Urbanization – Thoughts on the Current New Urbanization, Characteristic Towns, and Beautiful Rural Construction. Sino Foreign Architecture, 2017(06): 101–103.

[15] Pan Q, 2020, Discussion on the Development of Rural Tourism in Zaozhuang Under the Background of New Urbanization – Based on the Enlightenment of Rural Tourism Development in Provence, France. Contemporary Economy, 2020(04): 75–77.

[16] Sun L, Duan Y, 2018, Research on the Current Situation and Countermeasures of Building Beautiful Villages Under the Background of New Urbanization. Journal of Changchun University of Technology (Social Science Edition), 31(04): 123–126.

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Analysis of the Degree of Convenience of Xi'an Metro Station

Baoping Zeng*, Yonggang Li, Wanglong Jia, Hengbo Luo

China MCC22 Group Corporation Ltd., Xi'an 710061, Shaanxi Province, China

****Corresponding author:*** Baoping Zeng, zengbaoping@aliyun.com

Abstract: Urban subways have developed rapidly in recent years and has gradually become the primary choice of public transportation in big cities. Subways can effectively alleviate urban traffic congestion and improve passengers' green travel experience, especially in the old urban areas where urban space is limited, community facilities are aging and historical features are gathered. Subways play a huge role in guiding the expansion of urban space form and improving urban landscape environment. As the only channel for passengers to get in and out of the station, the subway entrance and exit act as a bridge. It is not only the transition space between the subway station space and the urban above ground space, but also an important node for the exchange and circulation of various elements in the urban space. In this paper, the influencing factors of subway entrance and exit space environments in the old city were investigated, and relevant basis for future planning, design, and construction of subway entrances and exits were provided. Firstly, the research results and shortcomings of subway entrance and exit channels were outlined. Secondly, based on the perspective of residents and passengers, this paper uses the analytic hierarchy process to determine six first-class evaluation indexes, including safety, convenience, practicability and aesthetics. This paper constructs the evaluation system of spatial environment index of subway station entrances and exits in the old urban area of Xi'an. Lastly, according to the evaluation results, the paper puts forward the targeted optimization strategies for the current situation of the entrance and exit space environment of the subway stations in the Xi'an.

Keywords: Subway entrance; Space environment; Evaluation system; Optimization strategy

Online publication: September 27, 2022

1. Research Background

Urban subways have developed rapidly in recent years due to its advantages of being a high-speed way, having large capacities, as well as being safe and comfortable. Thus, urban subways have gradually become the backbone of public transportation in large cities. The subway has played a huge role in improving traffic congestion in big cities, improving the green travel experience of passengers, improving the efficiency of land development and utilization, guiding the expansion of urban spatial forms, and improving the urban landscape environment. The "four-network integration" in transportation establishes a multi-level rail transit network system, and realize the highly integrated development of rail transit, railways and cities; it connects cities, realizes regional networking, urban integration, one-vote urbanization, and provides a basic realization path for the realization of the construction goal of "city on track" [1–3].

At the end of 2021, Xi'an City has ushered in a new era of large-scale networked operation of lines. The operating mileage was expected to reach 258 kilometers; the number of operating stations and the passenger volume was expected to exceed 159 and 1.02 billion, respectively [4,5]. During the 14th Five-Year Plan period, with the operation of the line under construction and the approval and implementation of the third-phase construction plan, it was expected that by the end of 2025, Xi'an will form an operating line network with a scale of more than 400 kilometers, and the number of operating stations will exceed 250, and subway traffic will account for public transportation. The share rate will reach more than 60%, and the construction of "Xi'an on the track" will gradually take shape [6,7].

2. Literature review

There are many research angles on subway stations and urban spaces: involving subway and urban land value, composite utilization between subway and urban public space, station passenger flow characteristics and station types, and so on. In the research on the spatial remodeling of different types of subway stations, many scholars also have done targeted research:

Leng Hulin investigated the relationship between subway entrances and exits and the surrounding space, and also the connection between the subway entrances and exits of Beijing and Shanghai and the surrounding spaces [8–10]. The subway entrances and exits mainly reflect the city's history and culture, and the same urban material [11,12]. At the same time, according to the connection between subway entrances and exits and different urban spaces, the advantages and disadvantages of using 3 different spaces including road space, building space and open space to set subway entrances and exits will be discussed [13–15].

It is worth noting that in recent years, many researchers have carried out numerous studies on the site and its surrounding space from the perspective of urban planning and updating, mostly in the following aspects: the evolution of urban space, the integration of commercial complex and site space, integration of urban above-ground and underground spaces, and so on [16–18]. It can be seen that extensive domestic research has been done on rail transit station space, and this research will carry out further research and experiments on this.

3. Convex space fabric accessibility evaluation

3.1. Lijiacun station hall floor

3.1.1. Integration analysis

The degree of integration refers to the degree of agglomeration or dispersion between an element and other elements in a space system, which measures the ability of a space to attract arriving traffic as a destination, and reflects the centrality of the space in the entire system. The higher the integration, the higher the accessibility, the stronger the centrality, and the easier it is to gather people. The integration degree can be divided into global integration degree and local integration degree. The global integration degree refers to the degree of agglomeration or dispersion between an element and other elements in a space system, which measures the ability of a space to attract arriving traffic as a destination, and reflects the centrality of the space in the entire system. The higher the integration, the higher the accessibility, the stronger the centrality, and the easier it is to gather a crowd. The degree of local integration reflects the degree of agglomeration between a certain space and adjacent spaces. In this study, the number of steps, n, is set to 3, 5, 7, and 9. In space syntax, the degree of fit, R, in the mathematical regression line, a trend line was plotted to express the relationship between the degree of global integration and the degree of local integration. The relationship between the global integration degree and the local integration degree indicates the degree of coordination of the overall space; the relationship between spatial structures was calculated by categorizing and using quantitative data calculation methods. The higher the integration value of a space, the better the spatial permeability. The graphs analyzed are from warm to cool colors: The warmer the color, the higher the integration degree and vice versa.

