

Design Strategies for the Regeneration of Existing Hospitals in Cold Cities with the Aim of Sustainability and Regionalism

A Case Study in China

Kexin LIU, School of Architecture and Design, Harbin Institute of Technology; Key Laboratory of Cold Region Urban and Rural Human Settlement Environment Science and Technology, Ministry of Industry and Information Technology; The Architectural Design and Research Institute of HIT Co., Ltd (HITAD), China

Jianfei CHEN, School of Architecture and Design, Harbin Institute of Technology; Key Laboratory of Cold Region Urban and Rural Human Settlement Environment Science and Technology, Ministry of Industry and Information Technology, China

Yu BAN, School of Architecture and Design, Harbin Institute of Technology; Key Laboratory of Cold Region Urban and Rural Human Settlement Environment Science and Technology, Ministry of Industry and Information Technology, China

Abstract

Urban regeneration is a continuous process of adapting urban spaces to the evolving needs of communities. Healthcare buildings, as essential components of the urban environment, play a vital role in the growth and well-being of cities. However, renewing these buildings presents several challenges as demands change. This renewal requires not only optimizing internal functions to accommodate modern healthcare needs and public expectations but also redesigning existing structures to better integrate with inclusive societal needs. This study uses a large-scale general hospital renewal project in Harbin as an empirical case. The main objective is to explore how to effectively incorporate new functions into the existing hospital environment and manage the coordination between buildings from different historical periods, including those with heritage protection, in line with policies for establishing a national regional medical centre. The study aims to achieve a comprehensive and organized renewal under the broader framework of sustainable urban development. This study presents a new design framework for urban hospital renewal and proposes specific techniques for such projects. The framework serves as a valuable reference for renovating medical buildings in the context of urban regeneration and effectively guides the refurbishment of existing structures and urban renewal efforts.

Keywords

Urban regeneration, General hospital, Cold region, Sustainability

1. Introduction

1.1. Research Background

The process of urbanization has posed significant challenges to human health, including environmental degradation, increased risks of chronic diseases, heightened psychosocial stress, and a rise in mental

health issues(Baker et al., 2020; Wang, Mao and Wang, 2023). In response to growing concerns and demands for health, the World Health Organization's (WHO) concept of health has evolved from merely the absence of disease to a broader focus on disease prevention, health promotion, and the attainment of holistic human well-being. The concept of the "Healthy City" was first introduced in 1984, marking a pivotal shift in urban planning with health promotion becoming a central objective(Lawrence, 2022). At the core of the Healthy City concept is the recognition of the potential of architecture and urban spaces to influence health outcomes. This expands the responsibility for health beyond traditional medical and healthcare institutions, addressing it on a broader urban and social scale.

As a crucial component of Healthy City development, the design of hospital buildings must align with the urban environment and function as part of the larger urban continuum(Moscelli et al., 2016). Architects must consider not only the visual aesthetics of hospital buildings but also their internal functionality and purpose, aiming to create spaces conducive to both living and healthcare needs(Castro, Mateus and Braganca, 2013; Cervinka, Roederer and Haemmerle, 2014; Tajudin and Amat, 2022; Sabir and Mustafa, 2023).

This study focuses on large general hospitals in urban environments to examine issues of urban renewal based on three key considerations. First, hospitals, as core urban structures, coexist and evolve alongside cities, serving as vital components of the urban health system(Kara and Bilgic, 2021). Second, the development of a Healthy City strategy, which integrates health considerations into broader urban and social frameworks, has become an effective means of promoting public health in many countries(Brown, 2020). Third, exploring the potential of architecture and urbanism to extend health promotion beyond healthcare institutions to the entire city can help achieve a low-cost, high-efficiency health promotion model.

1.2. Study Area

The project is located in Harbin, a renowned historical city known for its unique blend of traditional and modern elements. Harbin's cityscape reflects a harmonious fusion of ancient, elegant architecture with dynamic, contemporary styles, showcasing a blend of Eastern and Western cultures(Musgrove, 2007; Xie *et al.*, 2016).

