Based on Public-Private Partnership and Building Information Modeling Financial Controllable changes in the Construction of Characteristic Towns

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Abstract Characteristic town construction is one of the key directions for the future development of China's urbanization, designed to promote rural economic and cultural advancement. To effectively enhance the quality and benefits of characteristic town construction, the utilization of public-private partnerships (PPPs) and building information modeling (BIM) offers significant advantages. This paper is a discussion of the applicability and value of the PPP model and BIM technology within characteristic town construction, aiming at providing references for future endeavors in this domain. The development of characteristic towns is a pilot project within China's new urbanization strategy and a crucial pathway to achieve integrated urban-rural development. However, traditional construction methods and their management models have fallen short of meeting the evolving needs of these projects, leading to the adoption of the PPP mode and BIM technology in building characteristic towns. This study primarily focuses on investigating the financial benefits derived from the PPP+BIM model in the construction projects of characteristic towns; the consultation mechanism established in the research results is expected to enhance the implementation efficiency and quality, ultimately contributing to the sustainable development of characteristic town construction.

Keywords: Characteristic town; Public-Private Partnership (PPP); Building Information Modeling (BIM); Cooperation model; Financial Controllable

1 Introduction

As China's urbanization is pressing forward, the construction of characteristic towns has become a key direction for urbanization development, which will promote rural economic growth and improve the quality of the local culture and environment. However, the construction of characteristic towns has also been confronted with quite serious problems[1], such as financial constraints and volatile construction quality. Therefore, it has become an urgent challenge to effectively harness the advantages of combining the public-private partnership (PPP) model with building information modeling (BIM) technology to enhance the investment benefits and construction quality of characteristic towns, so as to promote the healthy development of these towns [2]. Characteristic towns can be categorized into various types with different infrastructure projects, among which some typical types and industrial themes are listed as follows Table 1:

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Table 1 Types and thematic features of characteristic towns

Type	Thematic features
(1) Culture town	Featuring traditions, history, art and culture
(2) Eco-town	Featuring ecological and environmental protection, ecotourism, ecological agriculture, etc.
(3) Leisure town	Featuring leisure and vacation, entertainment and consumption, health and wellness, etc.
(4) Creative town	Featuring creative industries, design and art, science and technology innovation, etc.
(5) Localized characteristic town	Featuring regional characteristics, folk culture, distinctive local businesses, etc.
(6) Tourism town	Featuring tourism resources, tourism services, tourism products, etc.
(7) Historical town	Featuring historical culture, monuments and historic sites, traditional architecture, etc.
(8) Agro-town	Featuring agricultural production, rural tourism, agricultural product processing, etc.

Under the PPP model, a project's financial performance can be planned and forecasted, and BIM technology can be applied to help achieve whole-life-cycle project management, thus ensuring that the optimal balance will be realized in the investment and return of the project. For example, in a road construction project under the PPP model, BIM technology can be adopted to optimize the design and construction plans, so as to improve the design quality and construction efficiency of the road and further reduce the project costs and risks [3][4].

BIM technology can also be used to comprehensively manage the budgeting and cost control of a PPP project, thus ensuring the financial benefits of the project. For example, in a water conservancy project under the PPP model, BIM technology can be applied to carry out all-around budgeting and cost control of the project design and construction, thus effectively reducing the cost and ultimately achieving the financial benefits of the project.

Under the PPP model, the application of BIM technology can help realize the whole-life-cycle management of a project, including design, construction, and operation, among other stages. For example, in a subway construction project under the PPP model, BIM technology can be applied to optimize the project design, improve the design quality and construction efficiency, and monitor and manage the construction and operation process, thus ensuring that the optimal financial and social benefits will be achieved for the project [5].

2 Advantages of Projects Adopting the PPP+BIM Model

The PPP model refers to the cooperation between the government and private sector institutions. In building a characteristic town, the government and private enterprises will jointly participate in the construction and share the benefits arising therefrom according to prior agreements [6]. On the other hand, building information modeling, referred to as BIM, can facilitate information sharing and collaboration in the process of building design and construction. By combining a PPP project with BIM technology, the construction of a characteristic town can be more efficient and transparent, implying the significant value of the PPP+BIM model in the construction of

this type of town. It is a model that can maximize the construction benefits and enhance the competitiveness and sustainable development of characteristic towns.

In the construction of a characteristic town, the following advantages can be reaped by combining the PPP model with BIM technology [2][6][7][8]: (1) Improve project quality. (2) Reduce project cost. (3) Improve project efficiency. (4) Promote sustainable development.

3. Benefits of Development and Construction under the PPP+BIM Model

(1) Promote the reasonable use of funds.

The PPP model allows the government and the enterprises to share both the costs and benefits arising from the construction of a characteristic town, thus increasing the rationality and transparency of the use of funds.

(2) Improve construction efficiency.

