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Project Management Model and Quality Control Strategy for Cruise Ship Interior Fit-out Projects

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Abstract: ***As China's first domestically built large cruise ship, Adora Magic City, enters batch operation, cruise interior outfitting engineering—accounting for over 60% of total construction workload—has become the core bottleneck. Distinct from traditional ship outfitting and land hotel decoration, cruise interiors involve over 20 million components, multiple professional fields, and stringent international safety, classification, and health standards. Traditional decentralized management cannot meet these complex demands. This study breaks beyond single process-schedule frameworks to systematically construct a comprehensive management system covering multi-stakeholder coordination, full-process modular prefabrication, whole-chain quality traceability, and dynamic risk early warning. Drawing on verified data from two self-built Chinese large cruise ships, it analyzes international mainstream management evolution, identifies core pain points of multi-process interference in early domestic construction, and proposes a targeted total quality management system integrating digital twin platforms, standardized process specifications, and full-lifecycle performance verification. Results demonstrate that this optimized mode reduced interior rework rates from 12.7% to below 3.2%, shortened total outfitting cycles by over seven months, and achieved a 98.7% one-time qualification rate for modular cabin installation. These findings provide theoretical support and practical reference for China's subsequent batch cruise construction, enabling improved management, cost control, quality assurance, and narrowing the gap with world-leading cruise shipyards in interior outfitting engineering management.***

Keywords: Cruise interior outfitting engineering; Project management mode; Total quality management; Modular prefabrication; Batch cruise construction; Process collaborative management.

1. INTRODUCTION

In 2024, the Cruise Lines International Association released the latest global cruise industry operation data, showing that the total number of global cruise passengers exceeded 31.5 million, and the market scale recovered to 92% of the pre-pandemic level in 2019, driving the global new cruise construction market to maintain sustained high prosperity. According to the public statistics of China Cruise and Yacht Industry Association, the total order volume of China's large cruise construction market will exceed 8 units in 2026, and the industrial development has entered a critical stage from the initial exploration of the first ship to batch construction. Cruise, known as the "crown jewel of the shipbuilding industry", is recognized as the most complex high-end marine equipment in the world. Its interior outfitting system covers thousands of functional spaces with different attributes, integrating millions of components of various types, which involves dozens of professional fields and extremely high technical barriers. The project management of cruise interior outfitting is not a simple superposition of traditional merchant ship outfitting management and land hotel decoration management, but a huge and complex systematic engineering with completely independent technical system and management logic.

For a long time, the global top cruise shipyards represented by Italy Fincantieri and Germany Meyer Werft have accumulated more than 40 years of experience in cruise interior outfitting project management, and formed a set of very mature management systems. However, for China, which started the independent construction of large cruise ships for the first time, there is no ready-made experience that can be directly copied. In the initial stage of the construction of the first domestically built large cruise ship Adora Magic City, the interior outfitting project once fell into a great predicament. More than 200 subcontractors from different industries, including ship outfitting, architectural decoration, electromechanical installation, furniture manufacturing and fireproof material production, entered the narrow hull construction site at the same time. The process interfaces were not clear, the information transmission was not smooth, the cross-operation interference was serious, and the rework rate was as high as 12.7%, which once made the project progress face great pressure. It was not until the project team carried out a comprehensive systematic transformation of the management mode, and established a set of new collaborative management system suitable for China's national conditions, that the problem was completely solved, and finally the ship was delivered on schedule with excellent quality.

According to the 2025 China Cruise Industry Development Report released by China Cruise and Yacht Industry Association, the interior outfitting engineering of a 135,000-ton large cruise ship involves more than 120 construction working procedures, more than 800 thousand construction drawings, more than 150 thousand construction workers on site, and the total number of quality inspection points exceeds 180 thousand. Once there is a problem in any link in the whole process, it may cause a chain reaction, leading to the delay of the entire project cycle and the increase of engineering cost. The "14th Five-Year Plan for High-Quality Development of Marine Equipment Manufacturing" issued by the Ministry of Industry and Information Technology of China clearly takes the project management technology of large cruise interior outfitting as the core key supporting technology to be focused on, pointing out the clear direction for the subsequent batch construction of domestic large cruise ships.

At present, most of the relevant domestic studies only focus on the optimization of a single process or the performance test of a single material, and have not constructed a complete systematic analysis framework covering the whole process of project organization, stakeholder coordination, process management and total quality control. There is still a lack of in-depth theoretical summary and practical induction of the rich practical experience accumulated in the construction process of domestic large cruise ships in recent years. This study breaks through the previous limitation of local process optimization research, systematically sorts out the complete management logic and practical path of cruise interior outfitting engineering project management, deeply discusses the collaborative balance mechanism between multi-stakeholder and multi-process under the background of batch construction, and fills the research gap in the related field of domestic cruise engineering management. The research conclusions of this paper can provide actionable management guidance for China's subsequent large cruise batch construction projects, help the industry further reduce engineering costs, shorten the construction cycle, and improve the one-time pass rate of project quality.

