Research on Construction Project Management of Commercial Satellite Super Factory: Optimization of Coordination, Mechanism and Service System

Lei Feng[1,*], Huayuan Hu[2]

[1]Department of Fixed Assets Management, Beijing Institute of Spacecraft Environment Engineering, Beijing, China
[2]Department of Asset and Industry Promotion, China Aerospace Sanjiang Group Co., Ltd. Wuhan, China
*fengl3203@foxmail.com

Abstract. Against the backdrop of the vigorous development of China's commercial aerospace industry, various regions are accelerating the layout of commercial aerospace industrial parks. The establishment of a commercial satellite super factory is a decisive factor in the development of the commercial aerospace industry in the park. This paper takes the Hainan Wenchang Commercial Satellite Super Factory as the research object, analyzes the characteristics of its construction project management content according to the implementation stages, and points out the problems existing in the project management process, such as the separation of responsible subjects, insufficient integration of the construction process with industrial needs, and rigid and outdated management mechanisms. To address these issues, optimization strategies are proposed, including establishing a special management system under the responsibility of the project manager, demonstrating construction plans against industry needs, adjusting construction content in response to technological changes, and fostering a service team with market awareness. These strategies aim to achieve high-level delivery and high-quality operation of the commercial satellite super factory, and promote the agglomeration of the commercial aerospace industry and local economic development.

Keywords: Commercial aerospace, Satellite, super factory, project management

1 Introduction

In the wave of vigorously developing the commercial aerospace industry in China, various regions are accelerating the planning and layout of commercial aerospace industrial parks, seeking to reduce the procurement costs of commercial satellites/commercial rockets by building and cultivating a complete industrial chain, thereby gaining an advantage in the fierce market competition [1]. In this process, due to the position of commercial satellite systems as terminal payloads in the functional value chain of commercial aerospace, they have a siphon effect that drives the layout of the entire com-

L. W. Koon et al. (eds.), *Proceedings of the 2026 7th International Conference on Management Science and Engineering Management (ICMSEM 2026)*, Advances in Economics, Business and Management Research 399,
https://doi.org/10.2991/978-94-6239-758-3_68

mercial aerospace industry chain around them. Therefore, establishing a fully functional and sufficiently productive commercial satellite super factory has become a key step affecting the success or failure of the industrial layout of the entire park [2] [3]. Taking SpaceX as an example, its Redmond base in Washington State is designed to produce 300 satellites per month (3600 satellites per year) [4][5]. It adopts an automated assembly line similar to automobile manufacturing, equipped with segmented production units and mixed-flow production lines, and uses technologies such as AI visual inspection and intelligent robot manufacturing. It can efficiently realize mixed-flow intelligent manufacturing of different types of satellites, with significantly cost reduction compared with traditional models. At the Boca Chica Spaceport (now renamed Starbase City), although the Starship Super Factory mainly focuses on rocket manufacturing, it supports the integration and testing of satellites and rockets. For example, the 8 simulated satellites carried in the ninth test flight of the Starship were assembled and tested in Boca Chica. It is possible that the future V3 satellites will undergo partial assembly or functional verification here.

Based on a thorough analysis of the successful experience of SpaceX in laying out the commercial aerospace industry, Wenchang City, Hainan Province, combined with its unique advantage of having both state-owned and commercial launch sites, formulated the overall construction plan and industrial planning layout of the Wenchang International Aerospace City. Among them, the Wenchang Commercial Satellite Super Factory has a planned annual production capacity of 1,000 satellites, with the first satellite scheduled to roll off the production line in 2025[6] . The completion of the Wenchang Super Factory will fill the production capacity gap in China's commercial aerospace satellite industry and drive the rapid improvement of the development momentum of the entire industrial chain. At the same time, due to the attraction of the super factory to the entire commercial aerospace industry chain, coupled with the strong introduction and cultivation by the local government, upstream and downstream enterprises in the industrial chain will gather in the Wenchang International Commercial Aerospace City, further promoting the emergence of new business forms and the outbreak of new growth, thereby feeding back the local economy of Hainan Province and becoming an important support for the high-quality development of the Hainan Free Trade Port.

2 Content of Construction Project Management for Commercial Satellite Super Factory

Wenchang International Aerospace City Industrial Base focuses on the collaborative design and manufacturing of satellites. Centering on the low-cost intensive manufacturing and efficient launch of satellites, it has formed a new commercial industrial cluster featured by large flat-panel satellites, promoting the high-quality development of commercial aerospace in Hainan. As the largest domestic manufacturing base dedicated to the construction of the satellite internet system which cost over 1 billion Yuan to build, the Satellite Super Factory could undertake over 70% of the country’s satellite production capacity for satellite internet projects and serves as a key support for the national “Hundred Rockets and Thousand Satellites” initiative.

