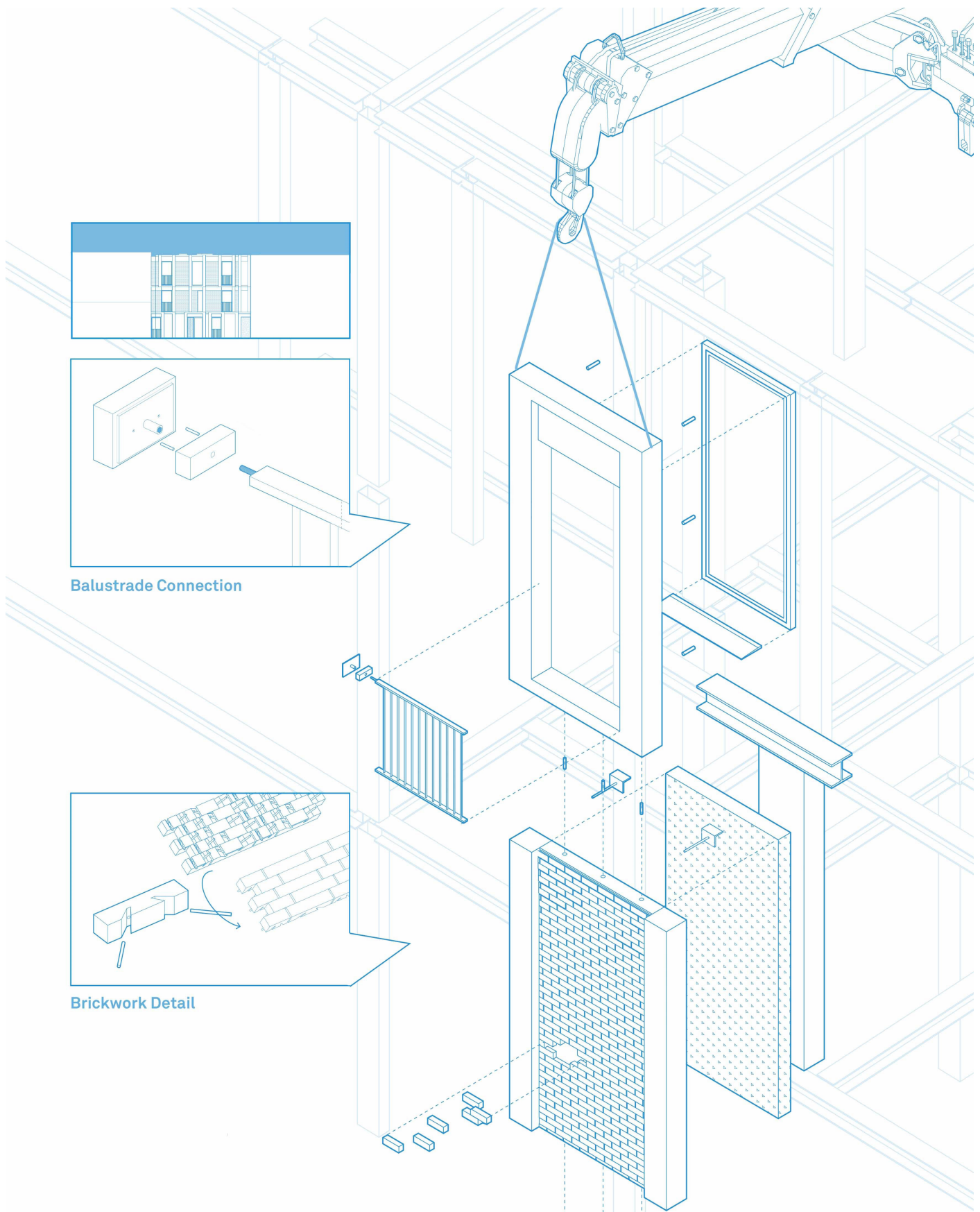


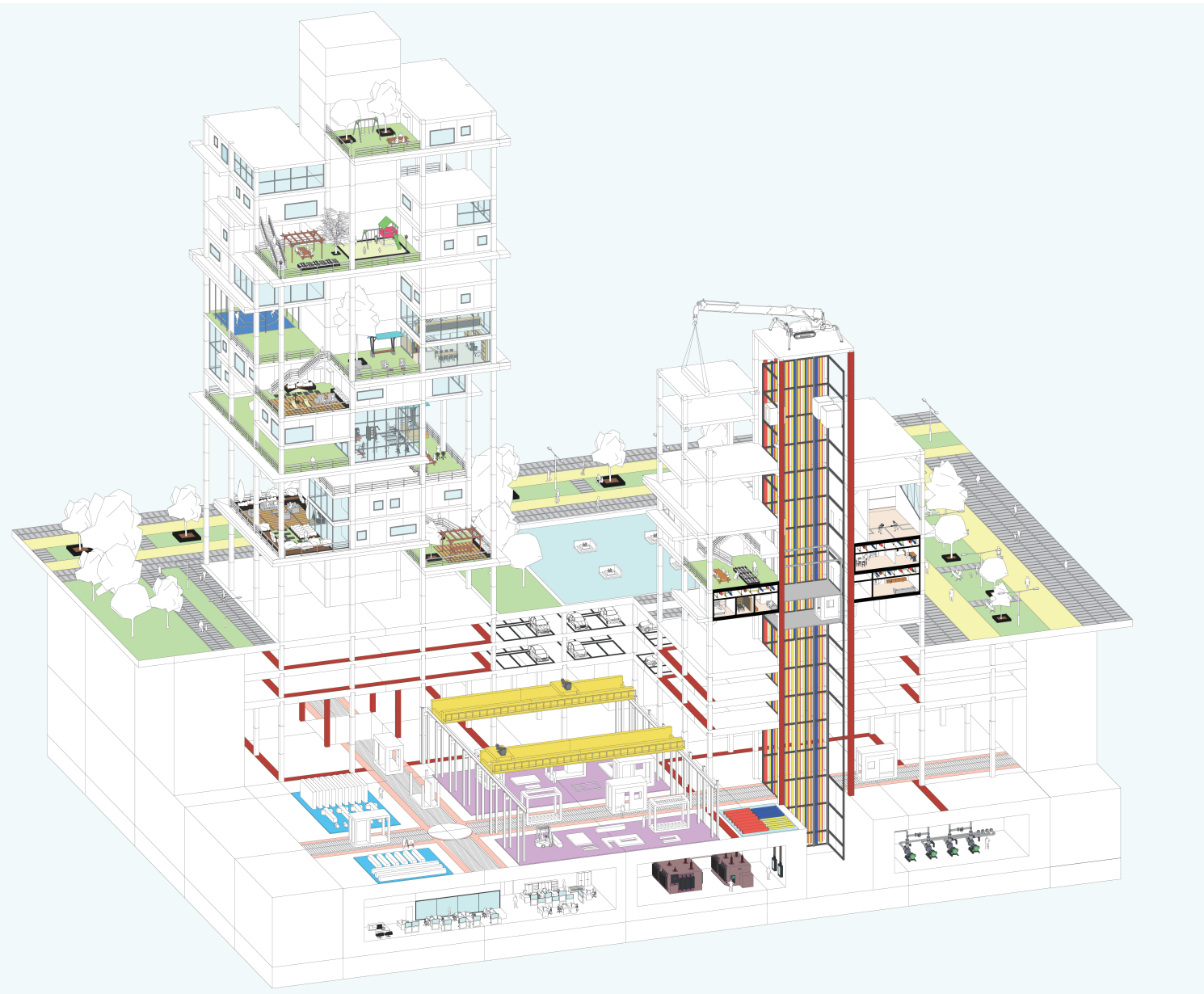


OSC System Apartment Design

A Design Proposal for Long-Life Housing Using the OSC System

Student
Jeong Jeong Ho

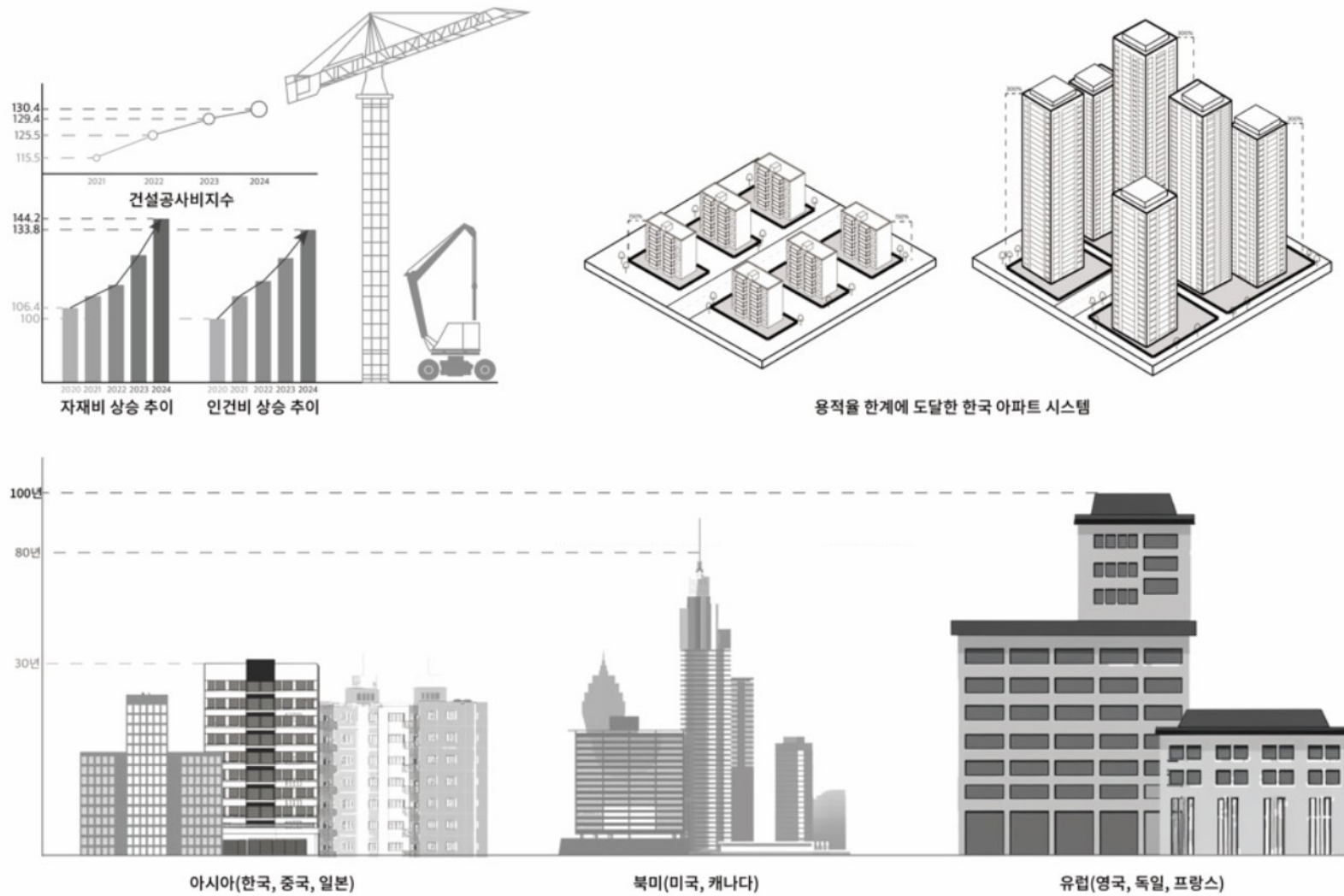
Supervisor
Lee-Jae



OSC System Apartment Design

A Design Proposal for Long-Life Housing Using the OSC System

Abstract



(Background and Purpose) Korean apartment buildings have an average lifespan of only 30 years, much shorter than in advanced countries. This short cycle leads to repeated redevelopment, forced relocation, loss of community, and heavy environmental impacts from waste and carbon emissions. To address these issues, this study proposes a long-life housing model using OSC (Off-Site Construction), applying a Skeleton-Infill structure to extend building lifespan and enhance sustainability.