The project site is located in the south of Harbin Central city, about 3.5 km away from Harbin West Railway Station, with a very convenient transport environment (Figure 1). The hospital in this study is located in the urban environment, and the surrounding area has formed very mature support functions, including residential areas, schools, office buildings, etc (Figure 2).As can be seen from the aerial photos of the project, the hospital itself has a good ecological environment, which is an important part of the urban memory and people's living space (Figure 3).



Figure 1. Location of the project in Harbin. Source: HITAD.



Figure 2. The urban environment surrounding the site. Source: HITAD.



Figure 3. Current environment of the site (pre-construction) . Source: HITAD.

2. Case Study

2.1. Project Background

The hospital under study is a large, comprehensive tertiary level hospital with a total site area of approximately 500,000 square metres. The entire hospital area is planned in a square and orderly manner, with a symmetrical layout. The architectural style is based on the ancient and elegant Chinese style, inheriting a long history. The existing hospital area is divided into six different functional areas: the medical area is located on the west side of the base, near Xuefu Road; the landscape area is located on the north side of the base on the central axis; the teaching area is located in the northeast corner; and the scientific research area, residential area and logistics area are located on the south side of the base, which is also the main area where the scope of construction is located.

The hospital boasts a long history of over 80 years, and many of its buildings have been designated as heritage sites by the government (Figure 4). Strict regulations are enforced within the conservation area to ensure the preservation and protection of these historically significant structures.



Figure 4. Existing buildings of different styles in the existing hospital compound . Source: HITAD.

2.2. Research Framework

In the early stages of hospital design, establishing a comprehensive and clear top-level design is crucial, as it plays an essential role in both new hospital projects and the renewal of existing facilities. The renewal of urban hospitals should be approached from a macro-level perspective that aligns with the hospital's strategic development goals, ensuring comprehensive coordination and scientific planning. This approach necessitates consideration of national policies, such as the hierarchical diagnosis(Wang *et al.*, 2024) and treatment system and the policy on close medical associations, to accurately guide the direction of hospital renewal.

Furthermore, the renewal of hospitals should be considered within the framework of the specific medical planning of a city, i.e. the renewal of hospitals should be closely coordinated with the specific medical

planning of the city in order to determine the appropriate positioning of hospitals (bed size and specialisation composition, etc.).

The innovation of this paper is to construct a design guidance framework for urban hospital renewal (Figure 5). The framework not only focuses on the improvement of medical efficiency, which is the basic requirement for the core function of medical services, but also skilfully integrates the preservation and inheritance of history and culture, the optimisation of the external environment and other broad and profound social dimensions, showing a high degree of comprehensiveness and innovation.