The super factory features four leading strengths nationwide: large scale, high efficiency, huge capacity, and intelligent operation.

- **Large scale**: It covers a land area of 60,000 square meters, ranking the largest in China, and is capable of mass-producing the largest direct-to-cell flat-panel satellites with a size of 4.6m×4.6m.
- **High efficiency**: It achieves a production rate of 3 satellites per day, with an annual output of 1,000 satellites.
- **Huge capacity**: The planned annual production capacity reaches 1,500 tons, comparable to SpaceX's satellite capacity in 2023.

The management process of the commercial satellite super factory construction project is generally the same as that of large-scale scientific research facility construction projects invested by the state. The main differences are as follows: (1) The investment subjects are diversified; (2) The "demonstration-construction-use" process is closely related to the needs of the landing and development of the commercial satellite manufacturing industry; (3) The design requirements of commercial satellites iterate rapidly, leading to many technical adjustments during the project construction[7][8]. The management content is briefly explained in chronological order as follows:

2.1 Feasibility Study and Investment Approval

The development of the commercial aerospace industry is primarily driven by "two core pillars": conceptualization and overall design (which guide the development direction) and the final assembly and launch of commercial satellite products (which realize commercial value and complete the industrial chain) [7]. Regions and industrial parks with commercial aerospace as the leading industry prioritize satellite factory construction, followed by subsequent industrial supporting development based on the supply chain layout needs of satellite factories [8]. This practice aligns with the "demand-oriented" principle of megaproject governance, emphasizing the need to anchor market demand in advance during the feasibility study and approval phase [9].

To ensure the project's alignment with industrial development trends, it is essential to conduct in-depth cooperation with market-leading satellite enterprises, focusing on the construction of large-scale satellite systems and future market demand. Additionally, considering the expandability of subsequent technological transformation for innovation and market adjustment is crucial, as highlighted in construction project management research [10]. The proposed construction plan must balance market adaptability, technical capability, and cost control—consistent with the cost-reduction goals of commercial aerospace manufacturing facilities, such as the 45% cost reduction achieved through mass production models [Qianlong Network, 2025].

In terms of investment approval, diversified funding channels should be explored. While leveraging state-owned funds and local industrial development funds, enterprise investment and social capital should be actively introduced through investment promotion and enterprise services [11]. This approach not only reduces government financial burden but also aligns with the mixed-ownership reform policy for commercial aerospace in Hainan Free Trade Port [National Development and Reform Commission &

Ministry of Commerce, 2021], sharing industrial development dividends with multi-stakeholders.

2.2 Preliminary Design and Detailed Design

The aerospace industry features high technical thresholds, making the layout, equipment configuration, and environmental protection requirements of satellite super factories significantly different from general industrial enterprises [12]. Based on market demand analysis, preliminary and detailed design must incorporate professional insights from leading commercial aerospace enterprises, professional institutions, and experts through repeated discussions and reviews [13]. This ensures the design plan meets the core objectives of commercial satellite super factories: "rapid production, stable output, quality control, and comprehensive support" [Hainan Free Trade Port, 2025].

Cost control is a key focus during the design phase, covering both construction and operational costs. Drawing on lifecycle project management theory [14], innovative concepts such as zero-carbon parks and source-grid-load-storage integration should be adopted. Additionally, localized design and selection of mature Commercial Off-The-Shelf (COTS) products can optimize costs while maintaining operational effectiveness—consistent with the cost-saving practices of international commercial aerospace facilities [PwC, 2025]. For example, the Wenchang Satellite Super Factory's 60,000-square-meter layout balances scale and efficiency, reflecting the "large-scale but cost-effective" design philosophy of modern aerospace manufacturing bases [Hainan Free Trade Port, 2025].

2.3 Bidding and Procurement Management

As the project implementer is a platform company under the aerospace city park, bidding and procurement must strictly comply with government procurement regulations, including public bidding procedures [15]. Given the high-tech nature of the commercial aerospace industry, the bidding plan must adhere to the principles of fairness, justice, and openness while fully reflecting industry-specific needs and technical indicators [16]. This ensures that winning bidders possess the qualifications and capabilities for construction and technical equipment development—critical for maintaining the quality and reliability of megaprojects [9].

Reference should be made to the procurement management experience of domestic and international aerospace projects. For instance, emphasizing technical compliance with satellite mass production standards (e.g., adapting to the Wenchang Super Factory's 1,000-satellite annual capacity [Hainan Free Trade Port, 2025]) and prioritizing suppliers with experience in commercial aerospace manufacturing facilities can mitigate risks and improve project efficiency [17].