(Method) The study examines institutional and structural factors behind the short housing lifespan through literature review and policy analysis. It explores adaptable housing concepts by analyzing international precedents such as Fun Palace and the Netherlands' Skeleton-Infill system, alongside current domestic modular construction technologies. Based on these findings, it proposes a design using precast concrete structures combined with modular infill units, supported by a Mega Core and crane system to enable efficient maintenance and unit replacement over time.

(Conclusions) An OSC-based Skeleton-Infill approach offers a practical alternative to Korea's short-lived apartment model. By combining a permanent structure with flexible infill, it improves environmental performance and housing adaptability. Further research on policy, economics, and implementation could enable real-world application and support a sustainable urban housing ecosystem.

(Results) The proposed design enhances flexibility and durability, reduces demolition and waste, lowers lifecycle costs, cuts carbon emissions, and helps preserve local communities. It shows clear potential to shift Korea's housing system from short-term redevelopment to a sustainable long-life housing model.

(Keywords) Modular, Precast Concrete, Apartment, Long-Life Housing, Community recovery

CONTENTS

01. Design Background

- 1.1 Design Background & Proposal
- 1.2 Design Method & Process

02. Theory Analysis

- 2.1 Theory & Consideration
 - 2.1.1 Community disintegration
 - 2.1.2 Crime rate increase
 - 2.1.3 waste of resources
- 2.2 Why Apartment Buildings Have a Short Lifespan
- 2.3 Living Architecture
 - 2.3.1 Fun Palace
 - 2.3.2 Nakagin Capsule Tower
 - 2.3.3 Open Housing (Support & Infill)

03. LMC Concept

- 3.1 LAND
- 3.2 Modular
 - 3.2.1 Modular Constuction
 - 3.2.2 Maintain System
- 3.3 Community

04. Basic Design Strategy for Long-Life, OSC-Based Housing

- 4.1 Modular Transport E/V System
- 4.2 Underground Repair Center
- 4.3 Rooftop Spider Crane
- 4.4 Quick-Connector Joint for Foundation
- 4.5 Installation Method for Electrical, Storm-water, and Sewage Piping
- 4.6 Proposal for an OSC-Based Housing System to Restore Local Community

05. Drawings

- 5.1 1F Plan
- 5.2 2F Plan
- 5.3 3F Plan
- 5.4 Master Plan
- 5.5 Keyshot

01. Design Background



1.1 Design Background & Proposal

In South Korea, the average lifespan of multi-family housing—particularly apartment complexes—remains approximately 30 years, a figure that falls far short of that of many advanced countries such as the United Kingdom (approximately 77 years) and the United States (approximately 55 years). This relatively short service life has triggered a cycle of large-scale reconstruction and redevelopment, which not only imposes substantial economic burdens but also leads to the involuntary displacement of tenants and long-term residents. As a consequence, local communities experience fragmentation and loss of social cohesion, accelerating gentrification in urban neighborhoods.

Scholars and practitioners have expressed growing concern regarding the environmental and social implications of this redevelopment-driven housing cycle. Professor Choi Won-chul of Hanyang University emphasizes that “Korean apartments require reconstruction after merely 30 years,” noting that demolition waste generated from such projects accounts for nearly half of all municipal solid waste. This trend raises the alarming prospect of a national “waste crisis” if the current redevelopment paradigm persists. Globally, the building sector is responsible for approximately 40% of total carbon dioxide emissions; thus, extending the lifespan of existing buildings and improving their maintenance strategies is emerging as a critical imperative for climate change mitigation.

International precedents provide compelling alternatives to the short-lived, demolition-oriented housing model. In the Netherlands, long-term housing frameworks such as the 100-Year Sustainable Building model employ a Skeleton–Infill approach that separates the durable structural frame from replaceable interior components, significantly reducing life-cycle costs while enhancing adaptability over time.

Similarly, Japan’s Long-Life Housing Certification system incentivizes residential designs that prioritize long-term structural use, modularity, and maintainability. These strategies demonstrate that separating the core structural system from the infill components is a viable method for achieving extended building lifespans and reducing environmental impact.

Despite these developments abroad, South Korea continues to rely heavily on wall-structured apartment buildings and short-term supply-oriented housing policies, resulting in limited adoption of long-life housing principles. The dominance of monolithic wall structures constrains flexibility in layout changes, hinders long-term renovation, and accelerates physical and functional obsolescence. Consequently, Korean multi-family housing remains locked into a rapid cycle of deterioration and redevelopment.

Given this context, the present study seeks to critically examine the lifespan characteristics and structural limitations of current Korean apartment systems and to propose an alternative design framework that addresses these shortcomings. Specifically, the research explores the potential of an OSC-based (Precast Concrete + Modular) Skeleton–Infill system that formally separates structural and infill components. Through this design strategy, the study aims to establish a viable model for long-life multi-family housing in Korea, enhancing sustainability, reducing waste, and strengthening community resilience.

1.2 Design Method & Process

This study employs a three-stage research methodology—literature review, conceptual exploration, and design proposal—to systematically investigate the limitations of Korea’s current multi-family housing system and to develop a long-life residential model based on the separation of structural and infill components.

(1) Literature Review

The first phase involves an extensive review of existing studies, policy reports, and statistical data related to housing reconstruction, redevelopment, and remodeling practices in South Korea. Through this analysis, the research identifies structural, economic, and institutional factors that have hindered the diffusion of long-life housing models in the domestic context. The review also examines regulatory frameworks, life-cycle costs, and the supply-driven nature of national housing policies to clarify why conventional apartment buildings continue to exhibit short service lives.

(2) Conceptual Exploration

The second phase investigates theoretical and international precedents for adaptable and long-life housing systems. Key references include Cedric Price’s Fun Palace, which embodies principles of flexibility and open-ended spatial use, as well as the Skeleton–Infill housing models developed in Japan and the Netherlands, which formalize the separation of robust structural frames from replaceable interior components. In the Korean context, the study analyzes the technological capabilities and product systems of leading modular construction firms—such as Hansung Modular, Zaigaist, and Wavy Room—to assess the feasibility of adaptable residential structures. This comparative conceptual investigation provides a foundation for identifying design criteria suitable for a Korean long-life housing model.

(3) Design Proposal

The final phase proposes an Off-Site Construction (OSC)–based housing model that physically separates the structural frame (skeleton) from the residential unit infill. The structural system utilizes precast concrete (PC) components designed for long-term durability, while modular units are assembled as interchangeable infill elements atop the primary structure. This design enables partial or full replacement, expansion, or reconfiguration of interior units in response to evolving demographic and lifestyle needs. The proposed framework outlines a practical application of OSC systems to realize adaptable, resource-efficient, and long-life multi-family housing in Korea.

02. Theory Analysis





2.1.1 Weakening of Community Cohesion

Large-scale redevelopment and reconstruction projects alter not only the physical urban fabric but also the social dynamics and trust networks among residents. Over the past three decades, urban regeneration initiatives have contributed to improving deteriorated housing stock and expanding the overall supply of residential units. Although these projects were originally intended to enhance housing quality for socially vulnerable populations living in deteriorated districts, redevelopment has increasingly deviated from this purpose. Instead, many low-income households face involuntary displacement, rising housing insecurity, and disruptions to their daily lives.

As long-standing residential networks are dismantled and residents with diverse socioeconomic backgrounds move in and out, the sense of place and community continuity is significantly weakened. The loss of shared experiences, neighborhood rituals, and informal support systems leads to a decline in community cohesion. This phenomenon produces long-term consequences that extend beyond the removal of aging buildings; it contributes to the deepening of intergenerational and socioeconomic inequalities, thereby generating social fragmentation and heightened tensions within urban communities.

2.1.2 Increased Crime Rates

Redevelopment-induced community dissolution has also been associated with changes in local crime dynamics. Shaw and McKay's Social Disorganization Theory (1920) argues that structural characteristics of a community—such as residential instability, population turnover, and socioeconomic heterogeneity—directly influence individual behavior. Rapid population displacement and the introduction of heterogeneous resident groups during redevelopment processes weaken customary forms of neighborhood control, eroding both formal and informal mechanisms of social regulation.

The breakdown of community surveillance, collective efficacy, and informal guardianship reduces natural monitoring within the neighborhood. This decline in social control is expected to increase opportunities for crime. Prior research has also demonstrated that redevelopment projects frequently produce conflicts among project stakeholders, further intensifying social tension and creating conditions conducive to disorder. Therefore, redevelopment without sustained community management can inadvertently contribute to rising local crime rates and broader social instability.

2.1.3 Resource Waste and Environmental Burden

Due to the structural characteristics of Korea's wall-structured apartment buildings, remodeling or functional upgrades are often technically unfeasible. Unlike column-slab structural systems, wall-structured buildings rely on load-bearing walls and slabs without columns, making it difficult to modify interior layouts, replace building services, or remove structural walls. As a result, renovation is typically replaced by full demolition, followed by reconstruction.

This practice leads to significant resource waste, as reusable structural components are discarded rather than recycled. The cycle of complete demolition produces excessive construction waste, exacerbating environmental degradation and imposing substantial economic costs. Professor Choi Won-chul of Hanyang University warns that "entire apartment buildings must be demolished after about 30 years, and the resulting construction waste accounts for nearly half of all waste generated nationwide." Such patterns underscore the urgent need for housing models that enable long-term structural use, adaptability, and material efficiency.

2.2 Reasons for the Short Lifespan of Apartment Housing

South Korea's housing policies have historically prioritized the rapid expansion of supply, resulting in a short-term, quantity-focused development paradigm. Within this framework, institutional incentives for long-life housing have remained limited, and market mechanisms have not sufficiently encouraged the adoption of durable or adaptable building systems. One of the most significant structural issues is the widespread reliance on wall-structured apartment buildings, a typology shaped largely by cost considerations.

Compared to wall structures, column-slab structural systems require approximately 3–6% higher construction costs. When factors such as high-rise design requirements, ventilation performance, and enhanced thermal insulation standards are incorporated, the cost increase can reach 10–15%. As a result, for the past 50 years, most Korean apartments have been constructed using wall-bearing systems, solidifying this structural approach as the dominant—and problematic—standard for contemporary housing.

The prevalence of wall structures severely restricts internal spatial modifications. Because load-bearing walls perform essential structural functions, alterations such as removing walls, expanding rooms, or reorganizing service spaces raise significant structural safety concerns. Consequently, large-scale remodeling becomes technically and economically infeasible. According to the Construction Industry Institute of Korea, approximately 90% of the domestic remodeling market is concentrated in non-residential buildings such as offices and commercial facilities, where column-based structures allow greater flexibility. In contrast, wall-structured apartments face substantial limitations, leading residents and developers to favor reconstruction over remodeling.

These structural constraints prevent the establishment of an environment conducive to long-life housing. Without the capacity for functional upgrades, spatial reconfiguration, or system replacements, Korean apartments reach obsolescence much earlier than international equivalents. The dominance of wall-structured design thus functions as a major barrier to sustainable housing practices, reinforcing a redevelopment cycle that shortens building life, consumes excessive resources, and undermines efforts to transition toward long-term, adaptable housing models.