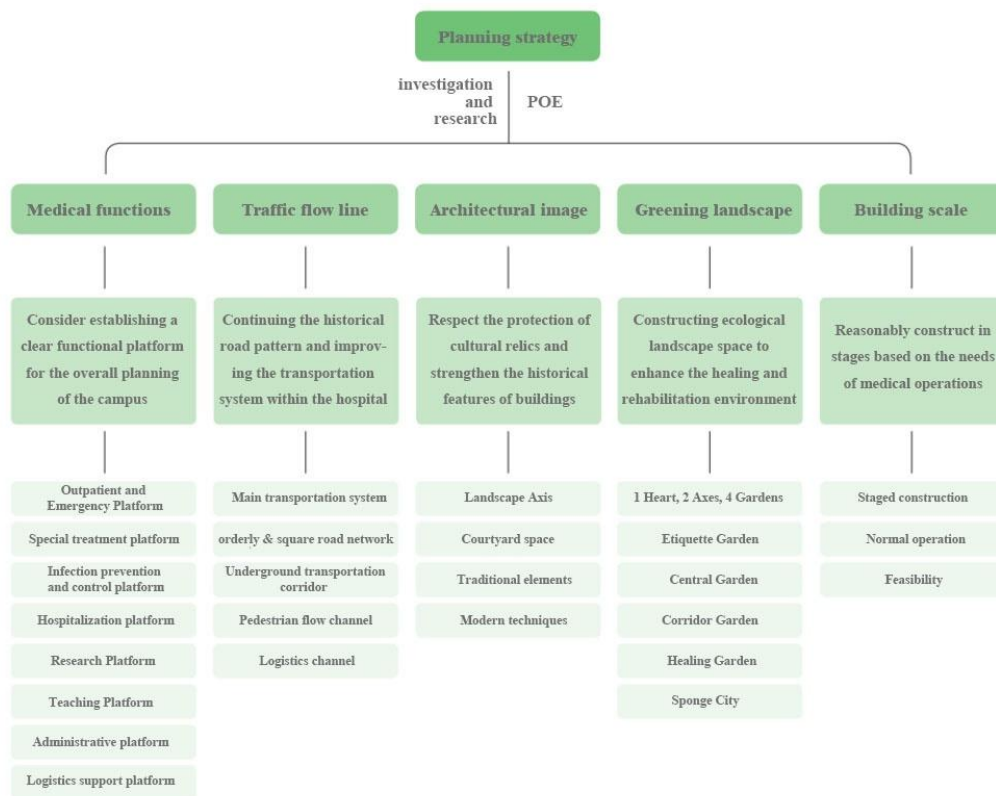


Figure 5. Guidance framework for urban hospital renewal and transformation. Source: HITAD.

3. Project Renewal Strategy

3.1. Establishment of a clear functional organisational platform

The design of the renewal of the existing hospital required a comprehensive review and integration of the hospital's development objectives, the adoption of modern healthcare process concepts (Jones-Kowalska, 2022), and a systematic reorganization and planning of the entire campus. This process required a careful balance between new and existing functions to optimize the overall layout and facilitate advanced and efficient healthcare workflows. Firstly, a detailed statistical study of the hospital's current building needs was carried out, and the data was then analysed against relevant building and development standards (Figure 6) to accurately determine the functional areas needed to be updated and the corresponding building sizes. A comprehensive assessment was also carried out for old buildings with unsatisfactory general layouts, floor plans and heights, but within their normal life cycle (Figure 7). The comparative analysis shows that demolition and redevelopment of these buildings makes more sense in terms of

optimising workflows and adapting functional layouts, and is more economical in terms of cost control, than retention and refurbishment. It is therefore recommended that a demolition and redevelopment strategy be adopted for these buildings.

Department	The proportion of seven types of rooms to the average floor area per bed	The measure of area		Present situation	Newly build	Total	Difference
		lower limit	upper limit				
Emergency department	3~6	20328	40656	19693	0	19693	635
Outpatient department	12~15	81312	101640	34046.5	0	34046.5	47265.5
Inpatient Department	37~41	250712	277816	121958	85600	207558	43154
Medical Tech Department	25~27	169400	182952	58084	52400	110484	58916
Support system	8~12	54208	81312	30369.5	18629.73	48999.23	5208.77
Business management	3~4	20328	27104	17167	0	17167	3161
In hospital life	3~5	20328	33880	2614	5000	7614	12714
Total	91~110	616616	745360	283932	161629.73	445561.73	171054.27

Sub item	Research, teaching, and training area (5850 beds according to national standards)	Current research and teaching building area								Area of research and teaching rooms in the newly-built comprehensive building	Total	Difference
		13 # Animal Experiment Building	15 # General Practitioner Building	17# Teaching Building	18 # Nursing College	19 # Pharmacy Dept.	20 # First Student Apartment	5 # Fourth inpatient dept. converted into student apartments	Total			
Experiment	55500	10000							10000	4500		
Train	23000	9950	22417	5020	736	7626			45749	2000		
Dormitory	9600						4286	16000	20286			
Total	88100	19950	22417	5020	736	7626	4286	16000	76035	6500	82535	5565

Figure 6. Statistical analysis of area indicators for existing buildings. Source: HITAD.