BIM technology can help achieve information sharing and collaboration in the building design and construction process, thus improving the quality and reducing the cost and time of the construction.

(3) Achieve scientific management.

The PPP+BIM model can make the management of a characteristic town more scientific and standardized, thus improving the management efficiency and development quality of the town.

(4) Promote social engagement.

The PPP+BIM model can promote the engagement and collaboration of all parties, thus improving social engagement and enthusiasm in building a characteristic town [9].

4. Impacts of the PPP+ BIM Model on Financial Indicators and Financial Consultation and Adjustment Mechanism

4.1 Impacts of the PPP+ BIM model on financial indicators

The PPP+ BIM model can be introduced to improve the financial benefits of a characteristic town for the specific indicators as follows [8] [10] [11]:

(1) Construction cost: BIM technology can optimize the building design and construction of a characteristic town and help to map out construction plans that are more pro-environment, energy-saving and sustainable, thus reducing the construction cost.

(2) Operating income: BIM technology allows a characteristic town to refine its operation management and improve its efficiency and service quality, thus attracting more merchants and tourists and further boosting its income from sales and operation. Meanwhile, the government-enterprise cooperation under the PPP model can facilitate joint exploration and development of the income potentials for the project, thus further increasing the operating income [3].

(3) Operating cost: BIM technology enables real-time monitoring of the facilities and equipment of a characteristic town and facilitates more accurate repair and maintenance, thus reducing operating costs. In addition, under the PPP model, resources of the private sector can be better shared to further bring down the operating cost.

(4) Return on investment (ROI): By optimizing the design and management of a characteristic town, the PPP+ BIM model can help reduce the construction and operating costs of the project and ultimately enhance the project's ROI [4].

(5) Payback period: BIM technology helps improve the construction efficiency and quality of a characteristic town, thus shortening the project's construction cycle and reducing its operating cost, which will lead to a shorter payback period of the investment.

(6) Profit margin: Under the PPP+BIM model, the design and management of a characteristic town can be optimized to enhance its market competitiveness, thus increasing the profit margin and economic benefits of the project. Furthermore, as the PPP model facilitates risk sharing under a project, it helps to reduce the operational risks and uncertainties of the characteristic town.

4.2 BIM technology optimizes the cost control of infrastructure PPP projects.

As an increasing number of enterprises are pushing for digital transformation, the infrastructure sector is shifting from the information technology era into the digital transformation era [12] [7]. For a PPP project, the management could be quite complex as it is a "community of shared interest" model where both the benefits and risks are shared by different parties throughout the whole process from project approval to delivery, and it has been a topic for heated debates and continuous practice in the industry regarding how to use BIM technology to upgrade the management tools, improve the management efficiency, reduce the costs, and increase the benefits [4] [5].

Data on the engineering quantities of a project is often derived from models and two-dimensional drawings. After comparison is done among three quantities: the bill of quantities (BOQ) in the engineering, procurement, construction (EPC) contract, the quantities on the construction drawing, and the modeling quantities, the data resulting therefrom will be passed over to the metering and yield management business (foundation for BIM), of which, the results of engineering quantities and modeling data can be used for cost management through the cost control system at the enterprise level, while the BOQ accounting results can be fed to the metering business. In this way, the utilization and value of the BIM data will be increased through the effective data flow, achieving the integrated management of the investment and cost, as demonstrated in Figure 1 and Figure 2 [18]:

(1) Figure 1 represents the controllable changes of investment costs at different stages of the life cycle of a development project, which shows that each stage is relatively independent and yet interrelated with each other in terms of management features, business flow, output results, and risk domains. As the life cycle evolves, the input of cost and human resources increases and shows an irrationality in the allocation of costs and resources.

(2) Figure 2 shows the controllable changes of investment costs at different stages of the life cycle of the development project with the introduction of the PPP + BIM model, which indicates that expenditure fluctuations can be comprehensively managed within the realm of

cost control to reduce the chance for surges in cost resources. This will help facilitate project implementation and reduce the risk of insufficient resources. The effective management of costs is one of the necessary conditions for but not the only measure of the success of a project. The adoption of BIM technology can promote more scientific cost control, provide more reliable cost data, and make the income-cost relationship more transparent and controllable, which will ultimately help achieve project profitability.