2.3 Concept of living architecture

2.3.1 living architecture

In South Korea, the average lifespan of buildings remains approximately thirty years, resulting in a recurring cycle of demolition and new construction. Buildings with insufficient economic value are often left abandoned, posing safety risks and accelerating urban decline. When aging is addressed solely through complete demolition and reconstruction, the consequences—community displacement, weakened social cohesion, increased crime rates, and significant environmental burdens—are repeatedly reproduced. Scholars note that conventional redevelopment practices generate excessive waste, exacerbate social disintegration, and undermine long-term sustainability (Choi, 2021; Shaw & McKay, 1920).

Recent research in sustainable architecture further emphasizes that adaptability is a fundamental criterion for reducing unnecessary demolition and minimizing environmental impacts. Design for Adaptability (DfA) has been recognized as an essential strategy for extending building life and preventing the generation of excessive construction waste, thereby reducing the resource footprint of the building sector (Geraedts, 2020). In this context, Cedric Price's Fun Palace represents a critical conceptual precedent. It introduced a vision of architecture as a dynamic, responsive system—what Price described as a “laboratory of change” rather than a static form.

The Fun Palace demonstrated how programmable, reconfigurable structures could respond to social and technological transformations. Scholars interpret the project as a prototype of “living architecture,” highly adaptable to shifting cultural and experiential conditions. This theoretical foundation aligns closely with the goals of long-life housing, where buildings must remain viable—even regenerative—over time rather than deteriorating into obsolescence.

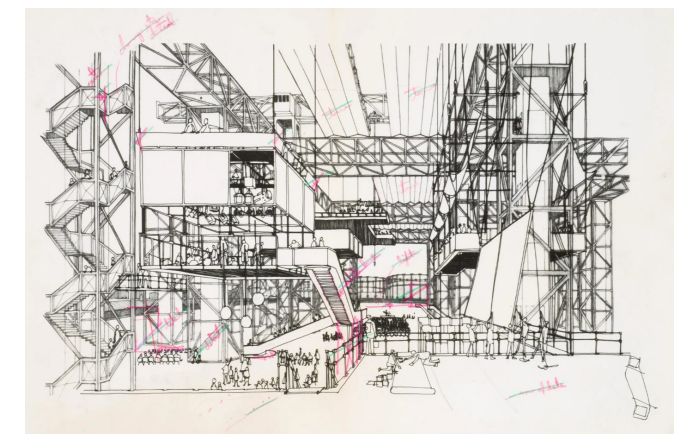
For these reasons, this study adopts the conceptual framework of the Fun Palace to propose a model of multi-family housing capable of long-term adaptation. By introducing architectural systems that can reorganize, replace, or upgrade components without full demolition, the design aims to shift Korean housing production toward a model of “living buildings” that evolve continuously with user needs and societal change. The integration of flexibility, modularity, and open-ended lifespan is thus positioned not as a design preference but as an urgent architectural necessity for Korea's changing urban future.

2.3.2 Fun Palace

Contemporary architectural practice faces a profound tension between the increasing volatility of social and environmental conditions and the urgent demand for long-term sustainability. As societies undergo rapid technological, cultural, and ecological transformations, buildings designed around fixed programs, typologies, and life cycles are proving insufficient for addressing the fluidity of modern life. This condition calls for architectural frameworks capable of accommodating continual change while minimizing environmental and material burdens. Within this context, Cedric Price's Fun Palace (1961–1974) offers a seminal yet often underappreciated paradigm for rethinking architecture's relationship to time, use, and adaptability.

Although never realized, the Fun Palace proposed a radically open, cybernetically-informed environment conceived not as a conventional building but as a dynamic system—one capable of evolving in response to its users, contexts, and temporal conditions. Its design positioned architecture as an indeterminate and reconfigurable matrix rather than a static object, challenging traditional assumptions about permanence, authorship, and typological rigidity. Recent scholarship has increasingly recognized the project's relevance for contemporary sustainability discourse, particularly as global ecological challenges demand architectural strategies that prioritize flexibility, modularity, resource efficiency, and active participation.

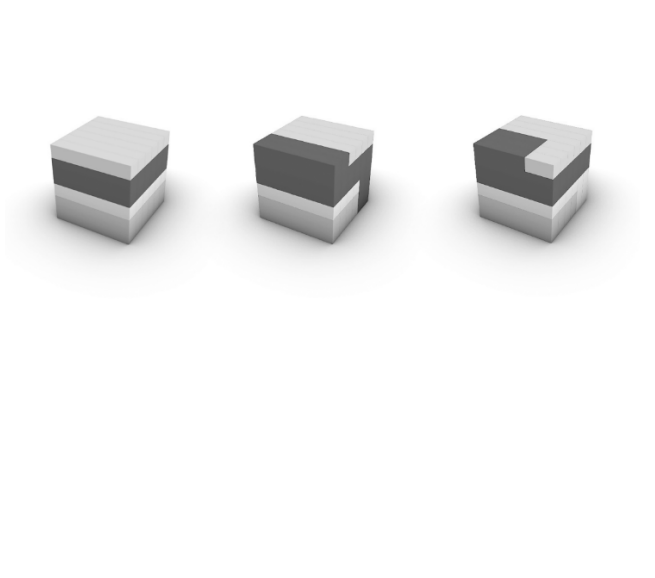
This paper revisits the Fun Palace not merely as a historical curiosity but as a forward-looking model from which essential principles for ephemeral yet sustainable architecture can be extracted. By analyzing the conceptual and technical foundations of the project, this study identifies five key lessons—open programming, open typology, user agency, modularity, and adaptability—that remain highly pertinent for reimagining sustainable built environments today. Together, these principles illustrate how architecture can reconcile temporal indeterminacy with long-term resilience, offering a framework for buildings that are simultaneously flexible, resource-conscious, and socially inclusive.



2.3.3 Fun Palace’s 5 Concept

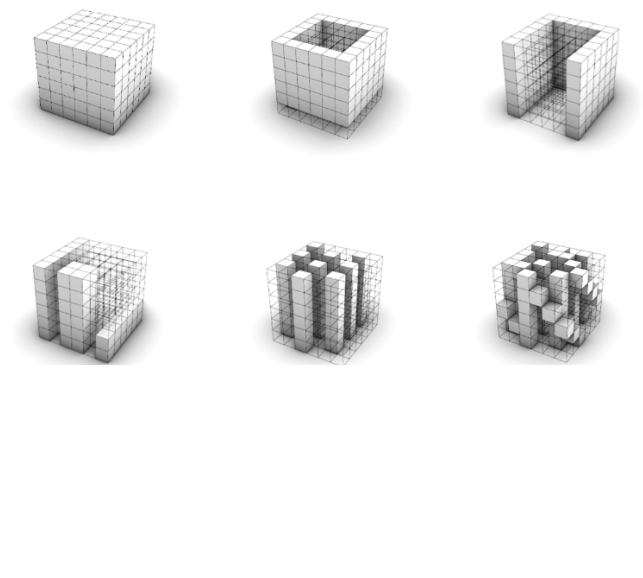
1. Open Programmatic Framework

The Fun Palace demonstrates that architectural programs should not be predetermined as fixed functional requirements. Instead, they must be conceived as open-ended frameworks capable of accommodating an evolving spectrum of activities over time. By rejecting prescriptive programming, Price positioned architecture as a system that anticipates uncertainty, change, and emergent use patterns, thereby enabling long-term relevance without functional obsolescence.



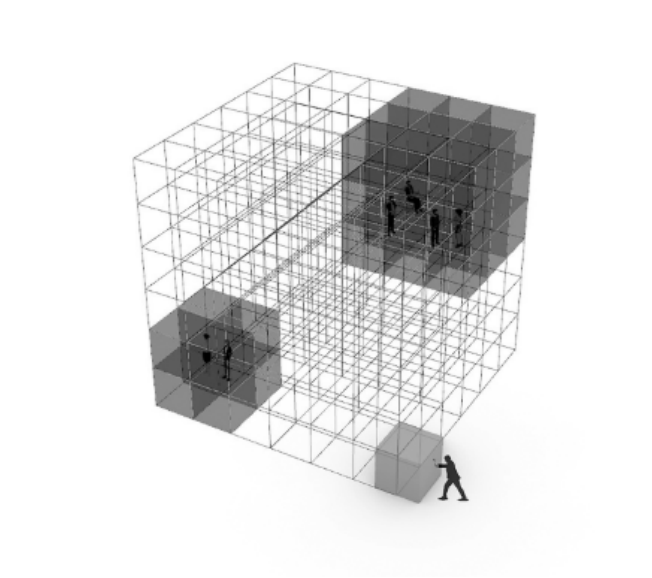
2. Open Typological Structure

Rather than adhering to fixed typologies that associate form with specific uses, the Fun Palace proposes an open typological model in which spatial configurations can be continually transformed. Its architecture serves as an adaptive matrix that allows different spatial types to emerge dynamically based on shifting contextual and social demands. This principle decouples architectural form from static function and reconceptualizes buildings as typologically indeterminate frameworks.



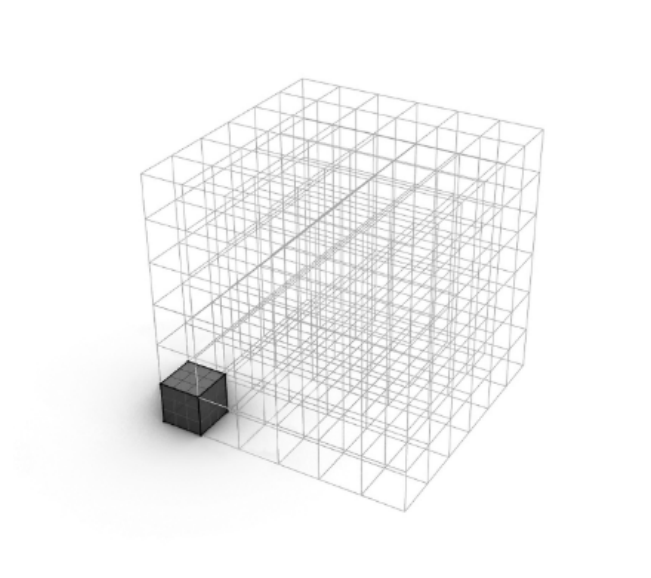
3. Users as Active Agents

A central contribution of the Fun Palace is its redefinition of users as active participants and co-authors of architectural space, rather than passive occupants. Drawing on cybernetic feedback principles, Price conceptualized the building as an interactive system that receives information from its users and responds accordingly. This approach positions architecture as a mediating device that supports diverse behaviors, encourages participatory spatial transformation, and fosters a sense of collective agency.



4. Modularity as a Mechanism for Transformation

The Fun Palace employs modular construction as a means to enable continuous reconfiguration. Through a lattice-like steel structural frame combined with interchangeable components—floors, walls, ceilings, and circulation elements—the project demonstrates how modularity facilitates rapid assembly, disassembly, and rearrangement. Modularity thus becomes a key instrument for supporting temporal flexibility, efficient resource use, and adaptable spatial organization, all of which are central to sustainable design.