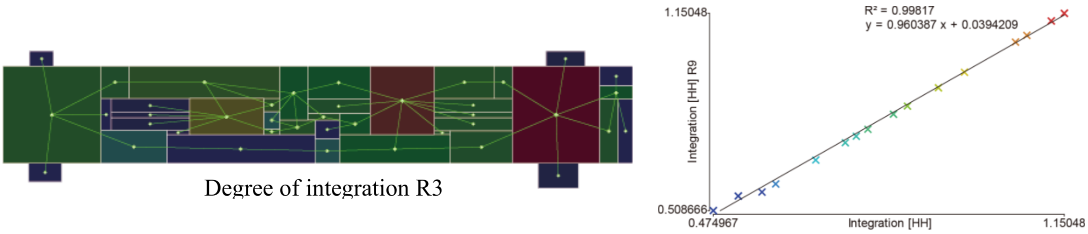


Figure 1. Model simulation of regional integration degree R3 of Lijiacun station hall floor

Figure 1 shows the model simulation of the integration degree R3 of the Lijiacun station hall area, which refers to other convex spaces that can be reached from a certain convex space within three topological space distances. Due to the different topological relations between the various convex spaces, the spatial depth of each convex space is different. Topological space depth can be simply understood as the reach ability of its convex space. The space with strong accessibility is easy to be used as a distribution center and a space for traffic flow. The right side is the linear regression analysis of the integration degree of R3 and the global integration degree. The overall R^2 value is greater than 0.5, which indicates a linear correlation, indicating that the research is representative of the actual situation with insignificant differences.

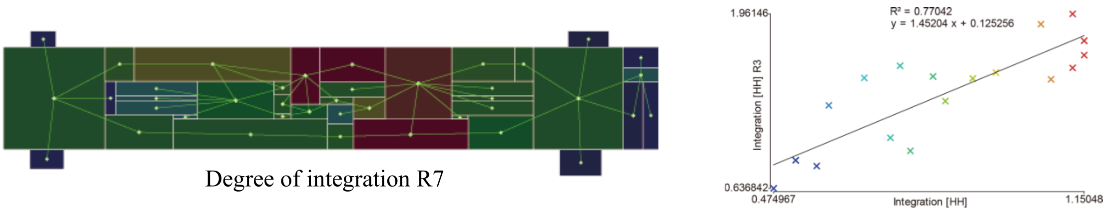
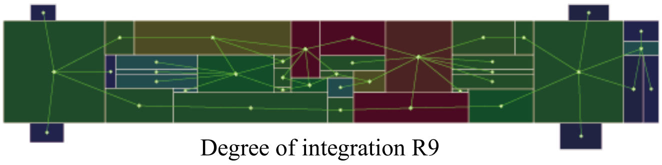


Figure 2. Model simulation of regional integration degree R7 of Lijiacun station hall floor

Figure 2 shows the model simulation of the regional integration degree R7 of the Lijiacun station hall layer. The deeper the topology, the closer it is to the global integration degree. The direction of divergent topological spaces is limited, which sometimes affects spatial depth and accessibility. Based on accessibility of each space at different topological depths, the R value is above 0.5, which means that the degree of fitting and spatial accessibility is good. The fit axis reflects the fit of the two different spaces.

3.2.2. Selectivity analysis

The degree of selectivity refers to the frequency of an element in the space system as the shortest topological distance between two nodes. Considering the advantages of the space unit as the shortest path for travel, it reflects the possibility of the space being traversed. The higher the degree of selectivity, the more likely to be traversed by people. The degree of selectivity refers to the relationship between the topological depth of each space and the degree of selection of people flow, and also represents the importance and accessibility of each space.



Degree of integration R9

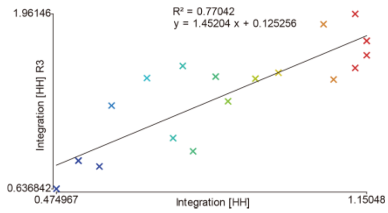


Figure 3. Degree of choice R9 and simulation diagram

Figure 3 is the model simulation of the selectivity R9 of the Lijiacun station hall floor. Based on the upper and lower figures together, a similar conclusion can be drawn. The replacement space in the middle is affected by the accessibility and activity of the stairs, elevators and straight ladders, making this area the most selective space. In other words, it can be called a must-pass place for people; the second focus is on the east and west distribution sites and the connecting corridor to the north. Compared with the previous selectivity analysis, the inaccuracy of the topological depth of the edge convex space was removed, so that the overall core area has a higher selectivity.

It can be seen here that in the convex space where the core space of people flow interaction is located where the east and west elevators are located [19]; secondly, it extends outwards. Since there are more choices of routes to go to the east and west ends, people will choose to stay in the middle, which is also a crowd control problem that will occur in practice. For example, at the peak of people-flow, certain carriages will be crowded and others would be uncrowded [20].

4. Conclusion

Xi'an faces various problems such as lack of public space, traffic congestion, aging community facilities, and the need for protection of historical features. The construction of the subway has improved the mobility and accessibility of the urban area, and the environment of subway entrances and exits has improved the tolerance and connection of the urban area. The integration and re-creation of rail transit and urban space will greatly promote the vitality and recovery of the urban area.

In conclusion, this paper uses the environmental spatial evaluation index system of subway entrances and exits based on AHP to evaluate a representative subway station entrance and exit in Xi'an urban area. Among them, Lijiacun Station is a transportation hub station, and the efficiency of the entrance and exit needs to be further improved. This includes improvement in walking time and walking distance; the evaluation results reflect the applicability of subway entrances and exits in various first-level indicators.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Leng H, 2012, Research on the Interaction Between Subway Entrance and Exit and Surrounding Space, dissertation, Southwest Jiaotong University.