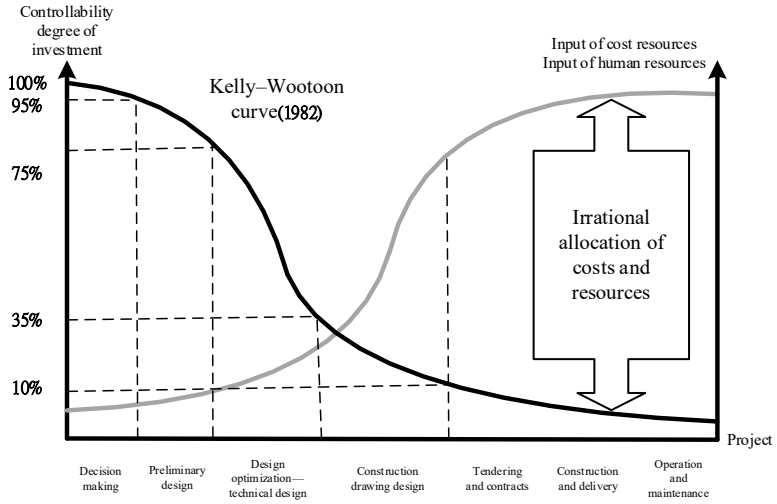

Figure 1 Controllable changes in investment costs at different stages of the life cycle of a development project [18]

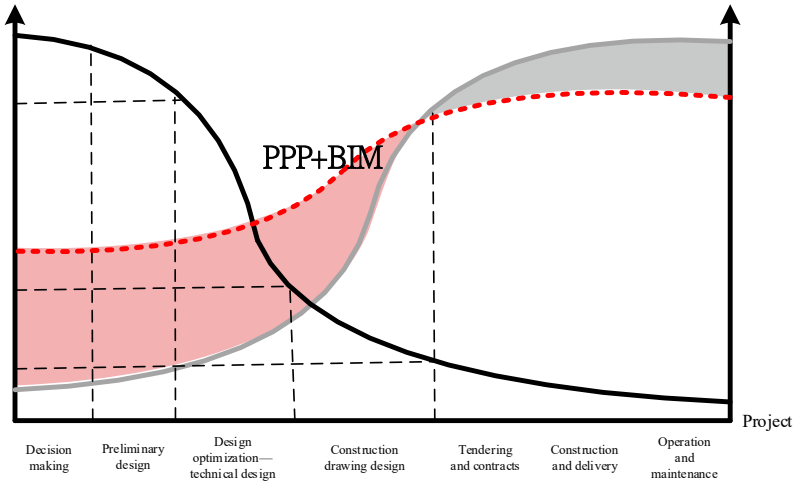

Figure 2 Controllable changes in investment costs at different stages of the life cycle of the development project based on the PPP+ BIM model. [18]

Based on the core technologies of BIM, geographic information system (GIS), business intelligence (BI) and artificial intelligence (AI), the recent Civil Station Construction (CSC for short) focuses on the whole-life-cycle management of engineering and construction projects from different aspects, including quality, safety, progress, investment, contract, staff, materials, machinery and equipment, and intelligent construction site, and a multi-terminal (web, desktop, and mobile) digital management cloud platform has been built, which is efficient, collaborative, and facilitates a high level of concurrency, availability and security [2].

To sum up, studies and trends have shown that the PPP+BIM model can improve the indicators for the financial benefits of a characteristic town through the optimization of the financial consultation mechanism, thus achieving the sustainable development of the town.

For the infrastructure PPP project of a characteristic town, BIM technology can be included to improve the efficiency of the design and construction management[4]. Where subcontracting is used to attract investments, consideration must be given to the different levels of financial development, such as overall financial development, phased financial development, and zoned financial development[13][14][8].

5. Case Study of Projects Adopting the PPP+BIM Model

This study is a discussion on and practice of some of the characteristic towns that have been recently built in China based on the PPP+BIM model with the features: the government and private enterprises have jointly participated in the building of the characteristic towns and the benefits are shared according to prior agreements; secondly, BIM technology has been adopted to promote information sharing and collaboration in the building design and construction process; and the application of the PPP+BIM model has maximized the construction benefits of the characteristic towns and promoted their sustainable economic and cultural development.

The following successful cases have fully demonstrated the effectiveness of the PPP+BIM model in building characteristic towns. Financial controllable changes in the construction of characteristic towns. Significant reduction in input construction cost ratio (11%~22.3%). These instances have underscored the significant role played by the PPP+BIM technology in this context, which can improve the quality of a project's infrastructure construction and the efficiency of its financial benefits and promote the sustainable development of the characteristic town.

(1) The PPP project of the Liandu District Characteristic Town in Lishui City: The characteristic town was jointly built by the government and enterprises with BIM technology used in the design and construction management. The project includes commercial streets, cultural squares, folk villages, leisure parks, etc., with a total investment of approximately RMB 1 billion yuan.

(2) The PPP project of the Guangling District Characteristic Town in Yangzhou City, Jiangsu Province: The characteristic town was jointly built by the government and enterprises with BIM technology used in the design and construction management. The project includes commercial streets, cultural squares, folk villages, leisure parks, etc., with a total investment of approximately RMB 500 million yuan.

