

Key Points and Difficulties in the Management of a New Guangzhou 12th People's Hospital Branch

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Abstract: During the 13th Five-Year Plan period, to improve medical and health services, the Guangzhou Municipal government invested billions in medical construction. During that time, Guangzhou was renewing its approval procedures for construction projects, and the COVID-19 outbreak changed the requirements of hospital construction. In addition to focusing more on spatial planning and layout, the integration of specialized departments, large-scale medical equipment, and numerous intelligent systems increased the complexity of hospital construction projects. The success of these projects often hinges on the quality of the management team. If a hospital construction project manager lacks experience and an understanding of the project's key aspects, they may struggle with organization, management, and problem-solving, leading to rework, resource waste, and delays. This paper uses the construction of a new Guangzhou 12th People's Hospital branch as an example to describe the key points and difficulties in each stage of project construction and proposes solutions for the management of similar projects in the future.

Keywords: Hospital construction project; Project management; Management essentials

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1. Introduction

In recent years, amid efforts to expand high-quality medical resources and achieve a balanced regional layout, hospitals nationwide have embarked on construction projects of varying scales. This period has seen an increase in new branches, the demolition and reconstruction of original sites, as well as maintenance and renovation of existing facilities. During the hospital construction and management process, a trend towards grouping, scientific research, intelligence, and comprehensive development has become apparent. This trend has increased the complexity of hospital construction, leading to more frequent issues such as project delays, rework, and budget overruns. The relocation project of Guangzhou 12th People's Hospital exemplifies the challenges in building quality medical resources in Guangzhou. By examining this project, common problems encountered in hospital construction project management can be identified from the perspective of a construction manager. This research proposes management solutions to address these issues and aims to summarize the management experience across all phases of a new hospital construction project, including the preliminary stage, design, construction, and completion acceptance stages.

2. Project pre-planning stage

The 12th People's Hospital of Guangzhou is a tertiary general hospital that offers comprehensive medical treatment, education, scientific research, and occupational disease prevention. The new project (**Figure 1**) was originally located in the second Central Business District of Guangzhou. However, due to conflicting development objectives with the district and Huangpu Harbor Economic Zone, the location was shifted to the Nangang plot, west of the Guangzhou International Toys and Gifts Centre and north of the Guangzhou-Shenzhen-Yanjiang Expressway. This new site lacks other tertiary hospitals and has an increasing population, necessitating adjustments in the design positioning and service coverage. Compared to the original site approval, the construction scale has increased by 24,192 m², and the green building certification has been upgraded from one star to two stars according to the latest "Green Building" review requirements. The adjusted project plans for a total of 800 beds and a construction area of approximately 141,210 m². This includes 88,290 m² for the general hospital, 7,700 m² for the occupational disease prevention business room, 2,500 m² for the overhead floor, and 42,720 m² for the underground garage. The project is divided into two phases. The first phase covers a land area of 55,144 m², and the second phase covers about 48,374 m². The first phase includes a total construction area of about 123,650 m², with 77,990 m² above ground and 45,660 m² underground (including the underground garage and some general hospital functional rooms). The construction scope includes an outpatient building, medical technology building, inpatient building, comprehensive building, hyperbaric oxygen chamber, logistics building, guard room, oxygen storage tank area, basement, road square, greening, and other outdoor supporting projects. The total investment for the first phase is estimated to be 108.549 billion yuan, which is about 36.304 billion yuan more than the original project.



Figure 1. The new 12th People's Hospital of Guangzhou branch

2.1. Emphasizing early-stage communication and research among relevant departments and construction personnel

A tertiary general hospital typically consists of at least 30–40 departments^[1], each led by a different director and staffed with various doctors, technicians, nurses, and other personnel. The design needs of each department require input from multiple positions within the general department, and these requirements can change over time, resulting in a significant communication workload. Consequently, the preliminary planning and design phase for hospital construction often takes longer than for other types of construction projects. From inception to completion, a hospital construction project generally spans 4–8 years. This timeline includes 1–3 years for

pre-consultation, planning, and design approval stages (such as land acquisition, demolition, and relocation), 3–4 years for the construction and implementation phase, and 6 months to 1 year for equipment commissioning. The longer the duration, the higher the likelihood that construction costs will exceed the initial investment.