[2] Zhuang Y, Yuan M, 2017, Station-City Synergy: The Distribution and Performance of Space Use in Rail Station Areas, Tongji University Press, Shanghai.

[3] Wang H, 2012, Research on Residential Space Design Along Beijing Rail Transit. Beijing University of Civil Engineering and Architecture.

[4] Chen F, 2011, Analysis and Design of Urban Spatial Form Characterization Around Transportation Hubs in Urban Central Areas dissertation, Beijing Jiaotong University.

[5] Liu J, 2018, Research on the Optimization of Block Space Around the Rail Transfer Station in the Main City of Chongqing, dissertation, Chongqing University.

[6] Oliveroverbel R, Moreno T, Fernándezarribas J, et al., 2021, Organophosphate Esters in Airborne Particles from Subway Stations. The Science of the Total Environment, 769: 145105.

[7] López-Contreras N, Puig-Barrachina V, Vives A, et al., 2021, Effects of an Urban Regeneration Program on Related Social Determinants of Health in Chile: A Pre-Post Intervention Study. Health and Place, 68: 102511.

[8] Nielsen KS., Cologna V, Lange F, et al., 2021, The Case for Impact-Focused Environmental Psychology. https://www.doi.org/10.31234/osf.io/w39c5

[9] Lo S–C，Chang W-J, 2012, Design of Real-Time Fuzzybus Holding System for the Mass Rapid Transit Transfer System. Expert System with Applications, 39(2): 1718–1724.

[10] Guo S-X, Lei Y, Chen X–M, et al., 2011, Modelling Waiting Time for Passengers Transferring from Rail Tobuses. Transportation Planning and Technology, 34(8): 795–809.

[11] Nielsen OA, Eltved M, Anderson MK, et al., 2021, Relevance of Detailed Transfer Attributes in Large-Scale Multimodal Route Choice Models for Metropolitan Public Transport Passengers. Transportation Research Part A: Policy and Practice, 147: 76–92.

[12] Yuan F, Yuan H, Wu S, et al., 2021, A Study on the Pedestrian Accessibility of the Subway Transfer Space Based on the Empirical Analysis of Space Syntax—Taking the T2 Terminal of Chengdu Shuangliu Airport as an Example. Journal Of Housing Environment, 36(06): 83–91. https://www.doi.org/10.13791/j.cnki.hsfwest.20210611

[13] Jiang F, 2001, Research on the Relationship Between Rail Transit Demand Forecast and Urban Passenger Transportation Hub. Transportation Systems Engineering and Information, 1(4): 311–315.

[14] Sun L-S, Rong J, Yao L-Y，et al, 2012, Entropy-Based Estimation of Transfers in a Terminal. Transportation Planning and Technology, 35(3): 305–315.

[15] Zhou W, Jiang C, 2005, Research on Passenger Transfer in Urban Transportation Hubs. Transportation System Engineering and Information, 5(5): 23–30.

[16] Nie T, Zheng W, Sun Y, et al., 2019, An Evaluation Method for Passenger Transfer Service Level In A Comprehensive Passenger Hub. Transportation Research, 5(6): 4–49.

[17] Zhao Q, 2019, Research on the Accessibility of Large Railway Passenger Station Transfer Station Hall Based on Space Syntax—Taking Nanjing South Railway Station as an Example. Urban Architecture, 16(12): 17–22. https://www.doi.org/10.19892/j.cnki.csjz.2019.12.005

[18] Sun H, Liu W, 2019, Research on Space Line-of-Sight Optimization for Super-Large Railway Station Transfer Based on Space Syntax. Huazhong Architecture, 37(03): 50–55.10.13942/j.cnki.hzjz.2019.03.012

[19] Hu B, Ni Z, Lv Y, 2016, Depth Map-Based Optimal Design of Subway Station Transfer Space Orientation. Urban Express Rail Transit, 29(01): 30–34.

[20] He H, 2014, Research on the Evaluation of the Guidance Sign System of The High-Speed Railway Passenger Terminal Station, dissertation, Southwest Jiaotong University.

Journal of Architectural Research and Development, 2022, Volume 6, Issue 5
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Comparison of Illuminance in Different Environments: A Case Study on Subway Stations

Tao Wang*, Jie Su

China Railway Siyuan Survey and Design Group Co., Ltd, Wuhan 430063, Hubei Province, China

****Corresponding author:*** Tao Wang, wangtaozhongtie4@aliyun.com

Abstract: With urbanization and the rapid development of social economy, China's rail transit industry has developed rapidly in recent years. In order to alleviate the pressure of road network, subways provide convenience as they are fast and space-saving. Subway stations are major energy consumers of urban power grid due to their large traffic volume and long operation time. On the premise of ensuring operation safety, reducing the energy consumption of subway helps in energy conservation and emission reduction as proposed in the 13th Five-Year Plan. According to the statistics of the energy-saving evaluation report of rail transit engineering, the lighting system accounts for 20%–30% of the total power consumption of the subway station. Due to the single lighting control mode of the lighting system in the subway station, the actual station illumination cannot be reported and adjusted in time, resulting in the waste of lighting energy and high power consumption of the system. Through in-depth research on the intelligent lighting system of subway station, this paper improves the system control, and finally summarizes the optimization scheme of subway station lighting design which can effectively save the power consumption of lighting system. The main contents of this paper are as follows: The research results of this paper can provide effective measures for energy saving of electric lighting in subway stations and reduce electric energy consumption; on the other hand, as an integral part of building lighting energy-saving system, it also has certain guiding significance for the research of building lighting energy-saving.

