



Social Dimensions of Architectural Space

--Residential Renewal Based on SAR Theory

Shiyin Li^{1, 2}

¹Soochow University, Suzhou, Jiangsu, China

²University of Plymouth, Plymouth, United Kingdom

ABSTRACT

Since the emergence of open building theory in the Netherlands in the 1960s, it has gained worldwide attention. Various countries have adapted and developed the theory in line with their unique social contexts, leading to extensive applications and innovations in areas such as urban and rural housing, post-disaster reconstruction, and historic urban renewal. This paper first traces the evolution of open building theory, summarizing its technical breakthroughs in practice. It then examines the core SI (Skeleton-Infill) system—the underlying design logic of the theory—and illustrates its design methodology and sustainable applications through relevant case studies. By emphasizing a design process in which both architects and users collaboratively define the boundaries between permanence and change, this study aims to provide a socially grounded perspective for China's transition into an era of residential stock renewal.

KEYWORDS

SAR Theory, Open Building, SI System, Housing Renewal.

1. FOUNDATIONS OF SAR THEORY

The SAR (Stichting Architecten Research) theoretical framework emerged in the post-war context of rapid industrialized housing development. For two decades after World War II, monotonous box-like residential blocks filled cityscapes, replacing customized, user-oriented dwellings. This led to depersonalized neighborhoods and a loss of urban texture [1]. By the 1960s and 70s, a wave of critical reflection arose. Scholars like Jane Jacobs, in *The Death and Life of Great American Cities*, pointed out how industrialized urban renewal contributed to social issues such as crime and the proliferation of slums, advocating instead for small-scale, flexible housing models [2].

1.1. SAR Theory and the Separation System

Founded in the Netherlands during the 1960s, the SAR research foundation focused on the modular coordination of structural and infill components of housing. The resulting SI (Skeleton-Infill) system divides a building into two major parts: the skeleton (support structure, pipelines, circulation spaces) and the infill (partition walls, interior furniture). The former is typically designed by professionals and has a longer lifespan, while the latter allows for flexible user participation and adaptation [3]. This represented a shift from developer-centered design to a more participatory model that served the public interest through industrialization.

1.2. Technological Evolution of the SAR Approach

SAR theory gradually evolved into a broader open building movement, characterized by its human-centric design principles and industrial adaptability. It was introduced to China in the early 1980s, notably in the Huishan New Village project led by Professor Bao Jiasheng.

The technical development of the SI system can be divided into four main stages:

-1960s–1980s: Emphasis on standardized unit types with structural elements (e.g., shear walls, short columns) designed to facilitate flexible infill through clear separation of load-bearing and non-load-bearing systems [4].

-1980s–1990s: Introduction of double-layer floors and recessed slabs to accommodate changing locations of kitchens and bathrooms without compromising the structure.

-1990s–2010: Increased industrial standardization with fixed wet areas and modularized partitions/furniture. Piping systems were entirely separated from infill to extend building life.

-2010–present: Development of prefabricated MATRIX TILE systems and unified vertical shafts integrated with smart technologies. Layered systems were further refined for use in urban renewal and disaster reconstruction projects, underscoring the adaptability and resilience of the SI framework.

2. DESIGN METHODOLOGIES AND PRACTICAL APPLICATIONS

2.1. Basic Design Methods

The SAR system employs a spatial breakdown strategy that divides floor plans into zones, margins, and sectors. Zones correspond to depth-based divisions: exterior-lit spaces near façades, internal areas without daylight, communal corridors, and private outdoor spaces. Margins are transitional interfaces that often accommodate structural walls, closets, passageways, or service shafts. Sectors refer to the resultant areas formed by multiplying structural bays with margins. Each sector may house one or multiple rooms. Users work with designers to determine spatial layouts within sectors, enabling flexible housing configurations [5].

In modern applications, this principle informs home renovations where architects establish the structural core with elevated service voids, and provide standardized interior components for user customization—dramatically enhancing industrial efficiency.

The SAR 73 model, oriented toward external residential environments, introduced the “Basic Unit of Community Life” design method. Similar to the internal zoning method, it divides neighborhood spaces based on road hierarchies and functions, combining historical context with modular principles to produce cohesive unit models [6].

2.2. Case Study: NEXT21, Japan

Constructed in 1994, the NEXT21 housing project in Osaka stands as a benchmark for SI-based flexibility. From 1996 to 1999, the complex underwent continuous spatial reconfigurations driven by resident feedback, showcasing the adaptability of the open building system.

The support components—made from high-strength prestressed concrete—were designed for a lifespan of up to 100 years, while the more transient infill components could be modified according to user needs (Figure 1). External walls were treated as part of the permanent skeleton, enabling varied internal layouts and dynamic street façades. Lower levels were designated for commercial and office functions, with floor heights and spans tailored accordingly [7]. Elevated floors allowed for ductwork placement above beams, and ventilation shafts were misaligned from structural elements to avoid damage or moisture issues [8].