The new project of Guangzhou 12th People's Hospital (referred to as the new 12th Hospital) was approved at the beginning of 2015. The modification, planning, and design phases occurred from 2017 to 2020, with formal construction starting in September 2020 and completion by the end of 2023. The project spanned eight years. Due to a lack of early-stage communication between the hospital and government departments in the site selection area, an adjustment in site selection was necessary after one-third of the preliminary design work had been completed. This led to wasted financial resources and a five-year delay in construction. The preliminary survey had to be redone, and opinions from various departments had to be reconsidered, leading to further complications. Additionally, the project faced rising costs for building materials and labor, necessitating extensive budget adjustments and increased investment. During the COVID-19 pandemic, construction frequently halted to comply with epidemic prevention policies, and the workforce could not be significantly increased. In the later stages of the pandemic, municipal financial investment funds became tight, and the project relied on bond issuance for three consecutive years to maintain construction funding.

2.2. Significance of zone planning

The planning of hospital construction should incorporate insights and input from a wide range of stakeholders, including nurses, doctors, administrative staff, patients, and individuals with relevant experience in hospital construction. This inclusive approach ensures that the flow lines for indoor and outdoor traffic, as well as regional flow planning, accurately reflect the needs and perspectives of those who will use the hospital daily. The success or failure of hospital construction often hinges on comprehensive planning that considers not only the functional distribution of buildings and entrance/exit design but also transportation planning.

The most significant disruption to the flow of people in a hospital occurs due to the interaction between the queues in the registration, payment, and medicine collection areas and the flow of patients in the outpatient building. The peak periods for hospital foot traffic are from 8:00–10:00 a.m. and 2:00–3:30 p.m.^[2]. To mitigate these disruptions, a vertical elevator is situated on the external wall of the outpatient building in the planning and design. This would allow individuals who do not need to register or pay fees to bypass the internal queues and directly access the floors from the outside of the building. Additionally, situating the registration and charging areas in zones connected to the external entrance of the outpatient building can minimize interference with the registration fee queue. Separating the medicine collection queue into a more independent space can further reduce mutual interference. In the design of the new 12th Hospital, the layout of the single-hall foyer in the outpatient building separates the registration fee area from the medicine collection area. However, the elevator is positioned far from the outpatient entrance, which is not conducive to efficiently directing individuals who do not need to register directly to their appointments. The first-floor plan of the hospital building is shown in **Figure 2**.