(3) The PPP project of the Shimen County Characteristic Town in Changde City, Hunan Province: The characteristic town was jointly built by the government and enterprises with BIM technology used in the design and construction management. The project includes commercial streets, cultural squares, folk villages, leisure parks, etc., with a total investment of approximately RMB 300 million yuan.

6. Conclusion

The PPP+BIM model promises a broad prospect and huge potential in the construction of characteristic towns, where the government, enterprises and residents can jointly participate in building the towns to achieve the balance of interests and maximization of the construction benefits. In addition, the application of BIM technology can help achieve information sharing and collaboration in the process of building design and construction, thus enhancing construction efficiency and quality[15][16][17]. Therefore, combining the PPP model and BIM technology is an effective cooperation model for the building of characteristic towns and can provide strong support for the development of such towns. This paper analyzed the data of the construction projects of several characteristic towns and carried out corresponding empirical research, with the following results identified:

(1) The PPP+BIM model can effectively reduce the construction cost of characteristic towns and improve the project efficiency and quality.

(2) The PPP+BIM model can realize the whole-life-cycle management of the construction projects of characteristic towns, thus improving the project's financial efficiency.

(3) Factors influencing the financial benefits of a characteristic town under the PPP+BIM model include construction costs, project cycle, operational costs, project revenue, etc. The different factors interact with each other and shall be considered comprehensively.

(4) The implementation of the PPP+BIM model for a characteristic town includes different components, such as pre-planning, signing of PPP contract, application of BIM technology, operation and management, etc., through which the actual situation and risk factors shall be taken into account comprehensively.

This study explores the application of the PPP+BIM model in the construction projects of characteristic towns. It is concluded that the model can improve the benefit and quality of the construction project of a characteristic town and realize the whole-life-cycle management of the project, thus reducing the project's cost and improving its financial benefits [3]. Meanwhile, this paper introduces plans for the implementation and risk control of characteristic town construction under the PPP+BIM model, which will furnish a scientifically grounded framework for decision-making in the development of characteristic towns.

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References

[1] Lin GZ. Evaluation Mechanism of Operational Performance for Private Sector's Participation in Public Construction Cases: A Report and Preliminary Recommendations Based on Professional Commissioning Services for Construction and Establishment (Project No. PG9507-0238). China Engineering Consultants Incorporated. TP: Department for Public Works and Affairs of the Case Area Administration; 2006.

[2] Chen XH, Zhang HY, Zheng HF. Discussion on the Management Model of BIM-Based PPP Projects [J]. Architecture Technology, 2018, 49(9): 876-879.

[3] Kooiman J. Modern Governance: New Government. London: Sage Publication; 1993.

[4] Wang J, Zhang WY. Risk Identification and Response Strategies of Characteristic Towns under the PPP Model[J]. Construction Science and Technology, 2019, 47(24): 235-237.

[5] Wang JL, Liu YB. Financial Risks of Building Characteristic Towns under the PPP Model[J]. Financial Accounting, 2019, 38(7): 47-49.

[6] Savas ES. Competition and Choice in New York City. Social Services. Public Administration Review. 2002;62(1):82-91.

[7] Li XL. BIM Technology Application and Other Related Issues in the Construction of Characteristic Towns [D]. Liaoning University of Technology, 2018.

[8] Park CS, Morales Peake E, Company's R. Contemporary Engineering Economics. Mishawaka: Better World Books; 1997.

[9] Raffel JA, Auger DA, Denhardt KG, Barbour C. Competition and Privatization Options: Enhancing Efficiency and Effectiveness in State Government. New York: Institute for Public Administration, Graduate College of Urban Affairs and Public Policy, University of Delaware; 1997.

[10] Reed BJ, Swain JW. Public Finance Administration. New Jersey: Sage Publications; 1996.

[11] Savas ES. Privatization and Public-private Partnerships. New York: Chatham House; 2000.

[12] DeHoog RH. Competition, Negotiation, or Cooperation: Three Models for Service Contracting. Administration & Society. 1990;22(3):317-340.

[13] Duffield C. PPPs in Australia. Public Private Partnerships. Opportunities and Challenges. 2005(22):5-14.

[14] D. F. Kettl & H. B. Milward. The State of Public Management. Baltimore: Johns Hopkins University Press. 1996: 92-117.

[15] Bevir M, O'Brien D. New Labour and the Public Sector in Britain. Public Administration Review. 2001;61(5):535-547.

[16] Clarke J, Clark J, Gewirtz S, McLaughlin E. Leisure: Managerialism and Public Space. New Managerialism, New Welfare. 2000:186-201.

[17] Falconer PK, McLaughlin K. Public-Private Partnerships and the "New Labour": Government in Britain. Public-private Partnerships: Theory and Practice in International Perspective. 2000:120-133.

[18] BIM Trends, PPP+BIM, Opportunities and Challenges for Engineering Cost Consulting Institutions Industry (sohu.com), https://www.sohu.com/a/249679882_99919399.