

Building an Intelligent and Eco-Friendly General Hospital—A Study of a Hospital Construction Practice in Wenzhou

Zhou Liya

The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang, 325000, China

Keywords: Intelligent, eco-friendly, general hospital construction

Abstract: The First Affiliated Hospital of Wenzhou Medical University was planned and constructed with the aim of "providing the best treatment environment for patients and creating efficient medical management for medical and nursing staff". With a large main building as the feature, the hospital has a bright and modern architectural style with abundant greenery and adopts a humanized and intelligent medical model, providing patients with an intelligent, efficient and comfortable medical experience. Although the hospital is a success, there are still many shortcomings. In general, the new hospital is intelligent and eco-friendly and it can serve as a reference for other large general hospitals.

1. Introduction

1.1 Background of the new construction

Wenzhou is one of the 14 coastal cities opened to the outside world in China. Since the reformation and opening up, with the rapid development of Wenzhou's national economy and society, people have also put forward higher requirements for medical and health care. The first affiliated hospital of Wenzhou Medical University was founded in 1919, and is one of the first Three-A general hospitals in Zhejiang Province which is also the most reputable and busiest large hospital in the north of Fujian Province, south of Zhejiang Province. In early 2000, the original hospital covers only 29 acres, with the increase in the number of consultations year by year, since the original hospital was overloaded for a long time and the development space was seriously restricted. In 2007, a new hospital with an investment of 2.3 billion and a new site of more than 500 acres started to construct in Nanbaixiang, Ouhai, Wenzhou and completed in 2012.

1.2 Back ground of the 1st affiliated hospital

Founded in 1919, the 1st affiliated hospital of Wenzhou Medical University is one of the first four general hospitals in Zhejiang Province to pass the Three-A review, with medical services radiating nearly 30 million people in southern Zhejiang, northern Fujian. The hospital covers a total area of 530 acres, with a construction area of 430,000 square meters, 3,380 approved beds. The First Affiliated Hospital of Wenzhou Medical University is a general hospital with comprehensive functions including medical treatment, teaching and scientific research. The hospital is ranked 68th

in China's hospital science and technology influence ranking as well as 27 disciplines are listed in the top 100 national disciplines. The hospital has a complete set of disciplines and outstanding health care ability, and has been approved as a provincial-level regional medical center in Zhejiang, which can provide people with all-round and full-cycle health services.

2. Planning and design strategies

2.1 Master plan of 1staffiliated hospital

The new hospital was planned with outpatient and emergency specialized center, medical and technical ward complex, medical care center and infectious disease center. The hospital adopted new ideas and advanced concepts, reforming the traditional management mode and medical process, highlighting the medical concept of 'disease-oriented, patient-centered and people-oriented', centering on the functional specialization of each department, and setting several related specialties close to each other to facilitate joint diagnosis and treatment[1].

The overall planning was based on the concept of "providing the best treatment environment for patients and creating efficient medical management for medical and nursing staff", with a reasonable layout of functional partitions as is shown in figure 1[2]. The separation of medical and patient flow, cleanliness and dirt flow was planned to reduce cross-infection. The hospital was designed with mainly multi-story buildings, which was combined with the environment to create a garden-style ecological hospital as is shown in figure2 and figure3 [3].



Figure 1 Overview of the new hospital



Figure 2 Master plan of the new hospital



Figure 3 Renderings of the new hospital

According to Table 1, the project was a new off-site construction with 2,000 medical beds. The total construction area was 338,994m², mainly including 223,797m² of outpatient and emergency medical and technical ward complex, 7,354m² of healthcare center, 9,189m² of infection center[4]. The underground was mainly set up for logistics, operation equipment and garage [5].

Table 1 Main technological and economic indicators of the planning

Construction site area (m ²)	333733.3
Total floor area (m ²)	338994
Building Floor Area Ratio	0.74
Building density (%)	17
Main building height (m)	40.5
Parkings	2015
Number of design beds	2000
Design Daily Outpatient Volume	5000-6000
Design Daily Emergency Volume	500
Design day surgery volume	150

3. Project highlights and innovative practices

3.1 Architectural design

As is shown in figure 4, the new hospital had a uniform column network of 7.8m*8.5m, which was suitable for both the layout of the basement parking space and the configuration of the wards. In terms of building appearance, the simple rectangular structure was modern style. Inside the hospital, the horizontal traffic spread from all directions. Besides, the walking path was convenient and clear which can be reflected from figure 5. Outpatient receptions are directly in front of the main entrance and the outpatient medical and technical channel was in the east, and the inpatient channel was in the west, which helped patients achieve the quickest diversion and avoid the admission crowd to stay in a large area in the hall [6]. The hospital adopted a warm decorative style and introduces the color signs in figure 6. The hospital was set with different color schemes for different buildings, and good guidelines in special areas were arranged such as the nurses' station, and the reception desks as is seen in figure 7 and figure 8. Through such color signs, the whole medical guidance process was more concise, orderly and efficient [7].