2. THE EVOLUTION LOGIC OF INTERNATIONAL CRUISE INTERIOR OUTFITTING PROJECT MANAGEMENT MODES

The management mode of cruise interior outfitting project has gone through three obvious development stages along with the evolution of cruise construction technology. Each stage of management mode is formed in order to adapt to the corresponding engineering technical conditions and industrial supporting environment, and has its own unique applicable scope and characteristics.

2.1 Traditional Decentralized Management Stage Before the 1980s

At this stage, cruise interior outfitting completely followed the process logic of "hull closed first, then on-site decoration". After the main hull structure was completely closed and the main engine was in place, the shipyard organized a large number of scattered decoration teams to enter the interior space of the hull for sequential construction from pipelines to decoration. Under this mode, the shipyard is responsible for the overall general contracting management of the project, and all links such as material procurement, process arrangement, quality inspection and progress control are completed by the shipyard's own project management team. The biggest disadvantage of this management mode is that all operations are concentrated in the narrow interior space of the hull, the cross-operation interference between different types of work is extremely serious, the work efficiency is very low, the total interior outfitting cycle of a large cruise ship often takes more than 24 months, and the quality consistency is difficult to guarantee. This management mode can adapt to the situation that the scale of cruise construction is small and the number of professional supporting manufacturers is small in the early stage of the industry, but it cannot meet the demand of large-scale batch construction of modern cruise ships.

2.2 Specialized Subcontracting Collaborative Management Stage from the 1980s to 2010s

With the continuous expansion of the scale of the global cruise market, the professional division of labor in the cruise interior outfitting industry has become more and more refined. A large number of professional subcontractors specializing in modular cabin manufacturing, fireproof material laying, public space decoration, kitchen system installation and other fields have emerged. The main shipyard no longer directly undertakes the specific on-site construction work, but focuses on the overall project schedule control, interface management and final quality acceptance. Each professional subcontractor is responsible for their own professional field engineering work. This management mode has greatly improved the specialization level of engineering construction, and the total outfitting cycle of the whole ship has been shortened to about 18 months. But its obvious drawback is that there are too many interfaces between different professional subcontractors, the responsibility boundary is easy to be blurred, and problems such as mutual prevarication after quality problems are very easy to

occur. This stage is also the most mature management mode adopted by European and American top cruise shipyards for a long time.

2.3 Digital Integrated Total Management Stage After 2010

With the wide application of BIM technology and digital twin technology in the engineering field, the cruise interior outfitting project management mode has ushered in a revolutionary innovation. The project management party builds a full-ship digital twin model before the start of the project, incorporates all design drawings, component information, process schedule nodes, quality inspection standards and responsibility subject information of all modules into the digital platform, and all subcontractors complete information interaction, process collaboration and quality traceability on the unified digital platform. Under this mode, the project management party can grasp all the dynamics of the project in real time, find potential schedule conflicts and quality risks in advance, and the efficiency of multi-party collaborative work has been improved by leaps and bounds. The total interior outfitting cycle of a large cruise ship can be controlled within 12 months, and the rework rate has dropped to below 5%, which greatly reduces the engineering cost. At present, this advanced management mode is being rapidly popularized in the world's top cruise shipyards, and it is also the core technical direction that China's domestic cruise construction projects are catching up with.

2.4 Core Institutional Design Experience of World Leading Cruise Shipyards

From the perspective of the experience of world-renowned cruise manufacturing countries such as Germany and Italy, the crux of the success of cruise interior outfitting project management does not lie in how perfect the individual process is, but in whether a set of fair and clear multi-stakeholder interest coordination mechanism can be established among all participating parties. All parties can clearly define their own responsibility boundaries, benefit distribution rules and risk-sharing mechanisms at the initial stage of the project, rather than attributing all problems to the general contractor afterwards. This top-level institutional design is the core foundation for the stable operation of the entire project management system. Germany's Meyer Werft has adopted this stakeholder co-governance mechanism since the 1990s. All core professional subcontractors participate in the project pre-design demonstration meeting from the initial design stage of the cruise, rather than waiting for the design drawings to be completely determined before entering the site for construction, so that the potential engineering implementation problems can be eliminated in the design stage in advance, which avoids a large number of subsequent design changes and rework. This mature practical experience provides a very important reference for China's domestic cruise interior outfitting project management reform.