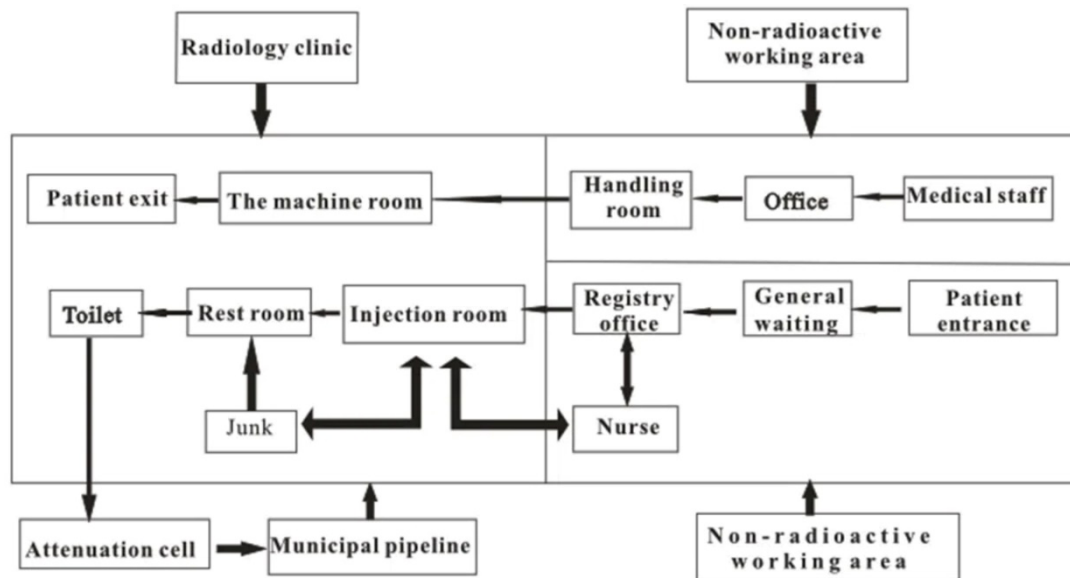


Figure 3. Functional distribution diagram of the nuclear medicine department

3. Design management phase

3.1. Impact of detailed design drawings and construction personnel on hospital construction

Hospital construction projects represent a convergence of expertise from highly skilled technicians. Given their lengthy construction periods, it is crucial to maintain a stable core team. Frequent turnover in management personnel leads to loss of experience, detrimentally impacting both quality and cost control. In the realm of hospital architectural design, domestic firms specializing in this field are relatively small. Designers often lack robust expertise in medical specialty technologies, research on hospital construction functional requirements, medical processes, new materials, and equipment. Additionally, tight deadlines imposed by general contractors on design firms result in shallow drawings, which subsequently lead to design errors and omissions. To mitigate these challenges, project managers with relevant experience should provide adequate time for designers to identify and rectify design issues promptly. This approach significantly reduces management errors. Hospital construction management, overseen by the hospital president and contractors, involves long-term coordination with the project management team. Successful project completion hinges on the project manager's adept gathering of opinions, balancing contractor interests, and resolving team conflicts. For complex construction decisions and technological challenges, timely expert meetings and research investigations are essential for effective problem-solving.

3.2. Utilizing building information modeling (BIM) technology in design adjustment during the pre-construction stage

Effective control of design adjustments is crucial for ensuring project schedule adherence and cost control in hospital construction projects. Therefore, proactive pre-control of design changes should commence as early as the preliminary design stage. Several common types of changes encountered in hospital construction include (1) adjustment of utilization requirements, (2) changes in functional area layouts, (3) alterations in pipe direction and positioning, (4) modifications to accommodate on-site equipment installations, (5) revisions or

replacements of design drawings, and (6) changes in construction processes, among others. The implementation of BIM technology plays a pivotal role in detecting and consulting these changes in advance [5]. For example, BIM technology is utilized in the new 12th Hospital project to calculate earthwork balance and external transport distances, as well as to perform comprehensive pipeline balance and collision detection on the facade and interior, as depicted in **Figure 4**. Three-dimensional modeling and internal virtual tours enabled hospital departments to gain a sensory understanding of the design's effects during the preliminary design stage, facilitating early identification of potential issues and allowing for modification suggestions to reduce the need for design changes later on. This proactive use of BIM enhances communication among stakeholders, improves design accuracy, and ultimately supports efficient project execution in hospital construction.