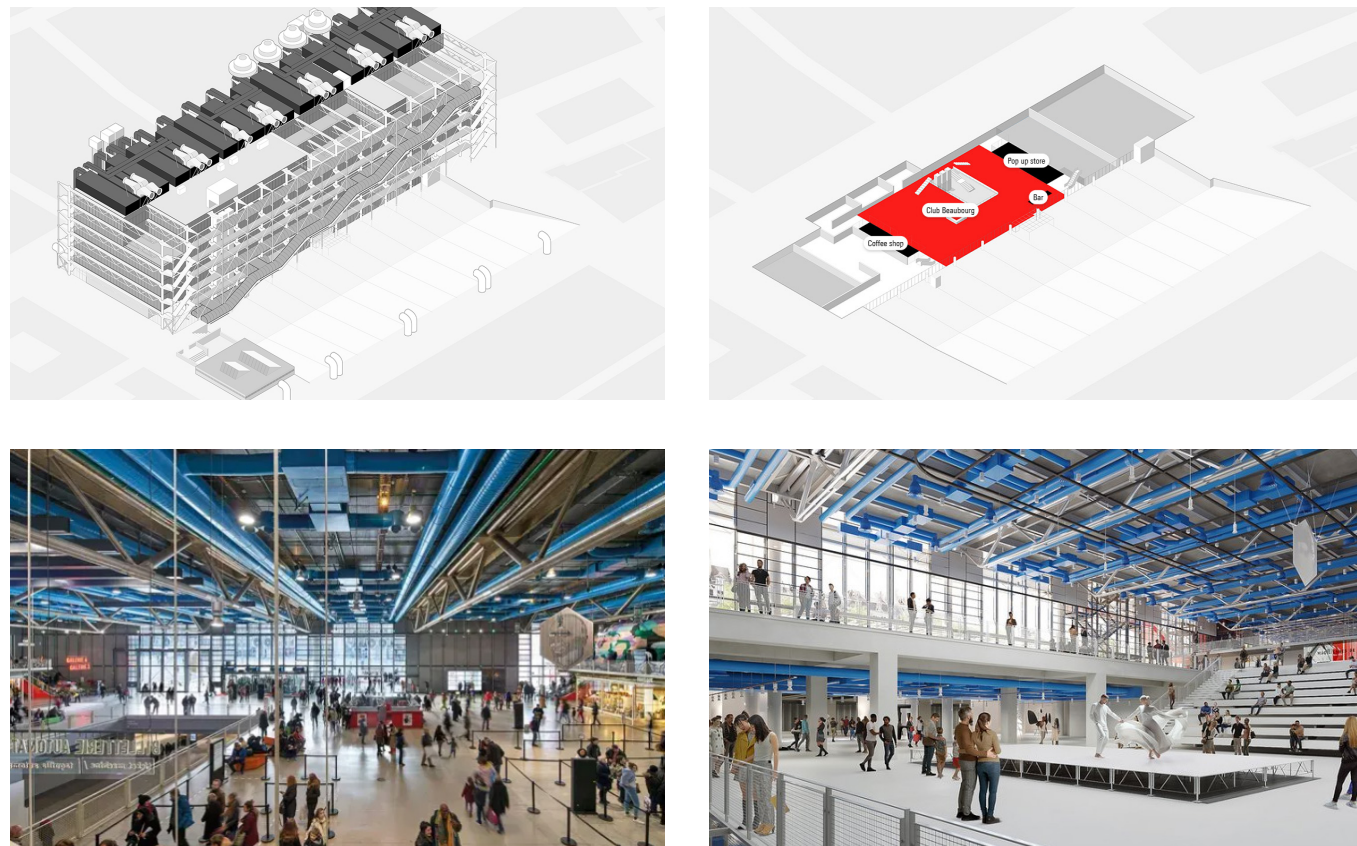


2.3 Concept of living architecture

1. Open Programmatic Framework

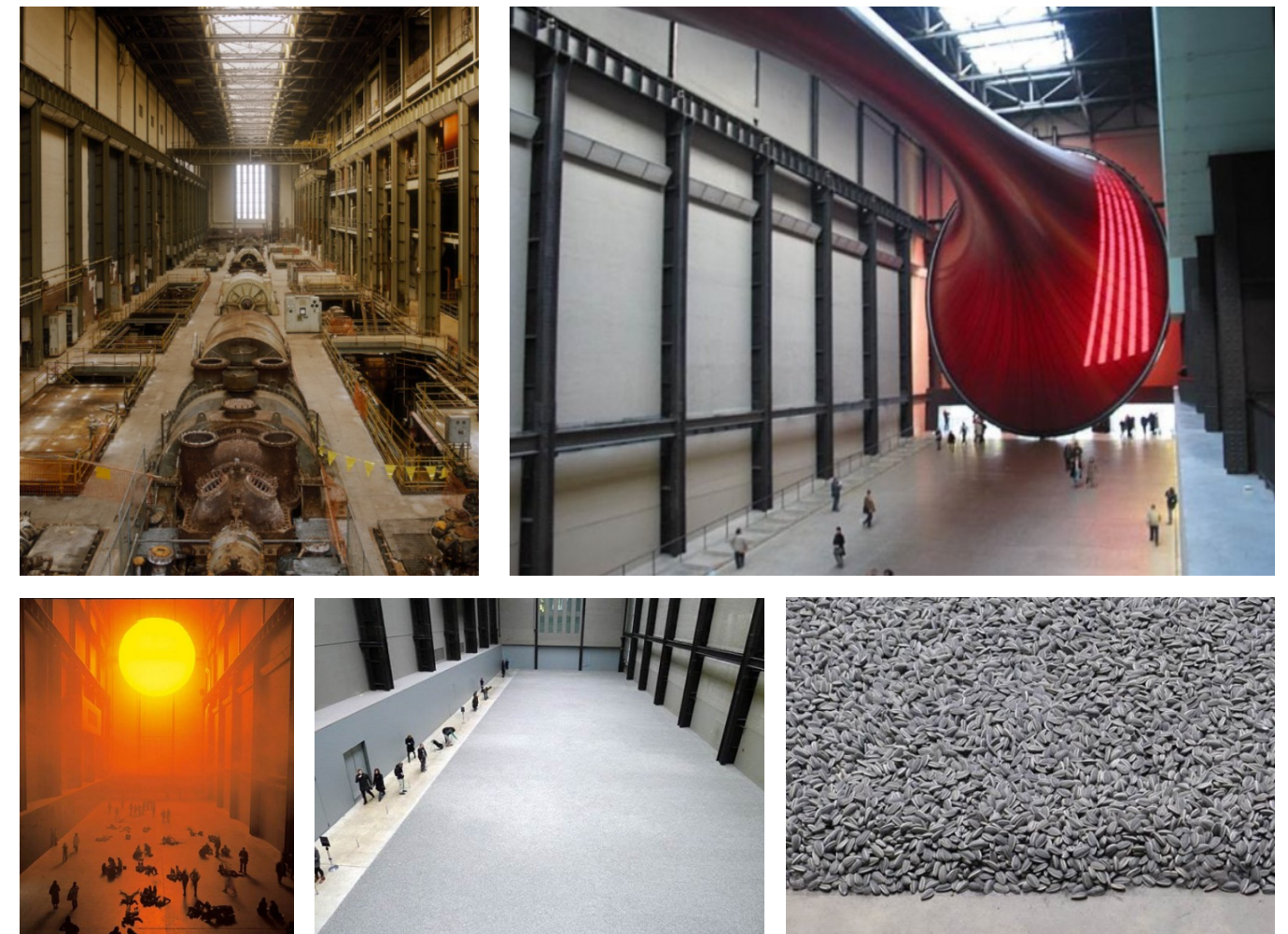
The concept of an Open Programmatic Framework becomes clearer when examined through architectural precedents that embody similar attitudes toward indeterminacy and temporal change. Cedric Price's Fun Palace served as an early theoretical prototype in which architecture was no longer conceived as a fixed container of functions, but as a dynamic matrix capable of supporting unforeseeable activities. Although unbuilt, it articulated a new paradigm in which programmatic openness was essential to preventing functional obsolescence.

This idea found its most celebrated material implementation in the Centre Pompidou in Paris. Designed by Renzo Piano and Richard Rogers, the Pompidou was intentionally conceived as an "urban machine" with column-free, flexible floor plates. Its interior spaces have been repeatedly reconfigured to host exhibitions, performances, educational programs, public gatherings, and temporary installations—activities that were never predetermined at the time of design. The building's longevity and continued cultural relevance stem from this very openness.



A similar logic operates in the Turbine Hall of Tate Modern, where a vast, unprescribed volume allows artists and curators to redefine the space with each new commission. The hall does not dictate its function; rather, it enables a continuous reinterpretation driven by emerging cultural practices. The spatial framework remains constant, but the program evolves endlessly.

These cases collectively illustrate the essence of the Open Programmatic Framework: the primary structure endures, while internal programs are continuously rewritten in response to shifting social demands. This separation of long-life structure and short-life use allows architecture to remain sustainable, adaptable, and resistant to obsolescence.



2.3 Concept of living architecture

2. Open Typological Structure

The idea of an Open Typological Structure can be understood not simply as rejecting conventional building types, but rather as adopting a spatial system in which a single architectural framework is capable of generating multiple architectural types over time. This principle emphasizes that a building's form should not predetermine its use; instead, form becomes an adaptable matrix that can absorb, reinterpret, and reconfigure new spatial types as contextual and social demands evolve.

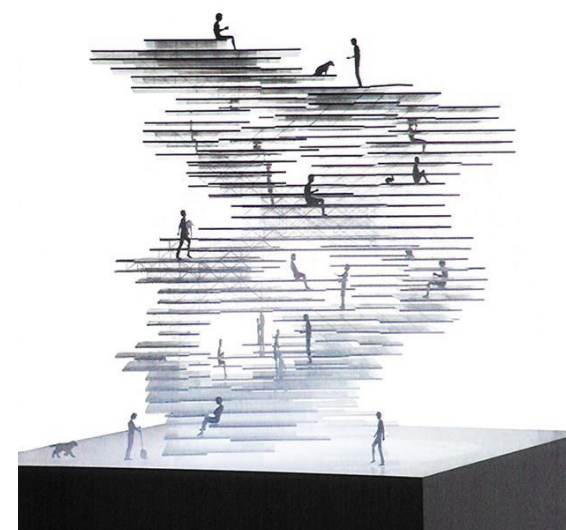
Several contemporary architectural experiments illustrate this concept clearly. For example, MVRDV's "The Why Factory" voxel studies explore how a uniform cubic volume can transform into fundamentally different spatial types—dense, porous, columnar, hollow, or layered—simply through strategic subtraction or addition within the same geometric frame. Here, the cube does not correspond to a fixed architectural type; rather, it becomes a generative system capable of producing multiple spatial identities.

A more urban-scale manifestation of this logic can be found in MVRDV's Vertical Village, which proposes a high-rise framework composed not of a single homogeneous building type but a heterogeneous aggregation of individualized dwelling forms. Within one structural matrix, diverse residential typologies—courtyard units, tower-like units, terraced houses, and freestanding villa-like volumes—coexist and can be recombined. Rather than prescribing a singular residential model, the Vertical Village treats the high-rise as a typological ecosystem in which multiple spatial types emerge simultaneously, demonstrating how a single architectural framework can sustain plural and evolving typologies over time.



Similarly, Sou Fujimoto's "Primitive Future" studies architecture as an aggregation of primitive units that can continuously reorganize into rooms, platforms, voids, or passages depending on human behavior. In this model, architecture does not impose a predetermined typology but evolves organically as users activate and reinterpret the space. The form remains constant, yet the spatial type is always in flux.

A built example of this logic can be found in BIG's LEGO House, where modular cubic volumes are stacked into a single structure, but their internal configurations shift dramatically. Within the same formal shell, spaces transform into exhibition halls, play zones, community rooms, or event platforms. The outer form is stable, but the interior typologies remain open, flexible, and plural.