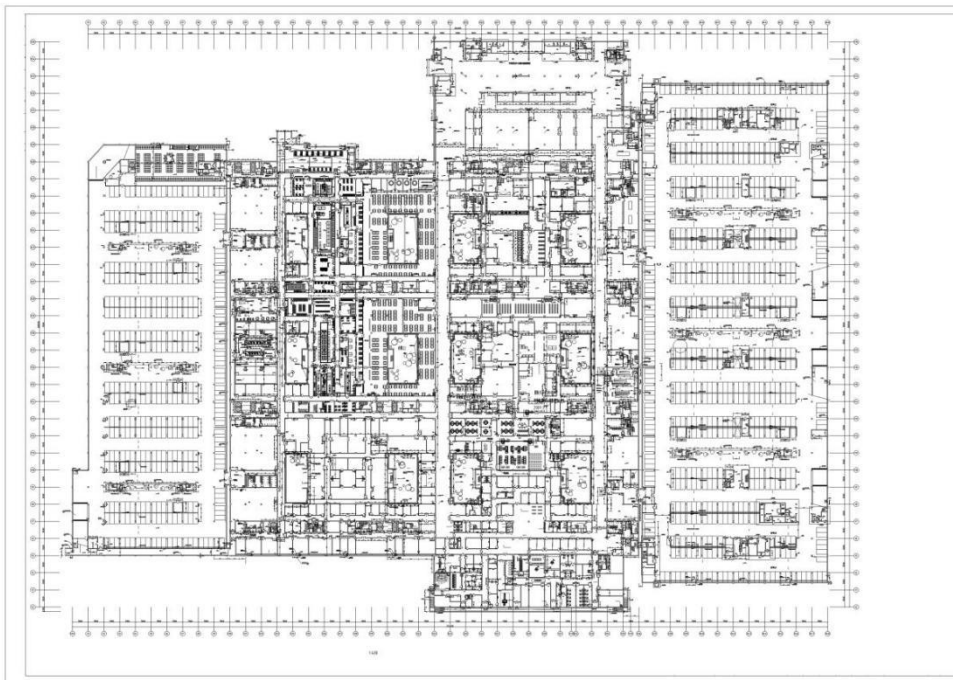


Figure 4 Map of the underground

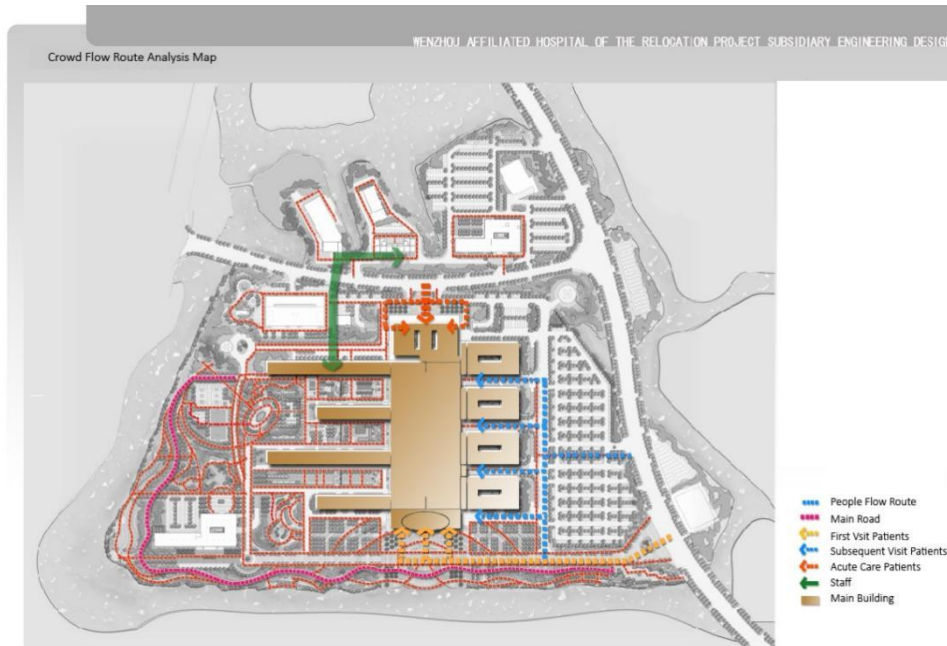


Figure 5 Crowd flow route analysis map



Figure 6 Rendering of emergency hall



Figure 7 Rendering of waiting area



Figure 8 Rendering of wards

According to figure 9, the buildings are installed with all glass walls, which is light and transparent, reducing the oppressive feeling of large volume. What's more, the surface makes the hospital blend with the surrounding greenery and rivers [8]. The north and south facades of all four buildings are alternately decorated with glass and aluminum insulation panels, giving people a friendly and bright feeling. The facade of the Medical Technology Center part of the building is paved with large, dense natural granite and glass embedded solids, running north and south through the four glass buildings as shown in figure10. Under the premise of meeting the functional requirements, the whole hospital forms a landmark modern hospital [9].



Figure 9 Rendering of the external facade



Figure 10 Photo of glass walls of the buildings

3.2 Greening of outdoor

The hospital is located on the riverside with fragrant apricot groves, with "one shore, two axes, nine gardens" as the spatial structure. The main building was built in the center of the base on the south side, and there are several green light-transmitting courtyards of 400m² inside the buildings. The courtyards are planted with natural green plants, forming an ecological zone and microclimate inside of the hospital, which is conducive to form an ecological zone and microclimate, and facilitate natural light and ventilation which can be seen in figure 11. The new hospital site has a clear zoning of greenery from east to west. The greenery in the courtyard was set up as a geometric pattern, and the greenery is scattered as a garden with between the gardens. The large inner courtyards of the hospital were designed as different thematic gardens, and even the underground parking garage has a lush green zone inside. The healthcare center is located in the southwest of the natural green zone, providing a natural environment for patients to heal and recover. The south plaza is surrounded by trees, making the entire medical area of the hospital feel like a dense jungle. The Infection Center is located on the north side, and the surrounding woods envelop the entire building, providing good greenery isolation and meeting the requirements of health and epidemic prevention. All buildings are surrounded by greenery, which makes the hospital integrated with the surrounding rivers and greenery, and becomes an ecological green hospital.



Figure 11 Eco-friendly hospital

3.3 Humanized and intelligent medical access model

Our hospital has created the "one thing for medical treatment" application, which is one of the whole process of "intelligent medical treatment" management, to achieve less queuing, more convenient payment, less examination, more intimate service and more convenient dispensing.