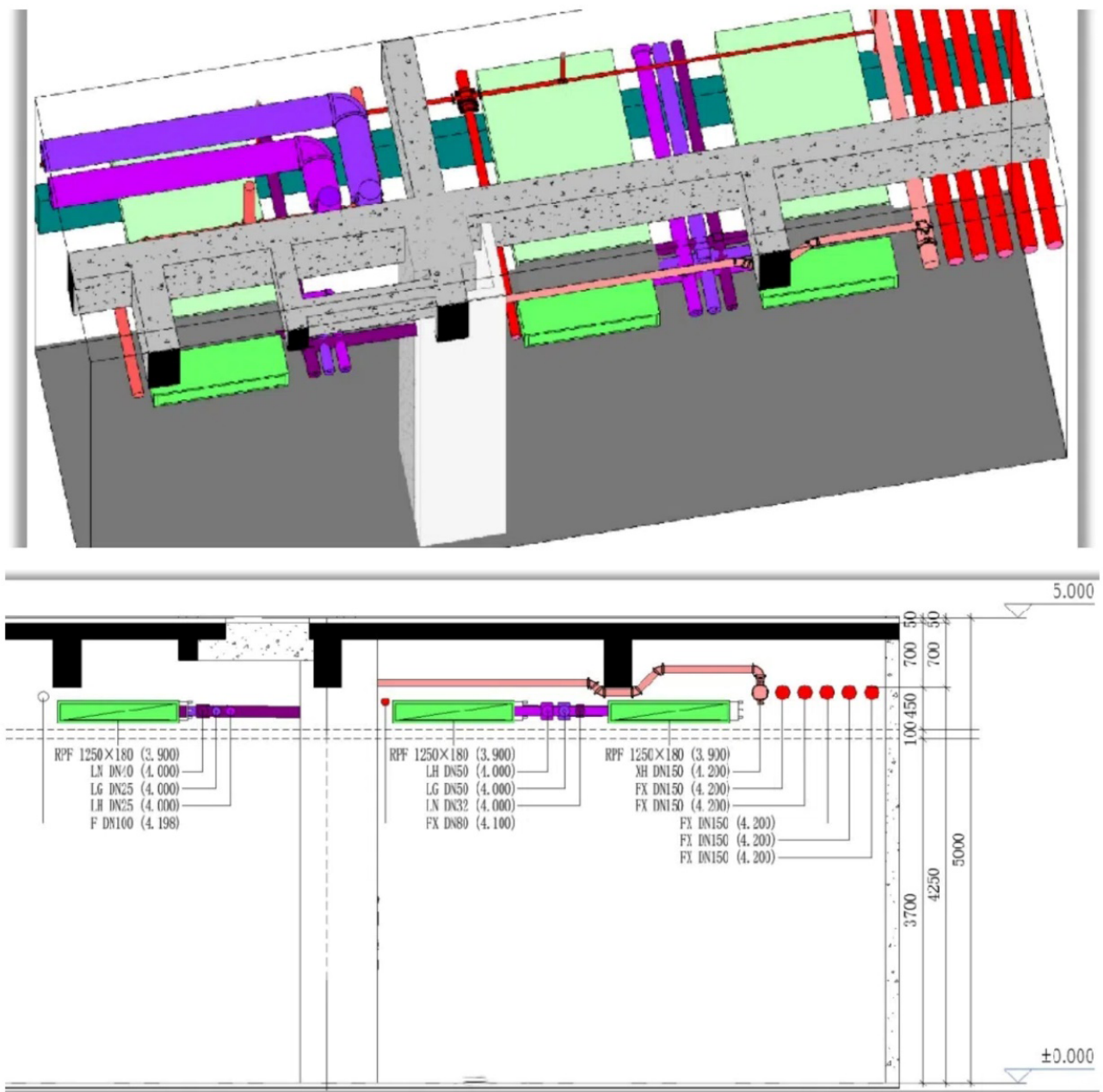


Figure 4. Application of BIM technology in designing the pipe layout in the lobby of the first floor of the inpatient building

Before equipment selection, the general contractor should proactively coordinate with the hospital to finalize the equipment procurement list. This list should include detailed specifications such as equipment nature, bare and packaging sizes, models, parameter requirements, load-bearing capacities, required areas, reserved holes, ordering timelines, arrival schedules, entry points, transportation, and installation requirements. Subsequently, the general contractor should convene a specialized meeting to thoroughly review these details. During this meeting, participants can utilize BIM technology to simulate equipment lifting scenarios, ensuring appropriate reservation of lifting ports and optimal installation environments.

In addition, in hospital construction management, it is crucial to emphasize the interface compatibility between imported and domestic equipment, as well as the matching of components, spare parts, and maintenance capacities among the main imported equipment. For instance, after completing the new 12th Hospital, some medical equipment from the old hospital will be relocated for continued use. This transition may lead to interface mismatches and differences in power consumption between the new and old equipment. Designers should compile a comprehensive list and detailed parameters of the equipment slated for relocation well in advance. This step allows for necessary design adjustments to accommodate the integration of existing equipment into the new hospital setting seamlessly.

3.3. Allowing for flexibility in the design of electromechanical and information equipment systems

In recent years, the investment in electromechanical equipment, information technology, medical equipment, and intelligent systems in hospital construction projects has been increasing. From the smallest X-ray film dispenser to the largest medical logistics system, the number of intelligent equipment used in the daily operation of modern hospitals is on the rise every year^[6]. Equipment planning should prioritize enhancing treatment effectiveness, following the principle of “moderate design, allowing for future capacity upgrades, and avoiding wasteful pursuit of overly sophisticated resources.” In the spatial design of new hospital construction, public corridors, passages, and doorways should be sized to accommodate equipment placement and movement effectively. To prevent collisions, service desks should be designed as inverted trapezoidal tables, and ample electrical sockets should be installed on both walls and floors. Hospitals typically procure medical equipment without always fully understanding the project’s power load requirements, leading to mismatches between ordered equipment and actual power capacities. This discrepancy complicates project demolition and renovation. Therefore, designers should regularly assess and verify the total power consumption of equipment, ensuring that the power system wiring anticipates capacity needs for the next decade. Additionally, special attention should be given to specific medical equipment requirements; for instance, surgery rooms, ICU, and large-scale medical equipment should ideally have separate power sources directly from the distribution room to avoid disrupting system-wide power supplies. Furthermore, MRI machines should be installed in magnetically shielded locations, positioned far from sources of vibration. If located in the basement, it is essential to avoid placing them along driving routes used by parking vehicles.