These examples clarify the essence of the Open Typological Structure:

Architecture becomes a typological generator rather than a typological object. The primary structure endures, but the spatial types it contains can continually change in response to new uses, demands, and cultural conditions.

By decoupling architectural form from static function, buildings are reimagined not as fixed typological categories, but as typologically indeterminate frameworks—frameworks that remain perpetually open to transformation.

3. Users as Active Agents

One of the most radical contributions of Cedric Price's Fun Palace is its redefinition of the user as an active participant and co-author of architectural space rather than a passive occupant. Drawing on cybernetic feedback theory, Price envisioned architecture as an interactive system capable of receiving information from its users and adjusting itself accordingly. In this framework, architecture is conceptualized not as a fixed object endowed with predetermined functions, but as a dynamic environment that evolves through continuous interaction with its inhabitants. The Fun Palace thus reframed the production of space as an open-ended process shaped by user behavior, agency, and collective participation.

Alejandro Aravena's Quinta Monroy project provides a tangible and contemporary manifestation of this principle. Instead of delivering fully completed housing units, Aravena designed a structural and infrastructural "half-house" framework that residents would complete, expand, and customize over time. By providing only the essential load-bearing skeleton and service core, the project deliberately transfers the architectural authorship of the remaining space to the inhabitants. As families enlarge, reorganize, or modify their homes according to economic capacity and changing needs, the built environment becomes an evolving record of lived experience. Here, the user is not merely accommodated by architecture but becomes the decisive agent who determines its eventual form, performance, and meaning. The project thus operationalizes the Fun Palace's notion that spatial outcomes should emerge from the ongoing practices of users rather than from the architect's initial prescriptions.

Far from being a technical strategy alone, the Half-House model represents a procedural shift toward user-driven spatial production. It establishes a framework in which architectural completion is not an instantaneous act but a long-term process distributed across the life of the building and governed by the agency of its inhabitants. In doing so, Aravena reinterprets Price's vision within the context of social housing, demonstrating that a participatory, feedback-based architecture can foster resilience, inclusivity, and adaptability. Ultimately, the Quinta Monroy project confirms that treating users as active agents is not merely a theoretical construct but a viable architectural paradigm—one capable of achieving forms of spatial and social sustainability aligned with the foundational ideals of the Fun Palace.



2.3 Concept of living architecture

4. Modularity as a Mechanism for Transformation

The principle of modularity occupies a central role in Cedric Price's Fun Palace, functioning as a fundamental mechanism that enables continuous transformation within the architectural environment. Rather than conceptualizing buildings as fixed configurations, Price proposed a lattice-like structural system equipped with interchangeable components that could be assembled, dismantled, and recombined according to shifting programmatic and temporal demands. This approach reframes architecture as a temporally open system—one that anticipates change and supports sustainable cycles of renewal rather than obsolescence.

The architectural implications of this principle can be clarified through two canonical examples. Kisho Kurokawa's Nakagin Capsule Tower offers one of the earliest and most explicit manifestations of modular transformation. Each capsule unit was conceived as an autonomous, factory-produced module capable of being replaced or upgraded independently of the structural core. Although the envisioned replacement cycle was never realized, the design fundamentally separates the enduring structural skeleton from short-lived infill components, mirroring the operational logic underlying the Fun Palace. Modularity here becomes the means by which architectural longevity and continuous adaptability coexist.

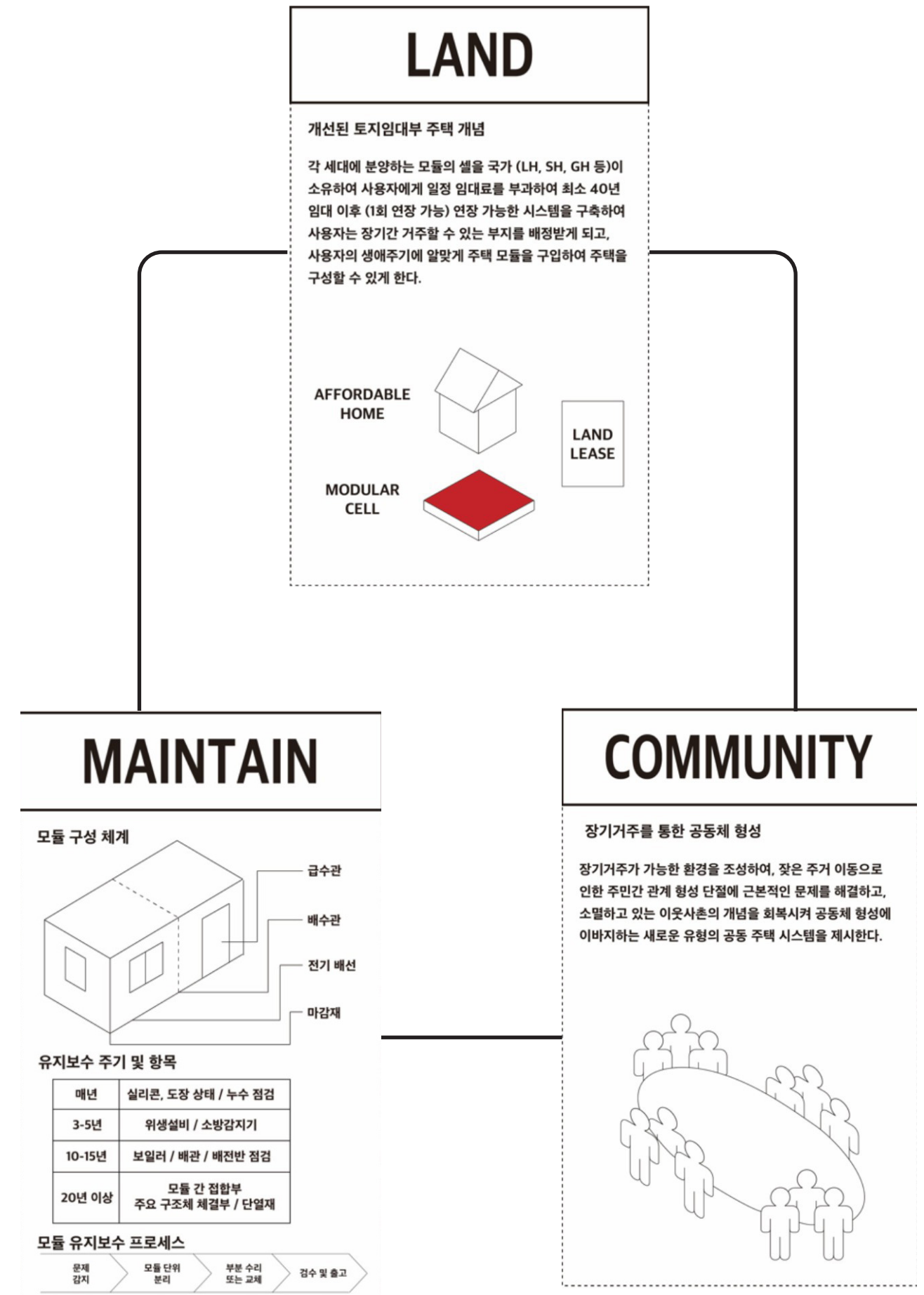


Complementing this is Moshe Safdie's Habitat 67, where a standardized concrete module serves as the basic unit from which a wide array of spatial configurations is generated. By stacking, shifting, and interlocking identical modules, the project produces diverse dwelling typologies without altering the fundamental construction logic. Habitat 67 thus demonstrates how modular aggregation can yield spatial richness and formal flexibility while maintaining material and procedural consistency.

Together, these precedents illustrate that modularity extends beyond a construction technique to operate as a transformative architectural strategy. It enables buildings to evolve through processes of addition, subtraction, replacement, and reconfiguration, thereby sustaining relevance over time. In this sense, modularity embodies a core aspiration of the Fun Palace: to establish an architectural framework in which structural continuity supports, rather than suppresses, the dynamic reorganization of space. Such modular systems not only facilitate adaptability and resource efficiency but also provide a robust foundation for advancing contemporary sustainable design paradigms.



03. Concept of LMC System



3.1 Land (Dual Ownership Policy for the Skeleton-Infill System

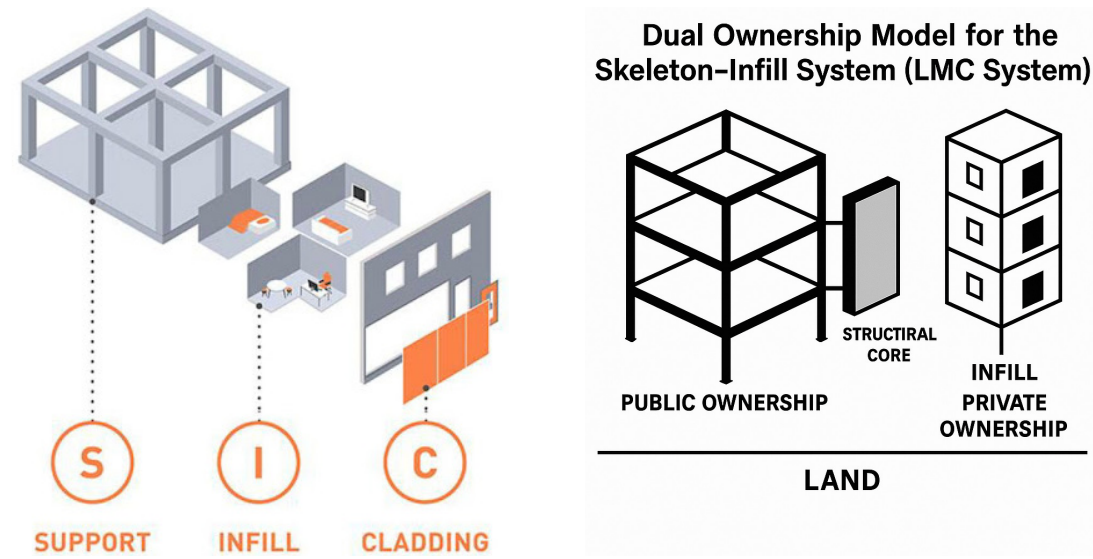
2.3.4 The Nakagin Capsule Tower Case

The Support & Infill System (Skeleton-Infill System) separates the structural framework (Skeleton) from the interior and service layers (Infill), thereby enabling extended building lifespans and a high degree of spatial adaptability. Habraken, in *Supports: An Alternative to Mass Housing*, conceptualized the structural layer as a “shared domain of collective responsibility” and the infill layer as the “domain of individual control,” arguing that such separation allows mass housing to accommodate both standardization and diversity. Subsequent developments such as Open Building theory and the Skeleton-Infill (SI) housing model have further demonstrated that this layered approach is essential for long-life housing and for enhancing user participation and customization.

Despite these theoretical advancements, the Korean institutional environment has not been conducive to adopting the Support & Infill System. One of the most critical barriers lies in the ownership regime of major structural components. Under current Korean real estate law, land, buildings, and interior spaces are treated as inseparable property units. As a result, structural components are fragmented into fractional ownership among individual unit owners, making it structurally impossible to manage the Skeleton as public infrastructure or to implement a coordinated long-term maintenance governance. International studies on SI housing similarly highlight that—even where technologies for Skeleton-Infill separation are fully developed—widespread adoption is severely constrained without an appropriate legal and ownership framework.