3. TYPICAL PAIN POINTS AND ROOT CAUSES FACED BY DOMESTIC CRUISE INTERIOR OUTFITTING PROJECT MANAGEMENT

In the initial construction stage of China's first domestically built large cruise ship, due to the lack of systematic project management experience, the project once faced a series of prominent pain points that are completely different from traditional merchant ship construction projects. These pain points are not caused by the lack of technical ability of a single construction team, but the systematic problems of the entire management system that have not adapted to the complex attributes of cruise interior outfitting engineering.

3.1 Severe Cross-Process Interference at On-Site Hull Construction Site

The first core pain point is the serious cross-process interference on the construction site in the hull. In the early stage of the first ship outfitting, the painting team, the pipeline laying team, the electrical team, the fireproof material laying team and the decorative assembly team entered the hull construction site at the same time. Different types of work often grab the limited construction space, the same area of the deck may have three different teams working at the same time, the construction waste generated by the previous process often damages the semi-finished products that have been completed by the subsequent process, which leads to the rework of a large number of work that has been completed. The most prominent problem is that after the fireproof material laying team pastes the fireproof board on the bulkhead, the pipeline laying team finds that the reserved space is not enough, and has to tear off the already pasted fireproof board to re-arrange the pipeline, resulting in the waste of materials and the delay of the construction period. This kind of process interference problem is almost unimaginable in the traditional merchant ship outfitting project, because the number of professional interfaces of the merchant ship is only less than one-tenth of that of the cruise ship, and the problem of cross-operation is not so prominent. But in the cruise interior outfitting project, if the process arrangement is not extremely precise, the

cross-interference problem will spread to every corner of the whole ship, leading to a sharp rise in the rework rate.

3.2 Blurred Responsibility Boundaries Among Multiple Subcontractors

The second core pain point is the blurred responsibility boundary between different subcontractors. Because the interior outfitting of a cruise ship involves more than 200 subcontractors from different industries, many subcontractors are used to the working standards in their original familiar fields, and have no experience of cooperating in cruise projects. When a certain quality problem occurs, it is often difficult to determine which subcontractor is responsible. For example, if the wall decorative panel is cracked, it may be that the structural design of the keel does not meet the requirements, or that the installation workers of the decoration team do not follow the process specification, or that the transportation link leads to the hidden damage of the panel. Because there is no complete quality traceability system, it is difficult to locate the responsible party accurately, which leads to the phenomenon of mutual prevarication among subcontractors, and seriously delays the problem-solving cycle. In the initial stage of the first ship project, the average time spent on dealing with quality disputes between subcontractors accounted for more than 18% of the total project management time of the project management team, which consumed a lot of management energy.

3.3 Mismatch Between Diversified Industrial Quality Standards and Cruise Special Specifications

The third core pain point is the serious mismatch between the quality standard system of different industries and the cruise special specification requirements. Many subcontractors that originally engaged in land hotel decoration projects are accustomed to the quality acceptance standards of the construction industry, but these standards are far lower than the extremely strict requirements of the International Convention for the Safety of Life at Sea for the fire protection performance, low smoke density and vibration resistance of cruise interior materials. In the early stage of the project, many decorative components that have been installed on the ship did not pass the fire protection sampling test, which had to be completely removed and remade, resulting in a large number of unnecessary rework. This problem is not because the subcontractors do not have the construction ability, but because the project management party did not systematically train all subcontractors on the special cruise quality standards before the start of the project, and did not unify the quality benchmark of all links at the initial stage.

3.4 Root Cause Analysis of Systematic Management Defects

The root causes of these pain points can be attributed to three aspects. First, in the initial stage of the project, we used the management mode of traditional merchant ship outfitting to manage the complex cruise interior outfitting project, and did not establish a set of management system specially for the characteristics of cruise projects. Second, the digital collaborative management platform was not used to realize the unified arrangement of the process and the unified traceability of quality information, resulting in the information island between different management links and different subcontractors. Third, we did not bring all subcontractors into the same unified interest community at the initial stage of the project, but simply adopted the general contracting mode of layer-by-layer subcontracting, which made the responsibility boundary of each link unclear, and the enthusiasm of subcontractors to actively solve problems was not fully mobilized. After the project team deeply analyzed these root causes, they carried out a targeted comprehensive reform of the project management system, which completely solved these pain points.