4. Construction management

4.1. Coordinating progress plans among participating parties and subcontracted specialties

Upon entering the construction stage, it is essential for the general contractor to ensure seamless coordination among all parties involved in hospital construction, including hospital infrastructure and equipment procurement departments. This coordination involves decomposing the overall project duration plan and mandating each

contractor to develop a detailed work schedule. Given the diverse subcontracting specialties typical in hospital construction projects, specific measures are crucial. Firstly, mechanical and electrical contractors, along with equipment distributors, must finalize their plans before the main civil engineering construction begins. This ensures timely embedding of mechanical and electrical equipment pipelines during civil engineering works. Additionally, professional contractors hired by the hospital should proactively define and manage construction interfaces in advance.

During the sprint and final stages of construction, when all site specialties are fully operational, multiple contractors often work concurrently in the same areas, potentially causing interference and complications if not managed properly. Effective project management is crucial to mitigate risks such as rework and major accidents. The project management company should enforce the supervision responsibilities of the supervisory firm, ensuring they deploy sufficient supervision engineers and increase personnel as needed. The supervisory firm should assist in monitoring site progress comprehensively, overseeing material inspections, reviewing installation and testing processes, and ensuring timely handover between phases. They should promptly address deficiencies, enforce deadlines for corrections, and alert responsible contractors to lagging progress, urging them to implement effective recovery measures. Emphasizing quality control throughout project execution and installation phases is essential for maintaining construction standards and ensuring project success.

4.2. Addressing conflicts during commissioning, acceptance, and operation of hospital equipment

Compared to other types of construction projects, hospitals have additional requirements such as radiation protection evaluation, health and epidemic prevention assessments, and environmental impact assessment reports. Upon project completion, hospitals must apply to local water companies, the Southern Power Grid, gas companies, and network operators to connect water, electricity, coal, and network services before equipment commissioning and acceptance. Furthermore, hospitals must obtain a sanitation license from the health and epidemic prevention department for secondary water supply before commencing operations. Applying for joint acceptance and approval for the project involves various specialized assessments including planning, fire protection, environmental protection (including sewage station and radiation protection assessments), and compliance with “Sponge City” requirements, which can be challenging ^[7]. The final acceptance stage of the new 12th Hospital project presents several intricate challenges: The new 12th Hospital encountered the following situations in the final acceptance stage: (1) Certain imported medical equipment requires uninterrupted power supply. However, recent revisions in transformer and distribution room standards mandated by the Electric power company clash with the fire department’s insistence on fire doors during the equipment acceptance process. This conflict complicates the alignment of safety standards with operational needs, requiring careful resolution to ensure compliance and functionality without compromising safety protocols ^[8]. (3) Changes in construction technology have altered the curtain wall area, and discrepancies between planned and actual acceptance areas arise from equipment installation on the top floor. ^[9] (4) Due to the project’s extended construction duration, compliance with updated building codes is required for both old and new construction phases during the acceptance processes.

During the project’s completion stage, challenges arise, such as the commissioning of equipment in the negative pressure ward taking several months to half a year. Hospitals often rush to use the ward prematurely, prompting the general contractor to deliver it before completing equipment commissioning and acceptance procedures, thereby impacting accurate equipment testing results ^[10]. Premature hospital operations alter the environment, complicating subsequent acceptance work for various specialties. Contractors then incur additional costs for site restoration due to premature installations, posing future audit and accountability risks

for the project management company. To prevent these issues, project management should pre-negotiate with the hospital regarding the implications and responsibilities of early project use, ensuring clear agreements are in place to manage such situations effectively.

5. Conclusion

Hospital construction is considered the most complex form of civil building construction due to its multifaceted functions, rapid development, and broad service scope. The experience from the Guangzhou 12th People's Hospital relocation project underscores the challenges posed by new hospital constructions and ongoing urban construction reforms. Experienced construction managers in hospital projects prioritize the stability and proficiency of their construction teams. Key strategies include: (1) Effective communication and coordination among stakeholders. (2) Thorough analysis of project planning and internal functional zoning. (3) Utilization of modern technology to enhance project execution. (4) Vigilant control over design changes. (5) Forward-thinking planning across all project stages, harmonizing actions and plans of all involved parties. As urban development promotes the fusion of talent and technology, innovative technologies will increasingly support construction management in future hospital projects, accumulating diverse project management experiences and enhancing the maturity of future managers in the field.

Disclosure statement

The author declares no conflict of interest.

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