Keywords: Subway illumination; Architectural lighting; Indoor thermal environment

Online publication: September 27, 2022

1. Introduction

The comprehensive energy consumption level of rail transit is lower than other forms of transportation with similar capacity. However, due to the large traffic volume and long operation duration, the total power consumption of rail transit is still high. Therefore, the power consumption of rail transit still has the potential of energy saving to a certain extent. In recent years, the subway construction scale and planned routes have been further expanded with growing investments and increasing construction speed. Facing such a huge urban rail transit network, subway has become the main electrical consumption equipment of the city. In order to respond to the 13th Five-Year Plan for building energy conservation and green building development issued by the Ministry of housing and urban rural development and implement the objective requirements of national energy construction and production [1–3], the goal of energy conservation and emission reduction should be reflected in the whole process of subway design. Therefore, the construction of rail transit should be people-oriented and be fast, convenient, and punctual. At the same time, according to the basic principle of energy conservation, the management of energy conservation and emission reduction of rail transit should be improved, the cost of energy use should be reduced, the utilization efficiency of energy should be increased, and the pollution of resources and environment should be reduced [4–6].

It can be seen from **Table 1** that the lighting system occupies 15% – 35% of the energy consumption of the whole subway station. According to the 2016 urban rail transit report, there were at least 260 subway lines under construction in China [1]. Although the scale of subway stations and the lighting scale are small, considering the large number of subway lines, their scale and number far exceed that of large buildings. In view of such high lighting energy consumption, reduction of energy consumption of the lighting system, improvement of the utilization rate of lamps, proper utilization of existing resources on the premise of meeting the working lighting of subway stations has long-term significance for the development of urban rail transit in the future [7–9].

Table 1. Total electricity consumption forecast for the entire station of the Metro Line 2

		Initial stage			The near future			Future		
Name of lighting load		**Power (Kw)**	**Average daily power consumption time (h)**	**Total annual electricity consumption (10^4 kWh/year)**	**Power (Kw)**	**Average time of power consumption (h)**	**Total annual electricity consumption (10^4kWh/year)**	**Power (Kw)**	**Average time of daily power consumption (h)**	**Total annual electricity consumption (10^4 kWh/year)**
Emergency light		8	24	7	8	24	7	8	24	7
Equipment area lighting		40	18	26.3	40	18	26.3	45	18	29.6
Public area lighting	*Electricity saved*	20	18	13.1	20	12	8.8	20	12	8.8
	Work	20	12	23.4	54	12	23.5	62	12	27
Other lighting loads such as advertisers		53	12	23.4	54	12	23.5	62	12	27
Total		-	-	78.6	-	-	78.7	-	-	85.5

2. Literature review

2.1. Foreign Research Status

Subway is an important mode of transport is many countries. Since the official construction of the world's first subway in London, the British capital, in 1863, nearly 300 subway lines have been constructed in more than 80 cities around the world, with a total length of more than 5100 km [10]. The research on lighting design abroad is more in-depth, and various countries have formulated corresponding lighting design standards of underground railways.

Germany, Singapore and Japan attach great importance to the design of subway lighting, emphasize comfort, use lighting to enhance the appearance of space, and make full use of the hierarchical design of lighting in lighting engineering [11,12]. OSRAM lighting company provided lighting for 162 New Delhi metros in India, installed parallel strip light panels on their roofs, and used the lighting control system to adjust and control the lamps within the predetermined range, which not only provided high-quality visible light, but also arranged the ceiling of the station in an artistic way, with excellent ornamental performance [13.14].

2.2. Domestic research status

In the early stage of subway construction and development, according to the specific practice of subway construction, China has designed the national standards: "Subway Lighting Standard" (GB/T 16275-1996) and "LED Lighting Design Standard for Subways Stations" (DB44/T 1620-2015), which stipulate the lighting degree, color temperature and lighting density of subway platforms [15]. At the same time, passageways, waiting halls, transitional passageways and other functional spaces were also given attention. Due to the lack of computer technology, the unified lighting layout causes no sense of hierarchy in the lighting and are unable to act as guides. The designed lighting environment is difficult to make passengers feel comfortable [16]. In the next 10 years, China's rail transit construction will enter an unprecedented period of prosperity. With the continuous improvement and perfection of lighting system design, intelligent lighting system will become a new direction in the field of lighting control [17,18].

3. Methodology (Data collection)

3.1. Experiment set-up

The research object of this project is Xi'an Lijiacun subway station. The research results of this paper can provide effective measures for energy saving of electric lighting in subway stations and reduce electric energy consumption. The performance of the instruments used are shown in **Table 2**.

Table 2. The performance of the instruments

Instrument	Measuring range	Measurement accuracy	Equipment size	Work environment
Noise detector (noise0501)	30db–120db	±0.5db	8*5*12cm	Air temperature: -40％~+60％ Relative humidity: 25％~90％ Static pressure: 65kpa~106kpa
Wind speed detector (wind0501)	0.2m/s–10m/s	±0.02m/s	8*5*12cm	-10℃~+50℃
Black ball temperature/ Humidity detector/ Illuminance detector	Illumination: 0~65535lux Humidity: -40℃~+125℃ Black ball: -10℃~+85℃	Humidity: ±0.3℃，±2％RH Black ball: ± 0.5℃	12*8*6cm	

The parameters measured in the study includes: wind speed, noise, black ball temperature, humidity and illumination information of the subway station.

The wind speed and noise information were recorded once every minute; the collection interval of temperature, humidity and illumination information was once every 10 minutes. The collected information will be uploaded to the server of the equipment operator and stored. The stored information can be viewed and downloaded at any time.

The period of data collection was from July 15, 2021 to August 10, 2021. All equipment operated continuously for 24 hours during the testing period.