As is shown in figure 12, solving medical problems and overturning the traditional medical process, the system automatically generates the patient's consultation schedule and provides the next consultation information in real time through intelligent guidance, and introduces AI intelligent navigation to make the path. In order to let patients master the consultation information, the system provides patients with a list after consultation so that the detailed cost of treatment, examination and test reports, medication and treatment notes are clear which can be seen in figure 13.



Figure 12 Rendering of the south hall



Figure 13 Big south hall of the new hospital with self-service machines

The hospital focuses on optimizing the medical environment and improving hospital management. Besides, the hospital advocates innovating the medical model and changing patients' medical habits. Further, we break the boundary between in-hospital and out-of-hospital treatment and implement online services. On the patient side, we provide modules such as online appointment with famous doctors, communication between doctors and patients, online payment, and express delivery of medicines, etc. On the doctor side, we give doctors the same patient management functions as offline.

After the application was online, the hospital's consultation environment is greatly improved, and the data from the invisible backstage services worked to enhance the rational allocation level of all kinds of medical resources.

4. Critical thinking

The First Hospital of Wenzhou Medical University is based on the principles of reasonable layout, economy, practicality, clear organizational structure. Furthermore, the medical process is innovative, efficient and economical, which can more flexibly adapt to the future development of medical career. The general layout of the hospital ensures a good treatment and recuperation

environment, prevents infection, facilitates management, reasonably partitions the land, leaves enough green area, keeps appropriate building density, so that medical buildings have good ventilation and sunlight conditions, and prospectively meets the requirements of energy saving, green and environmental protection.

The project has a large building volume, complex functions, tedious construction techniques, many subcontracting cooperation contents, and great difficulties in implementation. In the process of planning, design and construction management, it has gained great attention from the society and strong support from the government at all levels and relevant experts. Since the project has been put into use, it is running well at present. The hospital is built with clear flow lines for numerous processes, providing convenient patient experience and a good sense of staff happiness. The indoor and outdoor environment complements each other, and it has become a garden-style green and intelligent hospital.