To resolve these constraints, this study proposes a Dual Ownership Model in which the Skeleton is publicly owned and the Infill is privately owned. In practical terms, primary structural elements such as columns, beams, slabs, and service cores would be held by a public authority—such as the national government, local municipalities, or public housing corporations—while residents would hold ownership or long-term tenancy rights only for the modular Infill units. This arrangement operationalizes Habraken’s principle that “supports belong to the collective, infill belongs to the individual” within the Korean legal and housing context.

By decoupling the traditional unified ownership model of land and buildings into two distinct layers—(1) public Skeleton ownership and (2) private Infill ownership—this approach helps overcome both technical and institutional bottlenecks. Public management of the Skeleton ensures secure funding and governance for long-term structural performance and planned preventive maintenance, while the Infill can be flexibly upgraded, replaced, or reconfigured according to market dynamics and resident needs. This dual-layer ownership structure parallels international SI housing precedents, including Japanese Skeleton-Infill Housing and Kodan SI Housing, where shared structural components and private infill components are managed under differentiated ownership and responsibility. Consequently, the Dual Ownership Model serves as a foundational policy framework for institutionalizing Skeleton-Infill housing in South Korea and for realizing long-life, adaptable residential environments.



	Traditional Apartment Ownership	Dual Ownership Model (LMC)
Building Skeleton Ownership	Joint ownership by unit owners	Public ownership (State, municipality or public organization)
Infill Ownership	Undivided from skeleton Owned by unit owners	Private ownership Individual modular units
Building Maintenance Decisions	Consensus among all residents: often challenging	Long-term planned preventive maintenance (PPM) publicly
Building Lifespan	Relies on around 30 y Relies on redevelopment	80-100 year lifespan 8C-replacement/renewal
Adaptability	Modifications difficult Due to structure, walls fixed	Infill replacement expansion, renewal
Resident Relocation Upon Redevelopment	Full-scale demolition 100% resident relocation	Replaces Infill Minimizes resident relocation
Impact on Urban Communities	Reset approach Community displacement Fragmentation	Update approach Community accumulation/preserved
Environmental Impact	Significant demolition waste	Minimal waste through Skeleton

3.2 Maintain (Moduar System)

In long-life housing models based on the Skeleton-Infill System, the design and institutionalization of a systematic maintenance framework are essential. Unlike redevelopment-oriented paradigms—where buildings are demolished and rebuilt once they deteriorate—Skeleton-Infill housing is predicated on “repair, replacement, and reconfiguration.” Thus, maintenance is not merely a management component but a structural determinant of the building’s lifespan.

The United Kingdom and the United States represent leading examples of nations that operate highly developed lifecycle-based maintenance programs. The UK’s Building Research Establishment (BRE) standardizes inspection intervals, component lifespans, and replacement protocols through the Planned Preventive Maintenance (PPM) framework, which has proven effective in extending the physical life of buildings. BRE emphasizes that “buildings without scheduled maintenance achieve less than half of their intended service life,” underscoring the critical role of preventive maintenance. Similarly, the U.S. General Services Administration (GSA) manages federal buildings using the Facility Condition Index (FCI) and Facility Performance Model, quantifying deterioration levels and enabling cost-efficient maintenance decisions. According to GSA reports, “buildings that undergo preventive maintenance reduce repair expenditures by 30–50% and exhibit significantly delayed structural degradation.”

These international cases demonstrate that maintenance systems function not merely as operational guidelines but as mechanisms directly tied to building lifespan, environmental sustainability, and preservation of public asset value.

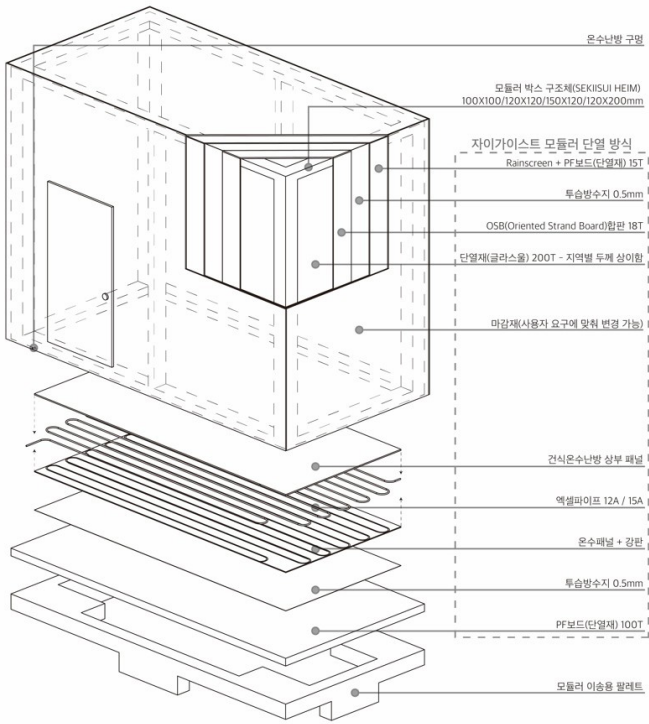
In contrast, South Korea’s building maintenance culture remains underdeveloped. The country’s short housing lifespan, fragmented regulatory environment, and supply-driven housing policies have prevented PPM-based maintenance systems from taking root. Domestic facility safety studies repeatedly highlight that “due to the absence of systematic maintenance, Korean buildings frequently fail to reach even half of their designed lifespan before demolition.”

Accordingly, the LMC system proposed in this study integrates a standardized modular maintenance program as a core component of the Skeleton-Infill long-life housing model. Each module—including insulation layers, drainage paths, inter-module joints, distribution panels, and heating systems—can be maintained independently according to predetermined replacement cycles. Based on the maintenance intervals presented in Table 2 (Annual / 3–5 years / 10–15 years / 20+ years / 30+ year full replacement), the LMC system establishes a unified maintenance protocol for the entire housing complex.

Such a maintenance system not only extends the physical lifespan of the building but also enables an “update-type housing model,” in which dwelling units can be replaced or upgraded without the need for full-scale reconstruction. This approach supports sustainable, adaptable, and community-preserving long-life housing.

	 한성모듈러	 웨이비룸	 자이가이스트
항목			
실제 구조 방식	H빔, 각파이프 기반 경량철골	스틸 프레임 구조	목구조 (전면 CLT 판넬 사용)
마감재 / 내부 자재	OSB 보드, 샌드위치 판넬	정밀 가구 완성도, 다양한 마감재	고급 목재 루버, 기존 주택과 동일한 마감
시공 방식	유닛 단위로 공장에서 거의 완성	공정을 3개로 분화 작업	반자동화 생산 시스템으로 균일화된 시공 품질 확보
특징 / 인상	저인원 소량 생산	1~2인 주거 최적화, 디자인 우선	목재 재사용 가능, 안정적인 품질 확보에 강점

Modualr Construct



Maintenance Schedule for Modular Long-Life Housing	
INTERVAL	TASK ITEMS
ANNUAL	Silicone, Floor Seals / Leak Check
3~5YEARS	Sanitary Fixtures / Smoke Detector
10~15 YEARS	Boiler / Drains / Distribution Panels
20+ YEARS	Inter-Module Joints / Primary Structural Connections / Insulation
30+ YEARS COMPLETE UNIT REPLACEMENT	Complete Unit Replacement

3.3 Community

The Skeleton–Infill System is not merely a technical architectural device but a spatial framework that enables the long-term continuity and accumulation of community life. By allowing the built environment to transform incrementally over time, the system provides a physical foundation upon which social networks, neighborhood identities, and collective memory can be sustained.

Within this model, the structural layer (Skeleton) functions as a long-lasting “slow layer,” providing stability over several decades. In contrast, the Infill—comprising interior layouts, service components, and sub-units—can be replaced, expanded, or reconfigured in response to demographic shifts, household restructuring, and evolving residential preferences. This adaptability eliminates the need for full-scale resident displacement, which has long been a defining characteristic of redevelopment-driven housing policies.

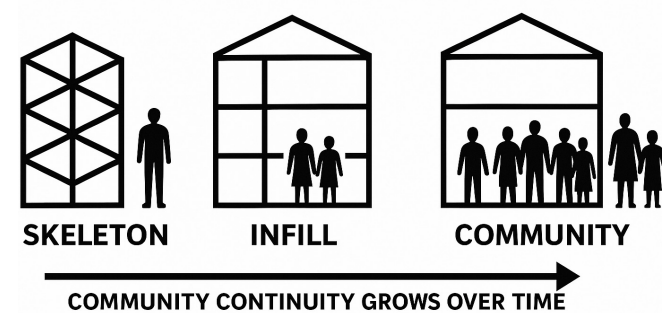
These international cases demonstrate that maintenance systems function not merely as operational guidelines but as mechanisms directly tied to building lifespan, environmental sustainability, and preservation of public asset value.

Urban sociologist Ray Oldenburg emphasizes that “enduring social relationships arise from enduring physical settings,” highlighting the essential role of spatial continuity in the maintenance of community life. Similarly, Jane Jacobs argues that the vitality of urban neighborhoods is rooted in the interaction between physical continuity and social continuity, asserting that sustainable communities emerge not from large-scale demolition but from gradual, cumulative adjustments.

Environmental psychologist Donald Appleyard also observed that dramatic physical disruption—such as mass clearance and relocation—weakens social bonds, while neighborhoods experiencing slower and incremental change tend to preserve stronger interpersonal ties.

In contrast to the redevelopment paradigm, which relies on a “spatial reset” that erases existing social structures, the Skeleton–Infill System allows for spatial updating, enabling the environment to evolve without dismantling the underlying community fabric. By preserving the structural framework while permitting adaptive internal change, residents can maintain their long-term attachment to place, reinforcing intergenerational continuity and neighborhood identity.

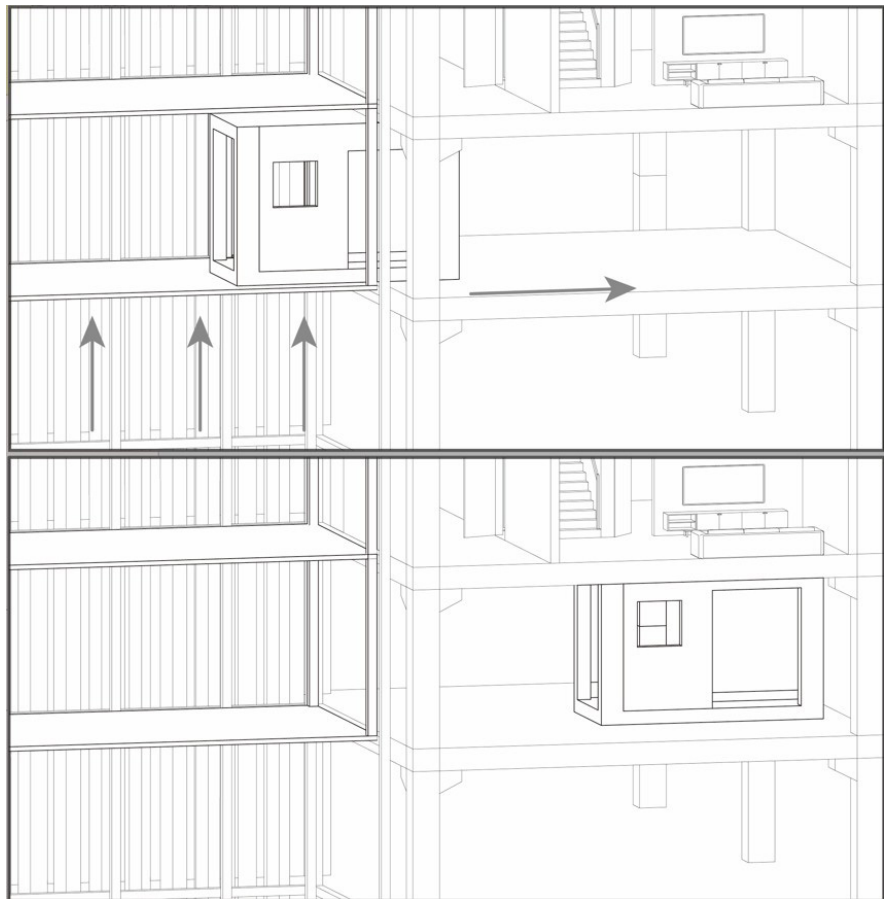
Thus, the Skeleton–Infill model provides a spatial foundation in which the longevity of the built environment directly supports the longevity of the community. Through incremental evolution rather than disruptive replacement, the model fosters conditions conducive to community recovery, preservation, and long-term strengthening.