All equipment monitored were non-radioactive and were placed against the wall, with a total floor space of about 1.5 square meters. Therefore, the operation of the subway was be affected during the monitoring period.

4. Results
4.1. Illuminance
4.1.1. Underground is measured two-point illumination description

Table 3. A1, A2 point illumination description

	A1 point illumination（lx）	A2 point illumination（lx）
Mean	123	118.52
Median	121	136
Max	126	145
min	110	81

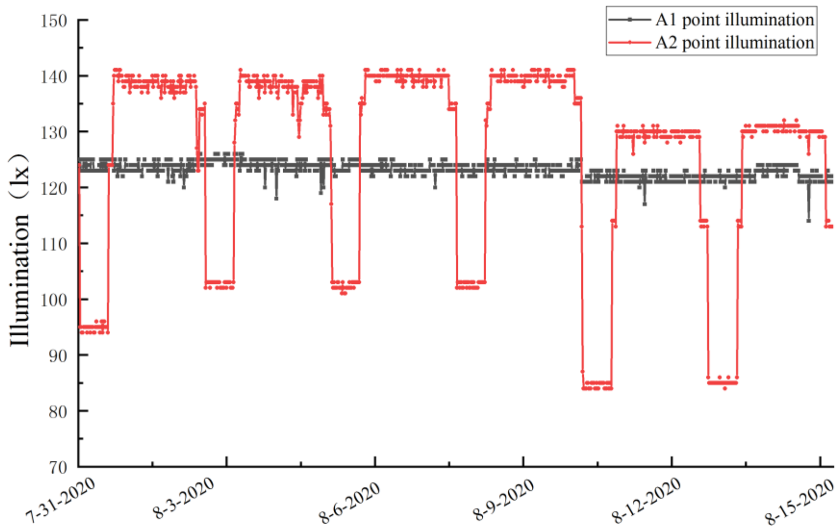


Figure 1. Scatter-point line chart of illuminance at each point on weekdays

(1) During the period of data collection, the illumination sensor is used to continuously collect the illuminance data on the two collection points A1 and A2 every 10 minutes, and the total data collected was 3744 copies (1872 copies of data for each collection point).
(2) As shown in **Figure 1**, it is the illumination change diagram of the two collection points. It can be seen from the figure that the illuminance value fluctuates up and down within 95(lx)-140(lx).
(3) As we can see from **Table 3** and **Figure 1**:

The peak value of the illuminance changes at point A1 is 142 (lx), which mainly occurs at 7:50 on August 9, 18:50-22:30 on August 9, and 9:20-13:10 on August 10. The illuminance changes at point A1 The valley value of 84(lx) mainly appeared on August 10th at 22:40-23:50;

A2 point illuminance change is relatively stable, there is not much fluctuation, it has been around 123lx. However, at 22:00 on August 14th the illuminance value was reduced to 110lx.

4.1.2. Compare with national standards
Underground space is one of the important public spaces in the city, and its sound, light and heat environments are crucial to residents' physical and mental health and ride comfort. At present, the domestic

illumination standards for subway spaces are based on GB 50034-2018 “Architectural Lighting Design Standards”, GB 50016-2014 “Code for Fire Protection in Architectural Design”, GB/T16275-2008 Urban Rail Transit Lighting” whereas the designs are according to the relevant content of national standards such as 06DX008-1 “Electrical Lighting Energy Saving Design” [19]. The lighting power density value of the relevant space can used as a reference to better control the lighting energy consumption of the subway station, so as to guide the designer to in saving lighting energy while making a comfortable light environment.

5. Conclusion

Good lighting design and improving the design of the lighting control system in subway stations has gradually become an important part of modern subway stations. Because the current lighting and control technology in the existing subway station lighting system is relatively outdated, and there is a lack of consideration for passengers’ vision and energy saving, it is necessary to optimize the existing subway station lighting system.

With the continuous improvement of lighting system design, the application of lighting system in new urban subway stations will increase with more variety of systems. As for now, the lighting system only satisfies the comfort of the light environment, and is slightly lacking in the artistic expression of the light environment of the station. Relying on the characteristics of intelligent lighting single lamp dimming, various control modes, and the ability to monitor and control the status of each lamp, the future intelligent lighting control can achieve a variety of lighting effects, making the light environment of subway stations more beautiful and intelligent.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Deng Q, 2019, Research on the Development Trend of Urban Rail Transit Energy Saving Technology. Traffic World, 2019(Z1): 250–251.

[2] Zou H, 2014, Design and Implementation of Urban Smart Lighting System in Tongzhou District, Beijing, dissertation, Tianjin University.

[3] Yu X, 2007, Simulation and Research on Passenger Flow and Vehicle Flow in Urban Rail Transit, dissertation, Beijing Jiaotong University.

[4] Tan B, Liu J, 2017, Design of Distributed Intelligent Lighting Control System Based on IEC 61499. Modern Electronic Technology, 40(22): 182–186.

[5] Kim I-T, Jang I-H, Choi A-S, et al., 2015, Brightness Perception of White LED Lights with Different Correlated Color Temperatures. Indoor and Built Environment. 24(4): 500–513

[6] Hou X, Duan Z, Ma B, 2014, Research on Intelligent Control of Artificial Light Environment in Urban Subway Stations. Industrial Control Compute, 27(05): 79–80 + 83.

[7] Li C, 2012, Research on Thermal Environment Characteristics of Residential Areas Based on Planning Elements, dissertation, Anhui University of Architecture.

[8] Zhao W, 2016, Research on Optimal Design of Sound and Light Environment in Commercial Building Atrium, dissertation, Wuhan University.

[9] Yu W, 2018, Research on the Interactive Relationship Between the Spatial Structure of Villages in

Severe Cold Regions and the Traffic Sound Environment, dissertation, China University of Mining.