However, during the nearly ten years of operation of the hospital, many design deficiencies and regrets have been found. In particular, there is a time lag between the design and construction of the hospital. Although 2,000 parking spaces were designed, due to the lack of traffic planning including the immaturity of the surrounding traffic infrastructure, the poor traffic flow, the narrow road network, coupled with the huge volume of emergency outpatients, the parking has become a serious problem of the hospital. Secondly, the single building is too large to find for patients. Thirdly, there are more dark rooms although many patios are used to introduce light and ventilation, leading to the great energy consumption of lighting and air conditioning. Fourthly, the layout of wards is still traditional with single corridor design, and the flow of doctors and patients has failed to be thoroughly separated. Last, the hospital's high quality development process puts forward higher requirements for research rooms, and the preliminary layout is relatively insufficient.

5. Conclusion

As the leading hospital and regional center for the diagnosis and treatment of difficult and critical diseases in northern Fujian and eastern Zhejiang, the hospital's medical service capacity and social influence have continued to rise in recent years. Taking advantage of the technical advantages of Wenzhou Medical University and the hospital in academic and scientific research, the Wenzhou Government is vigorously promoting the construction of Wenzhou Life and Health Town. The hospital was awarded as a provincial regional medical center and is striving to become a national regional medical center, which will bring new opportunities for infrastructure development.

During the 14th Five-Year Plan period, the hospital will be devoted to planning, designing and construction of Wenzhou Life and Health Medical Research and Innovation Center to build a first-class research platform and intelligent medical information innovation as well as R&D platform. In addition, the construction project of the Oncology Center of the hospital will be completed to promote the construction of key diseases. At the same time, the hospital actively promotes the renovation of the new and old hospital, further innovates ideas to accelerate the rationalization of the hospital's various functional layouts, and facilitates the construction of the hospital with high efficiency, high standards and high quality.

References

- [1] Guo Ying. *Exploring a New Method of Cost Management for Modern Hospital Construction Projects* [C]. // *Proceedings of 2019 International Conference on Emerging Researches in Management, Business, Finance and Economics (ERMBFE 2019)*. Francis Academic Press, 2019:845-849. DOI:10.26914/c.cnkihy.2019.041283.
- [2] Mohseni Zahra. *Observance of Architectural Principles in Hospital Construction; A Step Towards Energy Consumption Optimization* [J]. *Hospital Practices and Research*, 2018, 3(4).
- [3] Hayroman Ahmad, Abdul Rashid Abdul Aziz, Mastura Jaafar. *Success Criteria for Design-and-Build Public*

Hospital Construction Project In Malaysia—An Empirical Study[C] //Selected, peer reviewed papers from the 2015 International Conference on Intelligent Materials and Manufacturing Engineering (IMME 2015)., 2015:413-417.

[4] Mead Mitchell, Ibrahim Andrew M. *Strategies to evaluate the quality of hospital design with clinical data.* [J]. *Journal of hospital medicine*, 2022.

[5] Roseane Lins Vasconcelos Gomes, Rebeka Kelly Alves Guimarães de Souza, Rosalie Barreto Belian, Eliane Maria Ribeiro de Vasconcelos. *Systematization of nursing care in the hospital: construction of a system applied to academic practice* [J]. *Revista de Enfermagem UFPE On Line*, 2010, 4(esp2).

[6] Gamble Kate Huvane. *Building the future of healthcare. Part II: blueprint for success. More than just bricks and mortar, hospital construction requires intense collaboration among leadership, every step of the way.* [J]. *Healthcare informatics: the business magazine for information and communication systems*, 2010, 27(5).

[7] Popp Walter, Hoffman Peter, Fischnaller Edith. *Hospital Construction* [J]. *International Journal of Infection Control*, 2009, 5(2).

[8] James Barlow, Martina Köberle-Gaiser. *Delivering Innovation in Hospital Construction: Contracts and Collaboration in the UK's Private Finance Initiative Hospitals Program* [J]. *California Management Review*, 2009, 51(2).

[9] Su Zhibin. *Research on the design of general hospital after Medical street model implantation* [J]. *Chinese and foreign architecture*, 2023 (02): 107-113. The DOI: 10.19940/j.carol carroll nki. 1008-0422.2023.02.018.