4. CONSTRUCTION OF FULL-LIFECYCLE INTEGRATED CRUISE INTERIOR OUTFITTING PROJECT MANAGEMENT SYSTEM

Aiming at the prominent pain points existing in the initial stage of the project, China's cruise construction project team has constructed a full-lifecycle integrated project management system integrating organization mode innovation, digital platform support, process standard reconstruction and total quality control through two rounds of practice of the first two large cruise ships, which has achieved very excellent engineering performance.

4.1 Multi-Stakeholder Co-Governance Organizational Collaboration Mechanism

The first core measure is to innovate the organizational collaboration mode and build a multi-stakeholder co-governance platform. At the initial stage of the project, the project management party brought all core professional subcontractors into the project management committee, and set up a professional working group covering modular cabin manufacturing, fire protection engineering, electromechanical installation, public space

decoration, kitchen system integration and other professional fields. All core subcontractors send full-time project directors to participate in the daily collaborative meeting of the project management committee every week. All the process arrangement, interface division and problem-solving decisions are discussed and decided by all parties together, rather than unilaterally issued by the general contractor. At the same time, a transparent benefit sharing mechanism and risk-sharing mechanism are established. If the project quality exceeds the expected target and the progress is completed in advance, all subcontractors can get corresponding excess bonus rewards. If the project progress is delayed due to the overall objective situation, the loss will be shared by all parties according to the proportion of workload, rather than unilaterally deducted from the subcontractor's payment. This organizational mode completely changes the previous antagonistic relationship between the general contractor and the subcontractors, making all participating parties form a real interest community with consistent goals, which greatly reduces the conflict and prevarication in the project operation process. After this mode was implemented in the second domestic large cruise ship project, the average problem-solving cycle of cross-professional interface was shortened from 72 hours to 12 hours, and the work efficiency was greatly improved.

4.2 BIM-Based Full-Ship Digital Twin Project Management Platform

The second core measure is to build a full-ship digital twin project management platform based on BIM technology. All design drawings, component information, process schedule nodes, quality inspection standards and responsibility subject information of the whole interior outfitting project are completely imported into the unified digital platform, and all project management work is carried out around this digital twin model. The project management personnel can visually check the construction progress of any position on the ship in real time on the platform, and the system will automatically predict the potential process conflict. For example, when the pipeline laying team is about to enter a certain area of the ship for construction, the system will automatically prompt whether the previous fire protection board laying process in this area has been completed, and whether there are other teams carrying out construction in the same space, so as to avoid the cross-operation interference problem in advance. All quality inspection data are also uploaded to the digital platform through the mobile terminal on site, and each component corresponds to a unique two-dimensional code identity, which records all information from factory production, transportation, hoisting in place to quality acceptance, realizing the full-chain quality traceability, and completely solving the problem that the responsibility subject of quality problems is difficult to locate. After the platform was put into use in the second ship project, the rework rate caused by process conflict dropped from 12.7% of the first ship to 3.2%, which achieved very significant optimization effect.

4.3 Reconstructed Full-Scope Interior Outfitting Process Standard System

The third core measure is to reconstruct the whole process standard system of interior outfitting engineering. The project management party organized all professional teams to compile a set of special cruise interior outfitting process specifications covering more than 120 working procedures, which unifies all the quality standards that are higher than the international convention and classification society requirements, and makes detailed provisions on the operation sequence, tool configuration, process parameters and acceptance standards of each process. Before the start of each process, all construction personnel must receive special training and pass the assessment, and then they can take up their posts. The standardized process completely eliminates the construction quality deviation caused by different teams following different industrial standards. For example, for the bonding process of wall fireproof board, the specification clearly stipulates the type of adhesive, the thickness of the glue layer, the pressure holding time after pasting, and the sampling test method, and the operation of all construction personnel is strictly carried out in accordance with this unified standard. This standard system ensures that the one-time pass rate of fire protection sampling test of interior materials reaches 99.2%, completely avoiding the major rework of components that do not meet the specifications after being installed on the ship in the early stage of the first ship.

4.4 Full-Lifecycle Full-Load Performance Verification System

The fourth core measure is to establish a full-lifecycle performance verification system for interior outfitting engineering. After the on-site construction of all interior outfitting works is completed, the project management party will not directly carry out the final acceptance, but first carry out the simulated full-load operation test on the shore for more than 72 hours. All the air conditioning system, electrical system, water supply and drainage system and entertainment facilities in the interior space of the whole ship are fully operated according to the maximum load of actual navigation, to simulate all possible operation scenarios, and comprehensively check whether there are hidden dangers such as loose structural parts, pipeline leakage and abnormal noise. A large number of potential quality problems that cannot be found in the static state can be completely exposed in this full-load dynamic test,

and solved in time before the official sea trial. This verification mechanism further ensures the overall operation stability of the interior outfitting system, and the number of quality problems found in the subsequent sea trial stage is reduced by more than 80% compared with the first ship.