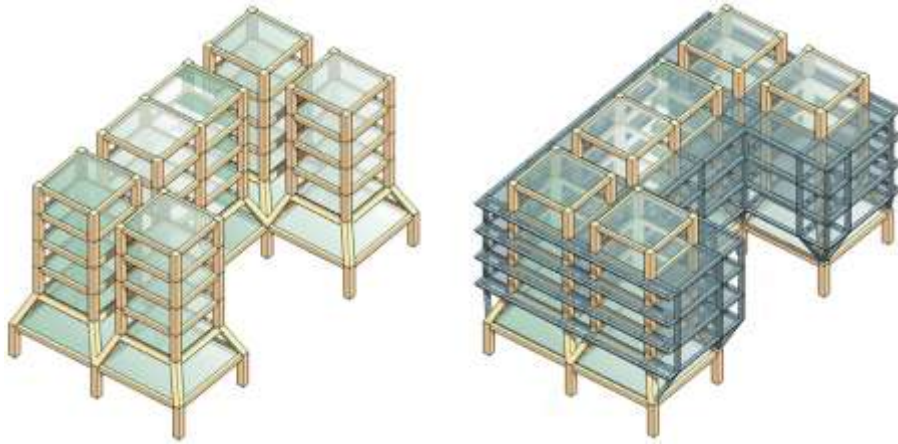


Figure 1. Structural Skeleton System of the NEXT21 Residential Complex in Japan.

Source:

<https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbname=CJFDLAST2016&filename=CSZZ201606007>

3. IMPLICATIONS FOR RESIDENTIAL STOCK RENEWAL IN CHINA

3.1. Current State of Residential Environments

China is experiencing a rapid increase in residential construction. However, many new developments suffer from uniformity, limited adaptability, and outdated spatial logic—problems that are exacerbated by demographic shifts such as the three-child policy and population aging.

In major cities like Beijing, Shanghai, and Guangzhou, aging neighborhoods dominate the urban core. These areas frequently suffer from structural degradation caused by intrusive piping, rigid load-bearing walls that resist modification, and unsafe insulation systems that detach under strong winds.

3.2. SAR Theory as a Guiding Framework for Renewal

For widespread multi-story housing typologies, scholars such as Gao Penghui from Beijing University of Civil Engineering and Architecture have proposed a “horizontal integration–vertical shaft–multi-division” model [9]. This approach involves selectively breaching load-bearing walls and reinforcing them with beams, allowing units to be combined or expanded. Vertical service shafts centralize plumbing in apartments lacking independent bathrooms, and infill layouts are customized for diverse household needs with future adaptability in mind (Figure 2).



Figure 2. “Horizontal Integration – Vertical Shaft – Multi-Division” Renovation Model. Source: Baidu Images

The SAR approach offers a new paradigm for urban renewal by operating on three interlinked levels: community, skeleton, and infill. It rejects large-scale demolition in favor of retaining existing urban textures while empowering residents to co-design their living environments [10]. Architects define immutable elements (e.g., heritage sites, street scales), governments mediate public interests, and residents contribute based on personal needs. This synergy fosters revitalized communities and a stronger sense of belonging.

4. CONCLUSION

The SAR system, with its seamless integration into industrialized construction processes, offers a viable and sustainable model for urban housing renewal. By maintaining a balance between standardization and flexibility, the SAR framework guides architectural design from unit-level typologies to neighborhood-scale planning. Through a comprehensive analysis of its theoretical evolution, methodological applications, and real-world implementations, this paper provides a strategic reference for China's ongoing stock renewal initiatives.

REFERENCES

- [1] Huang, X. (2021). Renewal and Activation of Historic Urban Districts Based on Urban Fabric. *Fujian Architecture*, (08), 9–17.
- [2] Liang, M. (2017). A Study on the Enlightenment of 'The Death and Life of Great American Cities' on China's Urban Development. *Century Bridge*, (08), 60–61.
- [3] Qin, S. (2014). Sustainable Residential Design and Practice Based on the SI System. (Master's thesis, China Architecture Design & Research Group).
- [4] Li, M., Xia, H., & Li, J. (2019). Research on Modularity Coordination in SI Housing Design. *Huazhong Architecture*, 37(05), 47–52.
- [5] Zhang, S. (1980). Design Methodologies for SAR Housing and Residential Environments. *World Architecture*, (02), 10–16.
- [6] Huang, J., & Zhou, J. (2016). Expressing Flexibility in Architecture through Open Building Theory. *Urban Housing*, 23(06), 32–36.
- [7] Cui, G., Ji, X., & Chen, X. (2015). Research on Systematic Design Strategies of Japan's Long-term High-quality Collective Housing. *New Architecture*, (5), 94–98.
- [8] Li, Y. (2018). An Analysis of the Open-Type Collective Housing NEXT21. *Wall Material Innovation and Building Energy Efficiency*, (4), 49–51.
- [9] Zhao, S. (2019). Research on the Renewal of Existing Multi-story Residential Buildings in Northeastern Cities Based on the SI Separation System (Master's thesis, Harbin Institute of Technology).
- [10] Shao, Y., Li, J., & Wang, M. (2015). Reflections on Shantytown Renovation Under the Enlightenment of Open Building Theory. *New Architecture*, (6), 108–111.