[10] Izadi T, Mehrabian MA, Ahmadi G, et al., 2021, Numerical Analysis of the Mirco-Particles Istribution Inside an Underground Subway System due to Train Piston Effect. J. Wind Eng. Ind. Aerod, 211: 104533.

[11] Shakya KM, Saad A, Aharonian A, 2020, Commuter Exposure to Particulate Matter at Underground Subway Stations in Philadelphia, Build. Environ. 186: 107322.

[12] Moreno T, Reche C, Minguillón MC, et al., 2017, The Effect of Ventilation Protocols on Airborne Particulate Matter in Subway Systems. Sci. Total Environ, 584-585: 1317–1323.

[13] Kim K-H, Ho DX, Jeon J-S, et al., 2012, A Noticeable Shift in Particulate Matter Levels After Platform Screen Door Installation in a Korean Subway Station, Asian J. Atmos. Enviro 49: 219–223.

[14] Chen T, Cao SJ, Wang J, et al., 2021, Influences of Optimized Air Curt at Subway Entrance to Reduce the Ingress of Outdoor Airborne Particles. Energ. Buildings, 244: 111028.

[15] Park S, Kim M, Kim M, et al., 2018, Predicting PM10 Concentration in Seoul Metropolitan Subway Stations Using Artificial Neural Network (ANN), J. Hazard. Mater. 341: 75–82.

[16] Lee S, Hwangbo S, Kim JT, et al., Gain Scheduling-Based Ventilation Control with Varying Periodic Indoor Air Quality (IAQ) Dynamics for Healthy IAQ and Energy Savings. Energ, Buildings 153: 275–286.

[17] Kim MJ, Sankara Rao B, Kang OY, et al., 2017, Monitoring and Prediction of Indoor Air Quality (IAQ) in Subway or Metro Systems Using Season Dependent Models, Energ, Buildings 46: 48–55.

[18] Wang J, Huang J, Feng Z, et al., 2021, Occupant-density-detection based energy effificient ventilation system: Prevention of infection transmission, Energ. Buildings 240: 110883.

[19] Peng J, Kimmig A, Wang J, et al., 2021, Dual-Stage Attention Based Long-Short-Term Memory Neural Networks for Energy Demand Prediction, Energ. Buildings 249: 111211.

Author Guidelines

Before your submission, please check that your manuscript has been prepared in accordance to the step-by-step instructions for submitting a manuscript to our online submission system. We recommend that you keep this page open for your reference as you move through the submission process.

If there are any differences in author guidelines between the print and online version, it is recommended that authors refer to the online version for use.

Manuscript Format

Journal of Architectural Research and Development accepts manuscript that is in MS Word or LaTeX format. All manuscripts must be written in clear, comprehensible English. Both American and British English are acceptable. Usage of non-English words should be kept to a minimum and all must be italicized (except for e.g. and i.e.) If you have concerns about the level of English in your submission, please ensure that it is proofread before submission by a native English speaker or a scientific editing service.

Cover letter

All submissions for *Journal of Architectural Research and Development* should include a cover letter as a separate file. A cover letter should contain a brief explanation of what was previously known, the conceptual advancement with the findings and its significance to broad readership. The cover letter is confidential and will be read only by the editors. It will not be seen by reviewers.

Title

The title should capture the conceptual significance for a broad audience. The title should not be more than 50 words and should be able to give readers an overall view of the paper's significance. Titles should avoid using uncommon jargons, abbreviations and punctuation.

List of Authors

The names of authors must be spelled out rather than set in initials with their affiliations footnoted. Authors should be listed according to the extent of their contribution, with the major contributor listed first. All corresponding authors (maximum 2) should be identified with an asterisk. Affiliations should contain the following core information: department, institution, city, state, postal code, and country. For contact, email address of only one corresponding author is expected within the manuscript. Please note that all authors must see and approve the final version of the manuscript before submitting.

Abstract

Articles must include an abstract containing a maximum of 200 words. The purpose of abstract is to provide sufficient information for a reader to choose either to proceed to the full text of the article. After the abstract, please give 3-8 key words; please avoid using the same words as those already used in the title.

Section Headings

Please number all section headings, subheadings and sub-subheadings. Use boldface to identify major headings (e.g. **1**, **2**, **3**, etc.) and subheadings (e.g. **1.1**, **1.2**, **2.1**, **2.2** etc.) For the sub-subheadings, please distinguish it further using non-boldface numbers in parenthesis (e.g. (1), (2), (3), etc.)

Introduction

Introduction should provide a background that gives a broad readership an overall outlook of the field and the research performed. It tackles a problem and states its important regarding with the significance of the study. Introduction can conclude with a brief statement of the aim of the work and a comment about whether that aim was achieved.

Materials and Methods

This section provides the general experimental design and methodologies used. The aim is to provide enough detail to for other investigators to fully replicate your results. It is also required to facilitate better understanding of the results obtained. Protocols and procedures for new methods must be included in detail to reproduce the experiments.

Ethics

Ethics information, including IACUC permit numbers and/or IRB name, if applicable. This information should be included in a subheading labelled "Ethics Statement" in the "Methods" section of your manuscript file, in as much detail as possible.

Results

This section can be divided into subheadings. This section focuses on the results of the experiments performed.

Discussion

This section should provide the significance of the results and identify the impact of the research in a broader context. It should not be redundant or similar to the content of the results section.

Conclusion

Please use the conclusion section for interpretation only, and not to summarize information already presented in the text or abstract.

Conflict of Interest

All authors are required to declare all activities that have the potential to be deemed as a source of competing interest in relations to their submitted manuscript. Examples of such activities could include personal or work-related relationships, events, etc. Authors who have nothing to declare are encouraged to add "No conflict of interest was reported by all authors" in this section.