04. Basic Design Strategy for Long-Life, OSC-Based Housing

4.1 Modular Transport E/V System

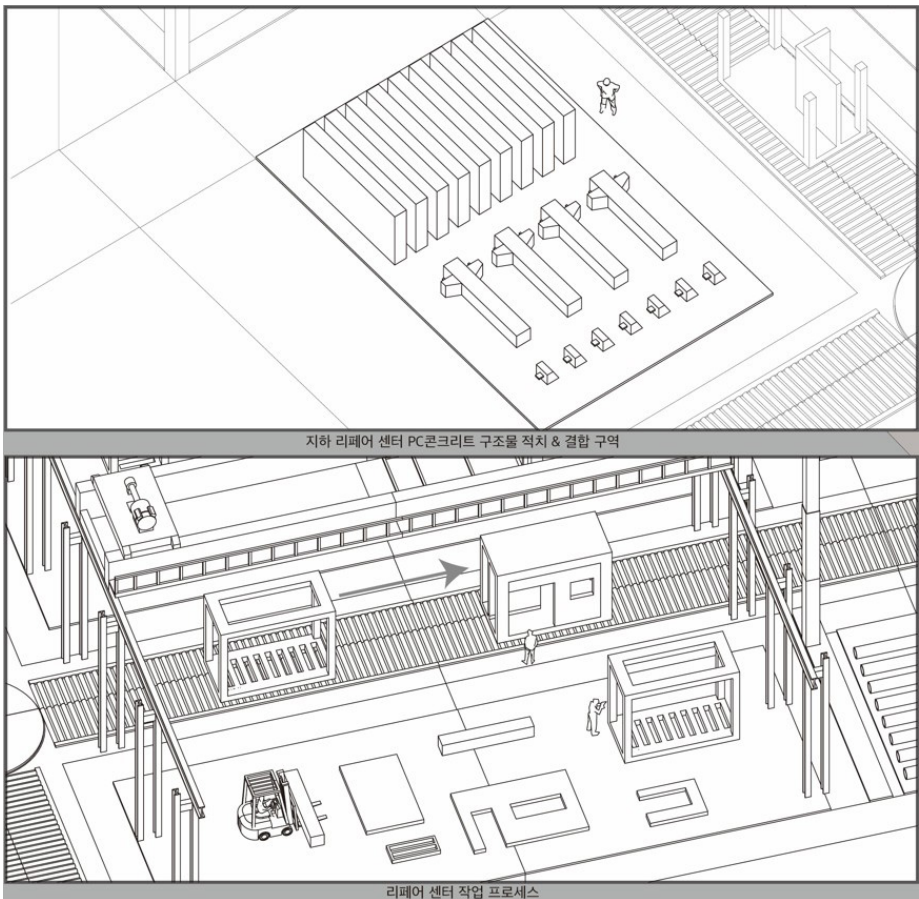
To transport the modules manufactured in the underground Repair Center to the target slab level, a heavy-duty industrial elevator capable of carrying loads of up to 32 tons is integrated into the housing system. This system enables modular units to be delivered directly to each floor. Once the module reaches the designated level, precise positional adjustments are carried out to ensure accurate alignment before installation on the slab.



4.2 Underground Repair Center

An underground Repair Center is incorporated into the system to store and process OSC components, including both precast concrete (PC) elements and modular units. Within this facility, PC and modular components required for extensions or new construction are fabricated and prepared. Once completed, the units are transported vertically to the upper floors via an integrated conveyor system.

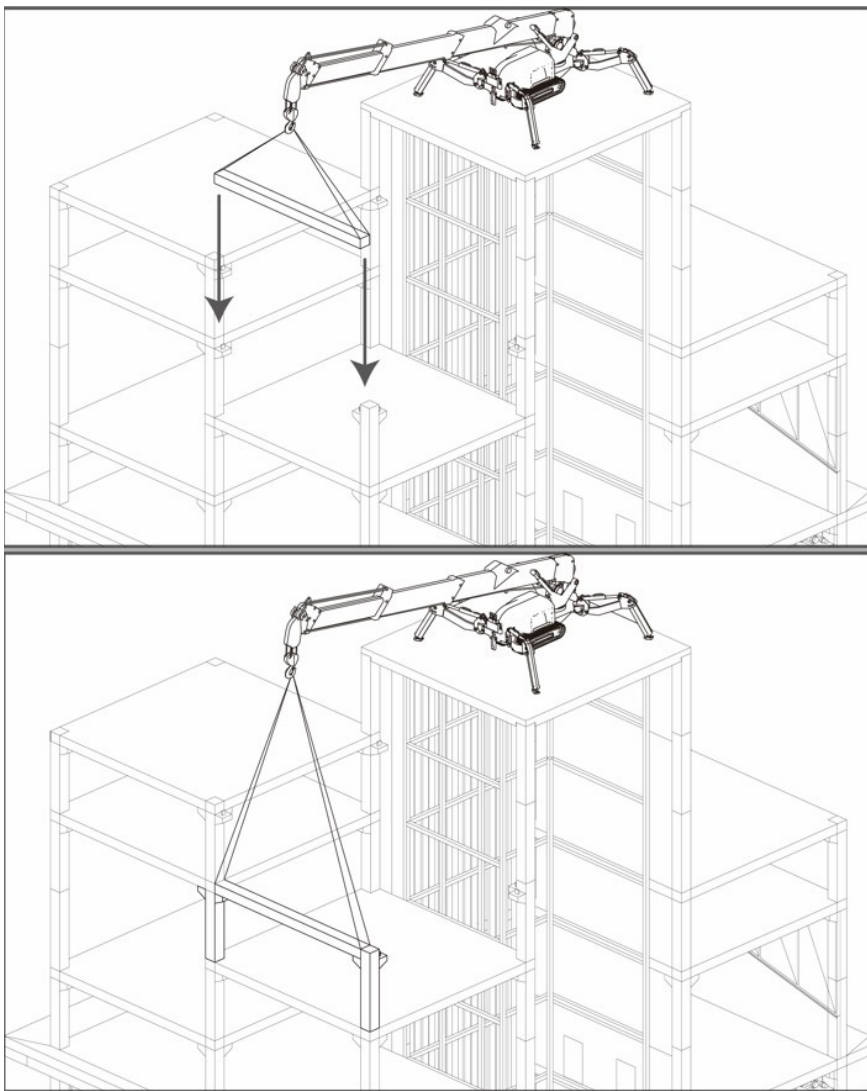
Upon arrival at the designated level, the modular units are set directly onto the slab surface, where they undergo final alignment and positioning. In contrast, the precast concrete components are lifted and placed using a rooftop-mounted spider crane, ensuring precise installation without disturbing adjacent structural elements.



4.3 Rooftop Spider Crane

The spider crane is positioned on the rooftop of the building, where its articulated legs extend outward to secure a stable footing and distribute loads effectively. Once anchored, the crane prepares for lifting operations from atop the structure.

The crane’s boom then extends horizontally and vertically to reach the designated lifting point, positioning itself to hoist precast concrete slabs, beams, or columns. The PC component is attached to the crane via lifting cables and rigging hardware. After the load is secured, the crane maneuvers the PC unit to the precise installation location. When the element is accurately aligned above its intended position, the crane gradually lowers it into place, allowing it to connect seamlessly with the Quick Connector system. Once the connection is fully engaged and stabilized, the crane disengages by releasing the ropes and hooks before repositioning for the next operation.

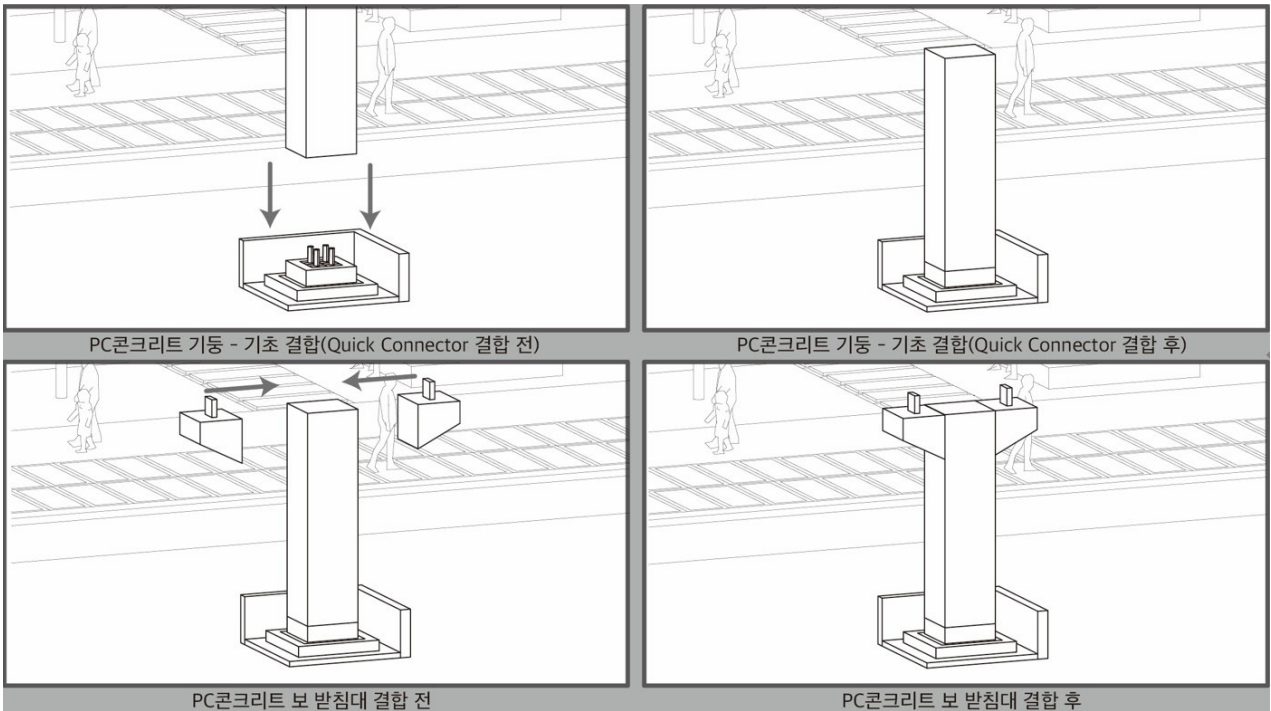


4.4 Quick-Connector Joint for Foundation

The installation of the precast concrete column begins with the Quick Connector system embedded in the foundation. This connector is engineered to align the column precisely with the footing and to ensure accurate verticality during placement.

Using a crane, the precast concrete column is hoisted and carefully guided toward the foundation connection beam. The column is then gradually lowered into the connector assembly, allowing it to slide into place with controlled precision.