Figure 7. Functional connection analysis and Demolition and renovation plans. Source: HITAD.

3.2. Preservation and respect for historical heritage

In studying the history of this hospital, we have found a historically significant central axis in the middle of the site, on which several historic buildings from different periods are landed. So in the master plan, we strengthened this historic axis so that the buildings on the axis form a consistent courtyard. This layout plan provides a better connection between the old buildings and the new ones. At the same time, the heights of the new buildings around the historic buildings are strictly controlled to reduce the impact of the new buildings on the existing environment.

In the design of the outlook of the buildings, we have kept the unity of the old and new buildings in spatial form, building height and appearance. Based on the above preservation strategies, the new

hospital has both historical characteristics and sense of modernity, so that the whole hospital environment presents a natural unity.

3.3. Enhancing the quality of ecological healing environments

In today's global trend towards green hospital design, more and more people are beginning to realise that hospital buildings should be used as an important part of a community's public life (Salehi and Eslami, 2010). Such hospitals are not only medical facilities, but also welcoming urban public spaces where the social atmosphere is effective in reducing patient stress and promoting harmonious community coexistence.

Scholars from different countries have found that the natural landscape can help patients recover from their illness (Reeve, Nieberler-Walker and Desha, 2017; Allahyar and Kazemi, 2021; Wang *et al.*, 2022). Therefore, we have not only built many natural courtyards, but also opened up the hospital's public green space to the city. In this way, we provide opportunities for patients and healthy citizens to communicate freely, which helps their recovery.

In the landscape design of the hospital renewal, we have arranged a number of easily accessible courtyards between the buildings, to provide space for patients and doctors to rest (Figure 8). In addition, we have also developed a rainwater harvesting system with the help of roof structural features, so that the rainwater falls on the roof can be collected in these courtyards. These strategies not only improve the environmental quality, but also respond to the sustainable urban development.

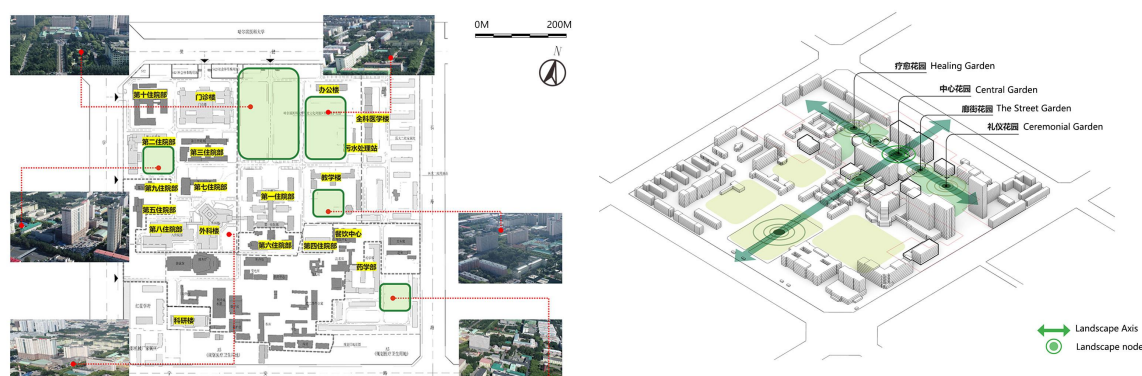


Figure 8. Natural landscape and public open space analysis. Source: HITAD.