2.4 Construction Process Management

As the core of the aerospace industrial park, the satellite super factory is typically constructed prior to other supporting facilities [18]. During construction, a comprehensive

management and coordinated scheduling mechanism should be established to unify supervision of general contractors and project construction units—consistent with the organizational coordination theory of megaproject governance [9]. Key priorities include ensuring basic guarantees (water, electricity, gas, roads) and resolving process conflicts and resource bottlenecks promptly to keep the project on schedule [10].

Drawing on the construction experience of the Wenchang Satellite Super Factory, which achieved main structure capping 60 days ahead of schedule [Hainan Free Trade Port, 2025], proactive coordination between stakeholders and dynamic adjustment of construction plans are essential. This approach aligns with the "collaborative construction" model advocated in industrial park development research, enhancing efficiency through cross-departmental and cross-enterprise cooperation [8].

2.5 Project Acceptance

Project acceptance must strictly follow relevant laws, regulations, and the acceptance procedures of superior state-owned assets units [19]. Given the technical complexity of commercial satellite production, experts and technical personnel with rich on-site experience in satellite manufacturing must participate in evaluating equipment and facility operational capabilities [20]. When conditions permit, trial operation and trial production should be conducted to verify process equipment functionality, production line operation consistency with design, and compliance of plant environment with standards [12].

Notably, acceptance indicators should include core performance metrics such as production capacity (e.g., 3 satellites per day for the Wenchang Super Factory [Hainan Free Trade Port, 2025]) and intelligent operation capabilities (e.g., full-lifecycle digital coverage [Hainan Free Trade Port, 2025]). This aligns with the performance evaluation system of commercial aerospace manufacturing facilities, ensuring the project meets industrial development requirements and lays a foundation for subsequent high-quality operation [PwC, 2025].

2.6 Investment Promotion and Production

As the construction of the satellite super factory project progresses, the departments responsible for investment promotion and enterprise services in the industrial park closely promote communication and on-site coordination with satellite enterprises, plan and implement in advance matters related to enterprise introduction, production capacity landing, talent placement, and policy guarantees, clear obstacles in the process of enterprise entry, help enterprises solve various problems, and ensure the efficient connection and promotion of satellite factory construction and enterprise entry and operation.

3 Existing Problems

3.1 Separation of Subjects Responsible for Project Demonstration, Investment and Construction, Investment Promotion, and Enterprise Services, Leading to Deviations Between Project Operation Effects and Industrial Development Expectations

Since industrial park management institutions often set up their organizations with reference to government agencies and implement a hierarchical parallel management mechanism in daily work, while the specific implementation of construction projects is promoted by subordinate platform companies, and the tasks of construction, introduction, and service are undertaken by different departments, it appears that the command is ineffective, communication is poor, and efficiency is insufficient in the process of coordinating the demonstration, construction, and investment promotion of the satellite factory, which is the core large-scale industrial project of the park.

3.2 Insufficient Management Actions in the Project Construction Process to Proactively Meet the Development Needs of the Commercial Aerospace Industry, Which is Not Conducive to the Control of Project Construction Costs and Schedules

Due to the disconnection between the construction subject, the investment promotion subject, and the service subject, the work idea of "each managing their own section and sweeping their own doorsteps" has long existed. However, because the construction subject is responsible for high integrity risk tasks such as bidding and procurement, and project construction, it has extremely high requirements for process compliance and formal compliance, and pays more attention to promoting construction work in accordance with the established plan and schedule, which invisibly limits the communication and coordination path with satellite enterprises. It is difficult to promptly implement new technical requirements continuously put forward by commercial aerospace enterprises, which have a short start-up time in China and have high iterative needs for technical schemes. From the perspective of ensuring the overall efficiency of the final efficient put into use of construction results, it is easy to cause delays in production and rework.

3.3 The Project Management Mechanism is Still Relatively Rigid and Outdated, Which is Not Conducive to the Cultivation of Commercial Aerospace Industry and the Construction of a Talent Team for Market-oriented Operation and Management

The demonstration, construction, and operation of the satellite super factory cannot be treated as general industrial construction projects. They must be placed in the position of the core of industrial layout and the cornerstone of local development for overall planning, construction, investment promotion, and operation, so as to achieve the ideal

effect of an accelerator for industrial growth. Rigidly adopting the separated management mode and working mechanism of traditional government-invested projects will lead to problems such as low construction efficiency, difficulty in reaching production targets, insufficient talent training, and inadequate team integration.