Funding

Authors should declare all financial and non-financial support that have the potential to be deemed as a source of competing interest in relations to their submitted manuscript in this section. Financial supports are generally in the form of grants, royalties, consulting fees and more. Examples of non-financial support could include the following: externally-supplied equipments/biological sources, writing assistance, administrative support, contributions from non-authors etc.

Appendix

This section is optional and is for all materials (e.g. advanced technical details) that has been excluded from the main text but remain essential to readers in understanding the manuscripts. This section is not for supplementary figures. Authors are advised to refer to the section on 'Supplementary figures' for such submissions.

Text

The text of the manuscript should be in Microsoft Word or Latex. The length of the manuscript cannot be more than 50000 characters (inclusive of spaces) or approximately 7000 words.

Nomenclature for genes and proteins

This journal aims to reach researchers all over the globe. Hence, for both reviewers' and readers' ease in comprehension, authors are highly encouraged to use the appropriate gene and protein nomenclature. Authors may prefer to utilize resources such as http://www.ncbi.nlm.nih.gov/gene

Figures

Authors should include all figures into the manuscript and submit it as 1 file in the OJS system. Reference to the "Instructions for Typesetting manuscript" is strongly encouraged. Figures include photographs, scanned images, graphs, charts and schematic diagrams. Figures submitted should avoid unnecessary decorative effects (e.g. 3D graphs) as well as be minimally processed (e.g. changes in brightness and contrast applied uniformly for the entire figure). It should also be set against a white background. Please remember to label all figures (e.g. axis etc.) and add in captions (below the figure) as required. These captions should be numbered (e.g. **Figure 1**, **Figure 2**, etc.) in boldface. All figures must have a brief title (also known as caption) that describes the entire figure without citing specific panels, followed by a legend defined as description of each panel. Please identify each panel with uppercase letters in parenthesis (e.g. A, B, C, etc.)

The preferred file formats for any separately submitted figure(s) are TIFF or JPEG. All figures should be legible in print form and of optimal resolution. Optimal resolutions preferred are 300 dots per inch for RBG coloured, 600 dots per inch for greyscale and 1200 dots per inch for line art. Although there are no file size limitation imposed, authors are highly encouraged to compress their figures to an ideal size without unduly affecting legibility and resolution of figures. This will also speed up the process of uploading in the submission system if necessary.

The Editor-in-Chief and Publisher reserve the right to request from author(s) the high-resolution files and unprocessed data and metadata files should the need arise at any point after manuscript submission for reasons such as production, evaluation or other purposes. The file name should allow for ease in identifying the associated manuscript submitted.

Tables, lists and equations

Tables, lists and equations must be submitted together with the manuscript. Likewise, lists and equations should be properly aligned and its meaning clear to readers. Tables created using Microsoft Word table function are preferred. Place each table in your manuscript file right after the paragraph in which it is first cited. Do not submit your tables in separate files. The tables should include a concise but sufficiently explanatory title at the top. Vertical lines should not be used to separate columns. Leave some extra space between the columns instead. All tables should be based on three horizontal lines to separate the caption, header and body. A few additional horizontal lines MAY be included as needed (example below). Any explanations essential to the understanding of the table should be given in footnotes at the bottom of the table. SI units should be used.

Supplementary information

This section is optional and contains all materials and figures that have been excluded from the entire manuscript. This information are relevant to the manuscript but remains non-essential to readers' understanding of the manuscript's main content. All supplementary information should be submitted as a separate file in Step 4 during submission. Please ensure the names of such files contain 'suppl. info'.

In-text citations

Reference citations in the text should be numbered consecutively in superscript square brackets. Some examples:

1. Negotiation research spans many disciplines [3, 4].
2. This result was later contradicted by Becker and Seligman [5].
3. This effect has been widely studied [1–3, 7].

Personal communications and unpublished works can only be used in the main text of the submission and are not to be placed in the Reference section. Authors are advised to limit such usage to the minimum. They should also be easily identifiable by stating the authors and year of such unpublished works or personal communications and the word ‘Unpublished’ in parenthesis.

E.g. (Smith J, 2000, Unpublished)

References

This section is compulsory and should be placed at the end of all manuscripts. Do not use footnotes or endnotes as a substitute for a reference list. The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should be excluded from this section.

For references in reference list, all authors must be stated. Authors referenced are listed with their surname followed by their initials. All references should be numbered (e.g. 1. 2. 3. etc.) and sequenced according to the order it appears as an in-text citation. References should follow the following pattern: Author(s) followed by year of publication, title of publication, full journal name in italics, volume number, issue number in parenthesis, page range and lastly the DOI (if applicable). If the referred article has more than three authors, list only the first three authors and abbreviate the remaining authors to italicized ‘et al.’ (meaning: "and others").

Journal

Journal article (print) with one to three authors

[1] Yao Y., Xia B. Application of Phase Frequency Feature Group Delay Algorithm in Database Differential Access. Computer Simulation, 2014, 31(12): 238-241.

Journal article (print) with more than three authors

[2] Gamelin F.X., Baquet G., Berthoin S., et al. Effect of high intensity intermittent training on heart rate variability in prepubescent children. European Journal of Applied Physiology, 2009, 105: 731–738.

Journal article (online) with one to three authors

[3] Jackson D., Firtko A., Edenborough M. Personal resilience as a strategy for surviving and thriving in the face of workplace adversity: a literature review. Journal of Advanced Nursing, 2009, 60(1): 1–9,

Journal article (online) with more than three authors

[4] Hargreave M., Jensen A., Nielsen T.S.S., et al. Maternal use of fertility drugs and risk of cancer in children—A nationwide population-based cohort study in Denmark. International Journal of Cancer, 2015, 136(8): 1931–1939.