3.4. Increasing adaptation to territorial climate

Due to the unique climatic conditions of cold regions (Caili *et al.*, 2024), the scale and spatial layout of hospitals must be designed to be more compact and efficient. It is necessary to use a reasonable spatial layout to withstand bad weather and ensure a pleasant and comfortable space for medical services. Compared with hospitals in other regions, large general hospitals in cold climate regions have more stringent and specific requirements for transformation and future development. In order to effectively address these challenges, a comprehensive analysis of the hospital's outdoor environment was carried out in this study using environmental simulation software (Ries and Mahdavi, 2001; Abaglo, Bonalda and Pertusa, 2017), with the aim of creating a high-quality outdoor space to facilitate the physical and mental rehabilitation of patients (Figure 9).

In addition, in order to reduce the negative impact of extreme winter weather, we designed an innovative underground pedestrian walkway system. This approach significantly improves the efficiency and convenience of daily access for medical staff and patients by connecting all buildings (Figure 10).

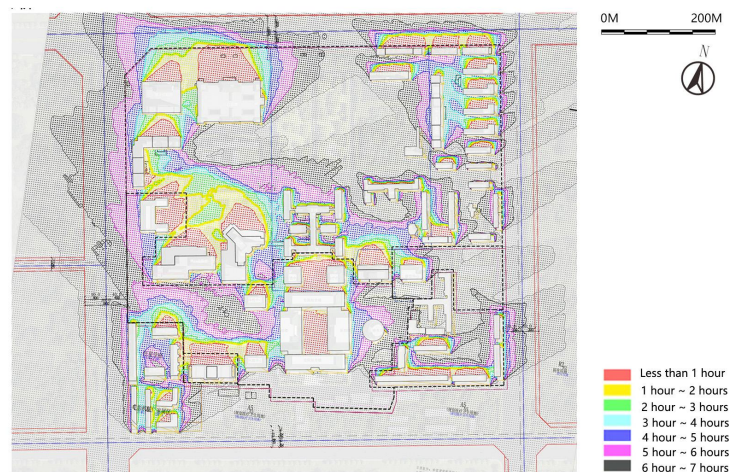


Figure 9. Natural environment modelling analysis. Source: HITAD.

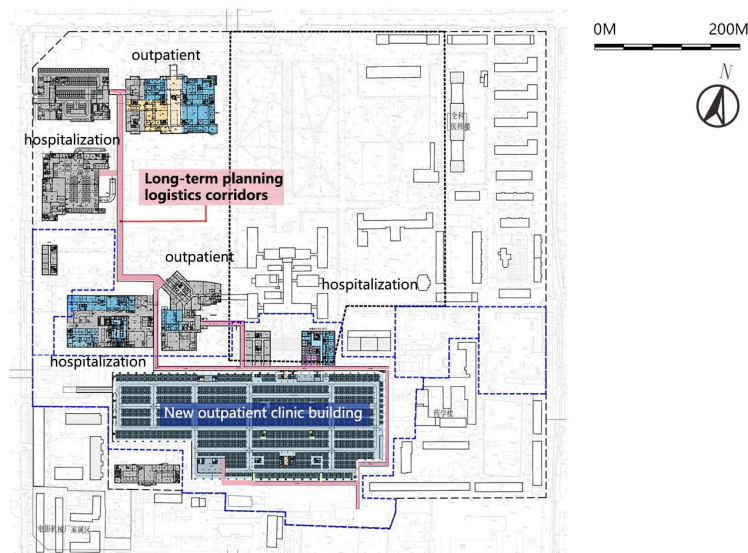


Figure 10. Indoor Underground Pedestrian System. Source: HITAD.

3.5. Developing sustainable development programs

There is a significant difference between updating an existing hospital and building a new one, mainly due to the need to ensure the safe and stable operation of the hospital while achieving hospital renewal. At every stage, the integrity of the hospital's core functions must be strictly maintained to avoid disruption to daily running. During the planning stage, careful strategies are needed to minimise negative impacts such as traffic congestion and noise disturbances during construction. Therefore, the renewal design of the hospital requires a precise phased construction plan.