4 Optimization Strategies for Construction Project Management of Commercial Satellite super factory

4.1 Establish a Special Management System Responsible for the Project Manager

In view of the problems of separated implementation subjects and rigid management mechanisms in the construction process of the satellite super factory, referring to the research, development, and production mode of key products such as satellites and rockets in leading aerospace enterprises, a special management system under the responsibility of the project manager and a core working team across departments, professions, and divisions should be established at the beginning of project demonstration. Closely centering on the construction goal of the satellite super factory, plan and implement the whole life cycle management of the project, implement work plans, ensure work support, coordinate and solve problems, decompose and implement work responsibilities to posts and individuals, and strictly carry out work performance appraisal. By establishing a vertical project management mechanism, break the inherent inefficient communication mechanism, eliminate the stubborn problem of passing the buck, and fully mobilize the work enthusiasm of personnel.

4.2 Demonstrate the Project Construction Plan by Benchmarking Leading Enterprises in the Industry and Industry Development Prospects

In the project demonstration and design stage, referring to successful experiences at home and abroad, widely listen to the opinions of leading enterprises in the industry and experts with practical experience, and formulate a construction plan that meets market demand, conforms to market expectations, and satisfies industry development prospects. In the demonstration process, it is necessary to eliminate the mentality of "staying out of the matter", put aside the excuse of "not understanding technology", avoid the behavior of "relying on outsourcing". Under the leadership of the project manager, the project team should immerse themselves in the industry, participate in discussions, clarify the direction, set indicators, ensure guarantees, and come up with a reasonable, feasible, advanced, and efficient construction plan. Taking the demonstration process of the Wenchang Satellite Super Factory as an example, the management department first put forward the goal of "building an aerospace city benchmarking SpaceX's Boca Chica Spaceport and a satellite super factory benchmarking Starlink and Tesla", and widely invited satellite overall enterprises, satellite manufacturing enterprises, various subsystem development enterprises, related supporting enterprises, as

well as architectural design and construction units to participate, brainstorm, and come up with a construction plan and design report that meets expectations.

4.3 Pay Close Attention to the Evolution of Commercial Satellite Technical Status and Adjust Construction Content in a Timely Manner

The development mode of commercial satellites is significantly different from that of traditional satellites. The core lies in that the product development mode of commercial satellites is closer to that of Internet products and consumer electronic products, which shape demand, face the market, adopt cutting-edge design, and iterate rapidly. The product development path is more bold and radical, focusing on the commercial market profit model and the improvement of company valuation. This leads to the fact that in the long-cycle work chain of "demonstration and construction - investment promotion and entry - product roll-off - production capacity peak" of the satellite factory, it is easy to have satellite scheme changes due to changes in market demand, which further leads to the mismatch between the original satellite factory construction scheme and the existing demand. This requires the project management team to pay close attention to market dynamics, establish an efficient communication mechanism, give full play to the coordination function, do a good job in relevant work support, first put forward reasonable and feasible adjustment opinions, evaluate the workload and risks around the opinions, and formulate work plans to implement them in the construction process.

4.4 Establish a Market-oriented Work Awareness and Build a Work Team Serving Enterprises

Commercial aerospace enterprises must attach great importance to the market, which is the most important factor related to the survival of enterprises and the success or failure of products. This also requires the work team engaged in the construction project management of commercial aerospace industrial parks to maintain the same keen market observation as enterprises and the work concept starting from market demand; otherwise, it is difficult to achieve the fundamental goal of resonance and coordinated development between the park and enterprises. In the project management team, it is necessary to select personnel with market vision and relevant work experience, strengthen project management awareness and market service awareness, do a good job in communication and docking with satellite enterprises and management institutions, and creatively promote the implementation of various work plans around the core goal of project construction. Through the specific practice of project construction management, exercise the team's ability, temper the team's cohesion, and build an ace team that can efficiently achieve work goals.

5 Conclusion

The construction and operation of the commercial satellite super factory is a key and decisive factor for regions to build a commercial aerospace industry cluster and shape characteristic commercial aerospace formats. To ensure the high-level delivery and high-quality operation of the construction project, it is necessary to benchmark commercial aerospace thinking, understand potential market demand, learn from the experience of successful cases from all aspects such as work thinking, working mechanism, working methods, and work teams, build a whole life cycle management system from the perspective of industrial success or failure and regional rise and fall, and carry out related work such as super factory construction, aerospace enterprise cultivation, and satellite production capacity guarantee in an integrated manner, forming an efficient industrial cycle of "production reaching the target as soon as construction-completed, launching as soon as leaving the factory".

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