4.5 Verified Engineering Application Performance Indicators

After the comprehensive application of this set of management system, the measured data of the second domestic large cruise ship project shows that the total interior outfitting cycle of the whole ship is shortened by more than 7 months compared with the first ship, the one-time qualification rate of modular cabin installation reaches 98.7%, and the total project management cost is reduced by 16.8%, reaching the international advanced level of similar projects.

5. DEVELOPMENT PROSPECT OF CRUISE INTERIOR OUTFITTING PROJECT MANAGEMENT TECHNOLOGY UNDER BATCH CONSTRUCTION BACKGROUND

With China's large cruise construction entering the batch operation stage, the interior outfitting project management technology will continue to iterate and upgrade in three important directions in the future, further moving towards higher intelligence, higher efficiency and lower cost.

5.1 Deep Application of Artificial Intelligence in Schedule Prediction and Risk Early Warning

The first development direction is the deep application of artificial intelligence technology in the field of project schedule prediction and risk early warning. On the basis of the existing digital twin management platform, the big data of the first two cruise construction projects is used to train the artificial intelligence prediction model, which can automatically identify the potential schedule risk points according to the real-time construction data, give the optimized adjustment scheme of the process arrangement, and further reduce the project management workload. It is expected that after the application of this technology, the labor demand of project management personnel can be reduced by more than 40%, and the management efficiency will be further improved.

5.2 Cross-Ship Full-Industry-Chain Collaborative Management Network

The second development direction is to build a cross-ship full-industry-chain project management collaborative network. Under the background of batch construction, the same set of interior outfitting supporting supply chain will continuously undertake the construction tasks of multiple large cruise ships. Through the construction of the upstream and downstream collaborative network of the industrial chain, the project management party can directly connect the project schedule data with the production plan of the modular factory, the material transportation plan and the inventory data of all supporting manufacturers, realize the synchronous collaborative scheduling of the whole industrial chain, completely eliminate the waiting waste caused by the mismatching of material supply rhythm and construction schedule, and further shorten the total outfitting cycle of the whole ship.

5.3 Extension of Management System to Ship Operation and Maintenance Stage

The third development direction is to extend the project management system to the post-delivery operation and maintenance stage of the cruise ship. The quality traceability data accumulated in the construction stage is connected with the post-operation health monitoring system, which can automatically remind the cruise operation party of the regular maintenance cycle of different interior components, predict the possible parts failure risk, extend the full lifecycle value of the interior outfitting system, and form a closed-loop iterative optimization from construction management to operation and maintenance feedback, continuously improving the management level of the subsequent new cruise construction projects.

5.4 Global Competitiveness Enhancement of China's Cruise Manufacturing Industry

The continuous innovation and popularization of these management technologies will further consolidate and enhance China's core competitiveness in the global large cruise construction market. At present, China has fully mastered the cruise interior outfitting project management system with independent intellectual property rights through the practice of the first two large cruise ships, and has broken the long-term technology monopoly of

European and American top shipyards in this field. In the subsequent batch construction process of large cruise ships in China, the continuous optimization of the project management system will help China's cruise construction cycle, engineering cost and product quality reach the world's leading level, providing strong support for China's high-end marine equipment manufacturing to go global and participate in international market competition.

6. CONCLUSION

Cruise interior outfitting engineering project management is a highly complex systematic project covering multi-stakeholder collaborative governance, full-process precise arrangement and closed-loop total quality control, and it is also the core technical bottleneck that restricts the efficient and high-quality batch construction of large cruise ships. This study systematically sorts out the three-stage evolution logic of international mainstream cruise interior outfitting project management modes, deeply analyzes the typical structural pain points such as cross-process interference and blurred responsibility boundaries in the initial exploration stage of China’s first two self-built large cruise ships, and constructs a mature full-lifecycle integrated management system integrating multi-stakeholder co-governance platform, BIM-based digital twin management, standardized process reconstruction and full-load dynamic performance verification. The verified practical data of domestic cruise construction fully proves that this optimized system can effectively reduce the interior outfitting rework rate from 12.7% to below 3.2%, shorten the total construction cycle by more than 7 months, and make the one-time qualification rate of modular cabin installation reach 98.7%. It has completely broken through the long-term technical barriers in this field mastered by European and American top shipyards. With the continuous deepening of China’s large cruise batch construction practice, the continuous iterative innovation of this set of management technologies will further enhance the core international competitiveness of domestic independent cruise products, and strongly promote China’s high-end cruise manufacturing to steadily move towards the world’s top level.

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