Book

Book with one to three authors

[5] Schneider Z., Whitehead D., Elliott D. Nursing and midwifery research: methods and appraisal for evidence-based practice. 3rd edn. 2009, Elsevier Australia, Marrickville, NSW.

Book with more than three authors

[6] Davis M., Charles L., Curry M.J., et al. Challenging spatial norms. 2013, Routledge, London.

Chapter or Article in Book

[7] Knowles M.S. Independent study. In Using learning contracts. 1986, Jossey-Bass, San Francisco, 89–96.

Others

Proceedings of meetings and symposiums, conference papers

[8] Chang S.S., Liaw L. and Ruppenhofer J. (eds). Proceedings of the twenty-fifth annual meeting of the Berkeley Linguistics Society, February 12–15, 1999: general session and parasession on loan word phenomena. 2000, Berkeley Linguistics Society, Berkeley.

Conference proceedings (from electronic database)

[9] Bukowski R.M. Prognostic factors for survival in metastatic renal cell carcinoma: update 2008. Innovations and challenges in renal cancer: proceedings of the third Cambridge conference. Cancer, 2009, 115 (10): 2273, viewed 19 May 2009, Academic OneFile database.

Online Document with author names

[10] Este J., Warren C., Connor L., et al. Life in the clickstream: the future of journalism, Media Entertainment and Arts Alliance, 2008. viewed 27 May 2009, http://www.alliance.org.au/documents/foj_report_final.pdf

Online Document without author name

[11] Developing an argument n.d., viewed March 30 2009, http://web.princeton.edu/sites/writing

/Writing_Center/WCWritingResources.htm

Thesis/Dissertation

[12] Gale L. The relationship between leadership and employee empowerment for successful total quality management. 2000, University of Western Sydney.

Standard

[13] Standards Australia Online. Glass in buildings: selection and installation. AS 1288–2006. 2006, SAI Global database.

Government Report

[14] National Commission of Audit. Report to the Commonwealth Government, Australian Government Publishing Service, 1996, Canberra.

Government report (online)

[15] Department of Health and Ageing. Ageing and aged care in Australia, 2008, viewed 10 November 2008, http://www.health.gov.au/internet/main/publishing.nsf/Content/ageing

No author

[16] Guide to agricultural meteorological practices. 2nd edn, Secretariat of the World Meteorological Organization, 2010, Geneva.

Note: When referencing an entry from a dictionary or an encyclopedia with no author there is no requirement to include the source in the reference list. In these cases, only cite the title and year of the source in-text. For an authored dictionary/encyclopedia, treat the source as an authored book.

Submission Preparation Checklist

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

1. The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in Comments to the Editor).
2. The submission file is in OpenOffice, Microsoft Word, RTF, or WordPerfect document file format.
3. Where available, URLs for the references have been provided.
4. The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
5. The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines, which is found in About the Journal.
6. If submitting to a peer-reviewed section of the journal, the instructions in Ensuring a Blind Review have been followed.

Integrated Services Platform of International Scientific Cooperation

Innoscience Research (Malaysia), which is global market oriented, was founded in 2016.Innoscience Research focuses on services based on scientific research. By cooperating with universities and scientific institutes all over the world, it performs medical researches to benefit human beings and promotes the interdisciplinary and international exchanges among researchers.

Innoscience Research covers biology, chemistry, physics and many other disciplines. It mainly focuses on the improvement of human health. It aims to promote the cooperation, exploration and exchange among researchers from different countries. By establishing platforms, Innoscience integrates the demands from different fields to realize the combination of clinical research and basic research and to accelerate and deepen the international scientific cooperation.

Cooperation Mode

BIO-BYWORD SCIENTIFIC PUBLISHING PTY LTD

OUR JOURNALS

The *Journal of Architectural Research and Development* is an international peer-reviewed and open access journal which is devoted to establish a bridge between theory and practice in the fields of architectural and design research, urban planning and built environment research.

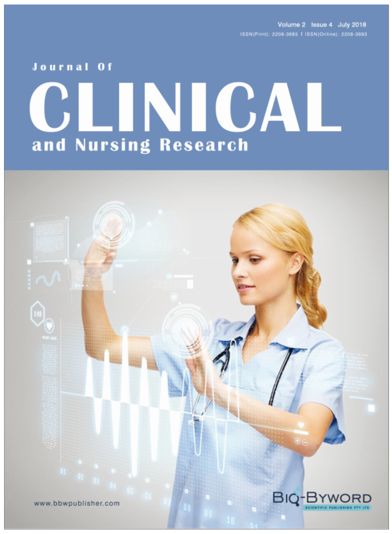
Topics covered but not limited to:

- Architectural design
- Architectural technology, including new technologies and energy saving technologies
- Architectural practice
- Urban planning
- Impacts of architecture on environment

Journal of Clinical and Nursing Research (JCNR) is an international, peer reviewed and open access journal that seeks to promote the development and exchange of knowledge which is directly relevant to all clinical and nursing research and practice. Articles which explore the meaning, prevention, treatment, outcome and impact of a high standard clinical and nursing practice and discipline are encouraged to be submitted as original article, review, case report, short communication and letters.

Topics covered by not limited to:

- Development of clinical and nursing research, evaluation, evidence-based practice and scientific enquiry
- Patients and family experiences of health care
- Clinical and nursing research to enhance patient safety and reduce harm to patients
- Ethics
- Clinical and Nursing history
- Medicine



Journal of Electronic Research and Application is an international, peer-reviewed and open access journal which publishes original articles, reviews, short communications, case studies and letters in the field of electronic research and application.

Topics covered but not limited to:

- Automation
- Circuit Analysis and Application
- Electric and Electronic Measurement Systems
- Electrical Engineering
- Electronic Materials
- Electronics and Communications Engineering
- Power Systems and Power Electronics
- Signal Processing
- Telecommunications Engineering
- Wireless and Mobile Communication