From the broader perspective of urban sustainability, we have developed a detailed renewal plan to ensure that the hospital continues to contribute to the city. The plan consists of two phases with detailed timelines for new construction, relocation, demolition, and redevelopment (Figure 11). The plan aims to balance the preservation of historic buildings with the current stage of medical needs, taking the city to a higher level of quality and sustainability.

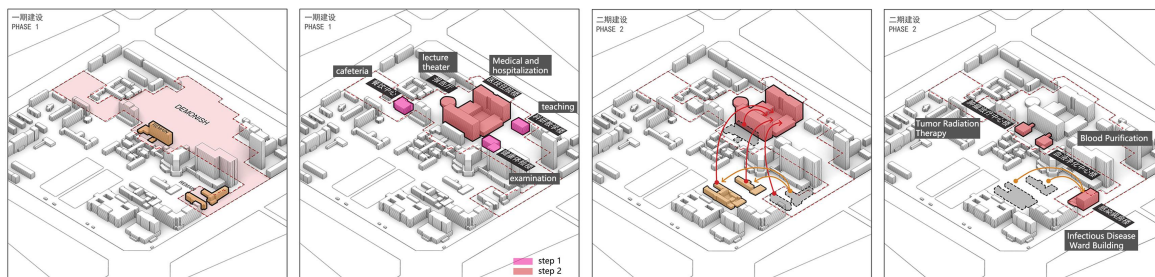


Figure 11. Phased construction plan. Source: HITAD.

4. Discussion

4.1. Summary of Case Characteristics

Guided by this renewal design framework, the proposed design scheme has been successfully completed. The scheme adheres to a human-centred design concept and follows the overall layout principle of "inheriting the essence of the university's culture and integrating the atmosphere of the sunny courtyard," aiming to create a harmonious and symbiotic healing environment. It combines this with the rational spirit of rigor and pragmatism in life sciences, thus achieving a seamless fusion of these two elements.

In the planning layout, the two existing north-south arterial roads were extended into the new site. An east-west road was constructed adjacent to the main entrance on the west side, forming a 'two longitudinal and one horizontal' main road system with the existing ones. This road system effectively connects the existing medical area, the new medical area and the teaching area, forming an efficient traffic network (Figure 12). Sunny and vibrant courtyards have been built between the buildings. These courtyards not only create a positive environment for patients to promote recovery, but also reflect the hospital's humanistic approach (Figure 13).



Figure 12. Master plan of the hospital in the long term. Source: HITAD.



Figure 13. Aerial view of the hospital in the long term. Source: HITAD.

With the help of the project practice, our research has developed a systematic and comprehensive design framework for hospital renewal. This framework has several clear advantages over previous: First of all, it grants equal importance to both the existing layout and the development needs of the hospital. Secondly, by taking patient health needs into account, it enhances the hospital's societal contribution. Thirdly, it improves the environmental quality while preserving the hospital's cultural heritage, so that the hospital can integrate with the current urban environment well. Above all, this design framework has a wide range of applicability and can solve similar design challenges.

4.2. Future prospects

In the following research plan, we hope to use some new quantitative research methods, such as, spatial and temporal big data analysis and spatial behaviour simulation, so that our research will become more scientific. We will also pay more attention to hot issues in urban regeneration such as preservation and usage of cultural heritage, optimisation of building efficiency and improvement of outdoor environmental quality. With all of the above efforts, we hope to enrich the renewal design strategy of existing hospitals in cold cities.

5. Conclusion

General hospitals with a long history have grown along with the city and have made a significant contribution to the city's public health. In the current new wave of urban regeneration, these hospitals are about to enter a new life cycle and become an important part of urban development. It is the responsibility and mission of every architect to improve the quality of hospital buildings through more scientific hospital renewal strategies. We hope that our efforts, combined with the refined hospital management model, will better meet the public's expectations for healthy and efficient healthcare services.

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