Once the column is fully seated within the connection interface, mechanical fasteners—such as high-strength bolts or integrated locking devices—are engaged to secure the column firmly to the foundation. This process provides immediate structural stability and prepares the assembly for subsequent frame erection.



4.5 Installation Method for Electrical, Stormwater, and Sewage Piping

A building-wide mechanical and utility system is installed within the central mega core. Unlike conventional Korean apartment construction—where service pipes are embedded within concrete shear walls—the exposed piping in the mega core remains fully accessible, greatly improving maintainability and inspection efficiency. The vertical risers housed within this core safely deliver electrical power, stormwater drainage, and wastewater services to each floor.

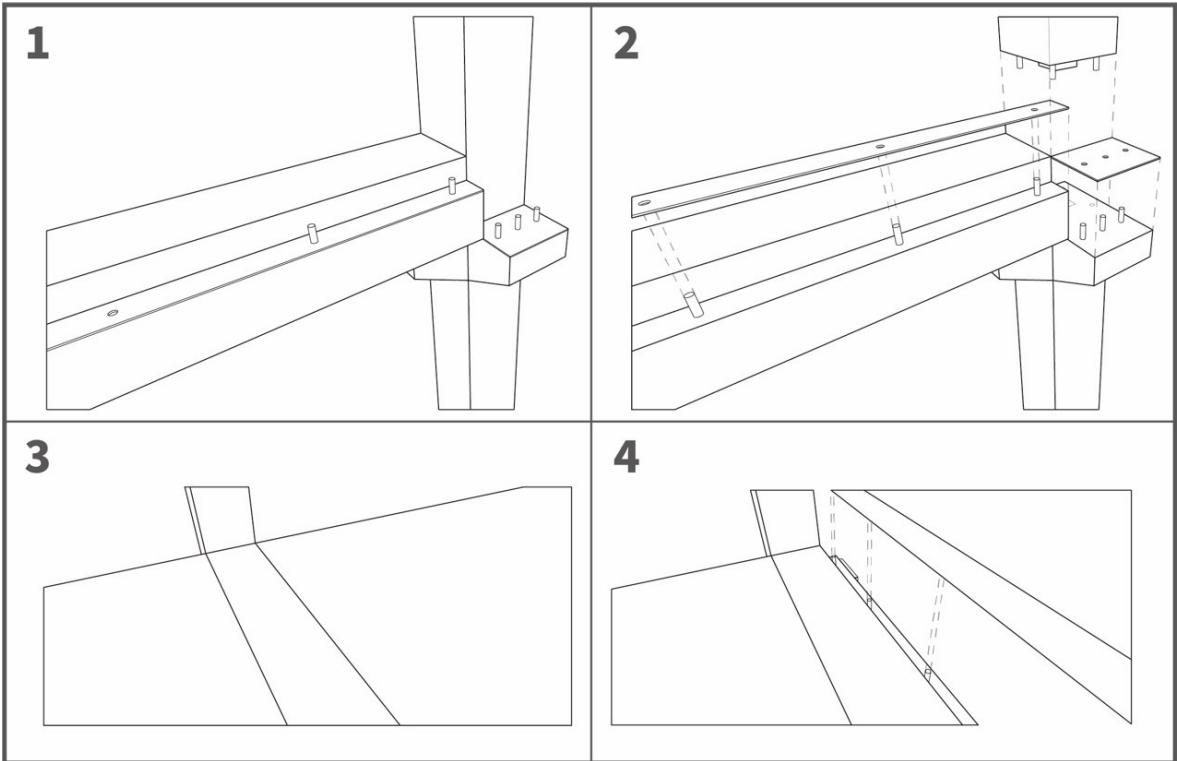
Within the residential units, these supply lines extend horizontally from the core into the living spaces. The distribution pipes are color-coded according to their function, enabling easy identification during installation, inspection, and maintenance activities. This open-service configuration reduces intervention time, minimizes invasive demolition during repairs, and supports a long-life housing model based on ease of upgrading and replacement.



4.6 PC Column–Beam–Slab Connection

The installation begins by lifting the PC beam and placing it onto the column head, ensuring that the shear key and embedded dowels align with the pocket or fixing points on the column. Once the beam is properly seated, temporary bolts or locking pins are inserted to hold it in position and maintain correct vertical and horizontal alignment. After securing the beam, a top support panel or flange plate is lowered onto it, allowing its connection inserts to fit into the beam's upper fixing holes. This panel provides a stable and continuous bearing surface for the upcoming slab installation.

Before placing the slab, the alignment of the entire column–beam–slab line is carefully checked to verify that there is no deviation that could affect structural performance. Once alignment is confirmed, the precast slab panel is lifted and positioned over the beam. As the slab is lowered, its underside connectors engage with the prepared top panel, ensuring accurate interlocking. Final bolts or dowel pins are then installed to complete the mechanical connection, securing the slab, beam, and column into a unified structural system.

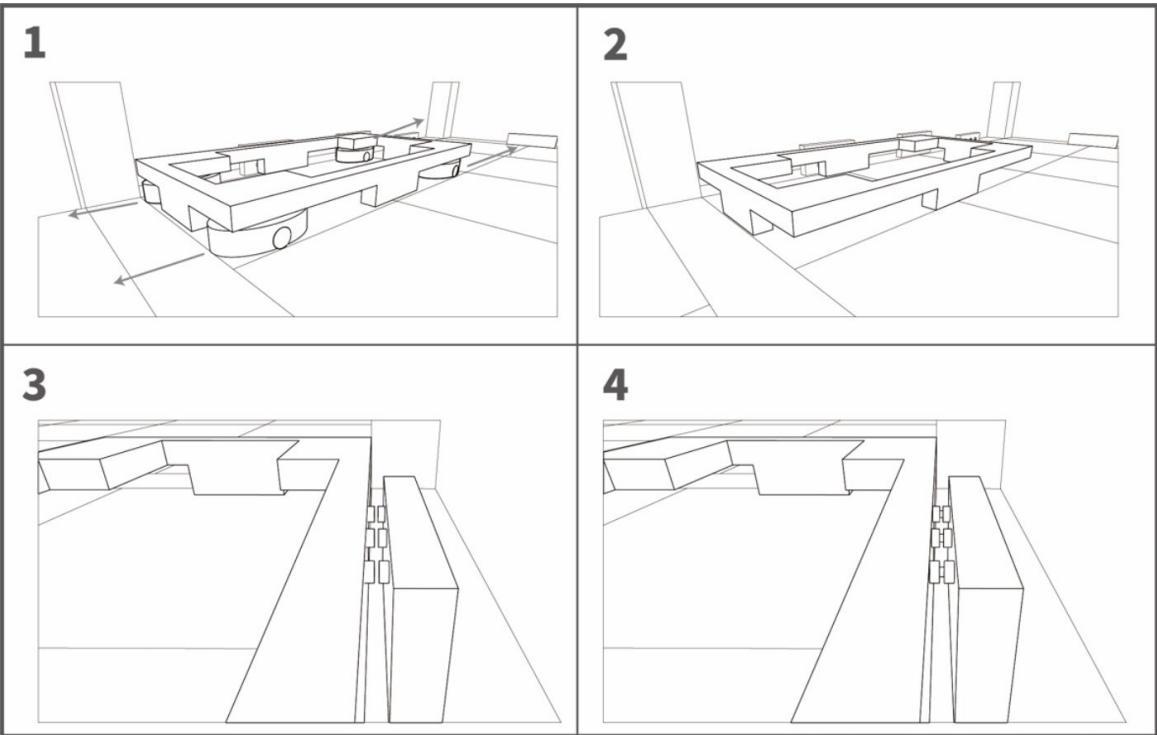


4.7 Modular Frame Connection

The installation begins with an industrial payload robot transporting the precast frame module to the designated position. The robot securely grips or supports the module using its lifting mechanism and moves it along the planned grid lines with high precision. As the robot approaches the installation zone, it adjusts the module’s orientation so that the bottom edges align smoothly with the layout markers on the floor. Thanks to the robot’s precise motion control, the module is placed without excessive sway or vibration, allowing workers to make only minor adjustments to achieve its final position.

Once the module is set in place, the connection interface between the newly delivered module and the adjacent one is carefully inspected. Embedded plates and mechanical inserts at the joint are checked to ensure that the gap, level differences, and lateral alignment remain within the required tolerances. When the alignment is verified, mechanical connectors—such as bolts, couplers, or locking devices—are inserted into the joint to pull the two modules together. These connectors create a stable horizontal linkage, ensuring structural continuity across the connection.

After the connectors are engaged, the alignment is checked once again, and any remaining deviation is corrected. The connection components are then fully tightened to complete the structural integration. Through this process, the module delivered by the industrial payload robot becomes seamlessly integrated with the existing structure, ensuring consistent load transfer, stability, and dimensional accuracy across the modular assembly.

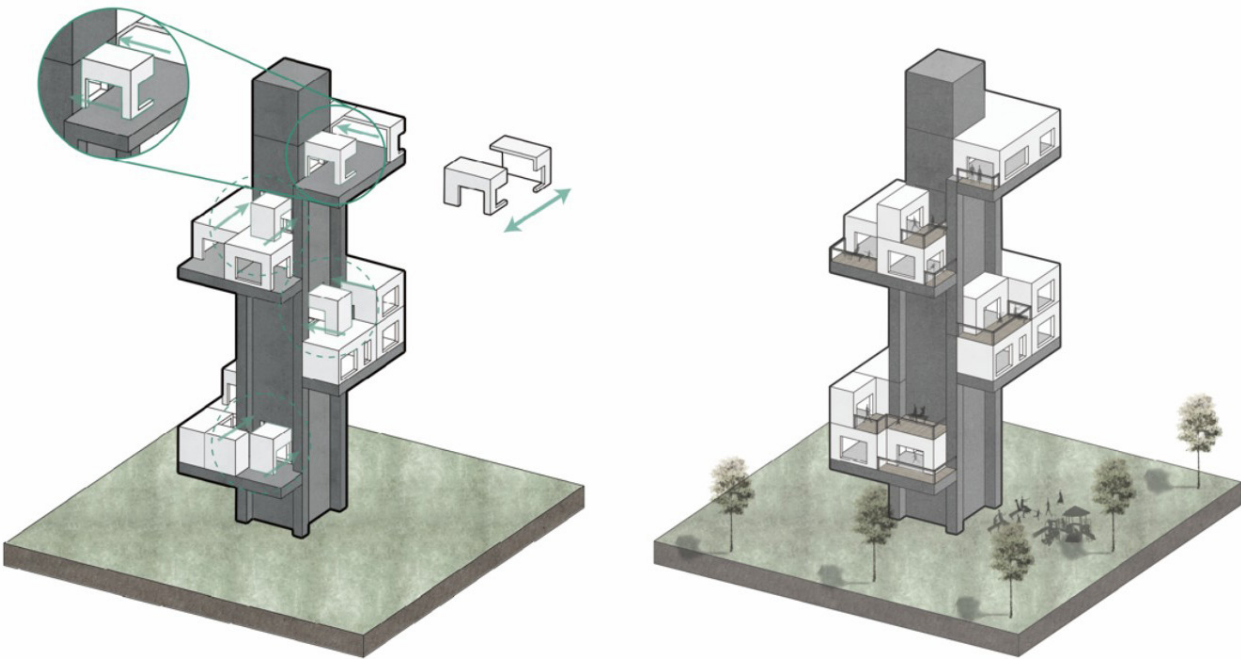


4.8 Proposal for an OSC-Based Housing System to Restore Local Community (Yiwoo-Saton) Relationships

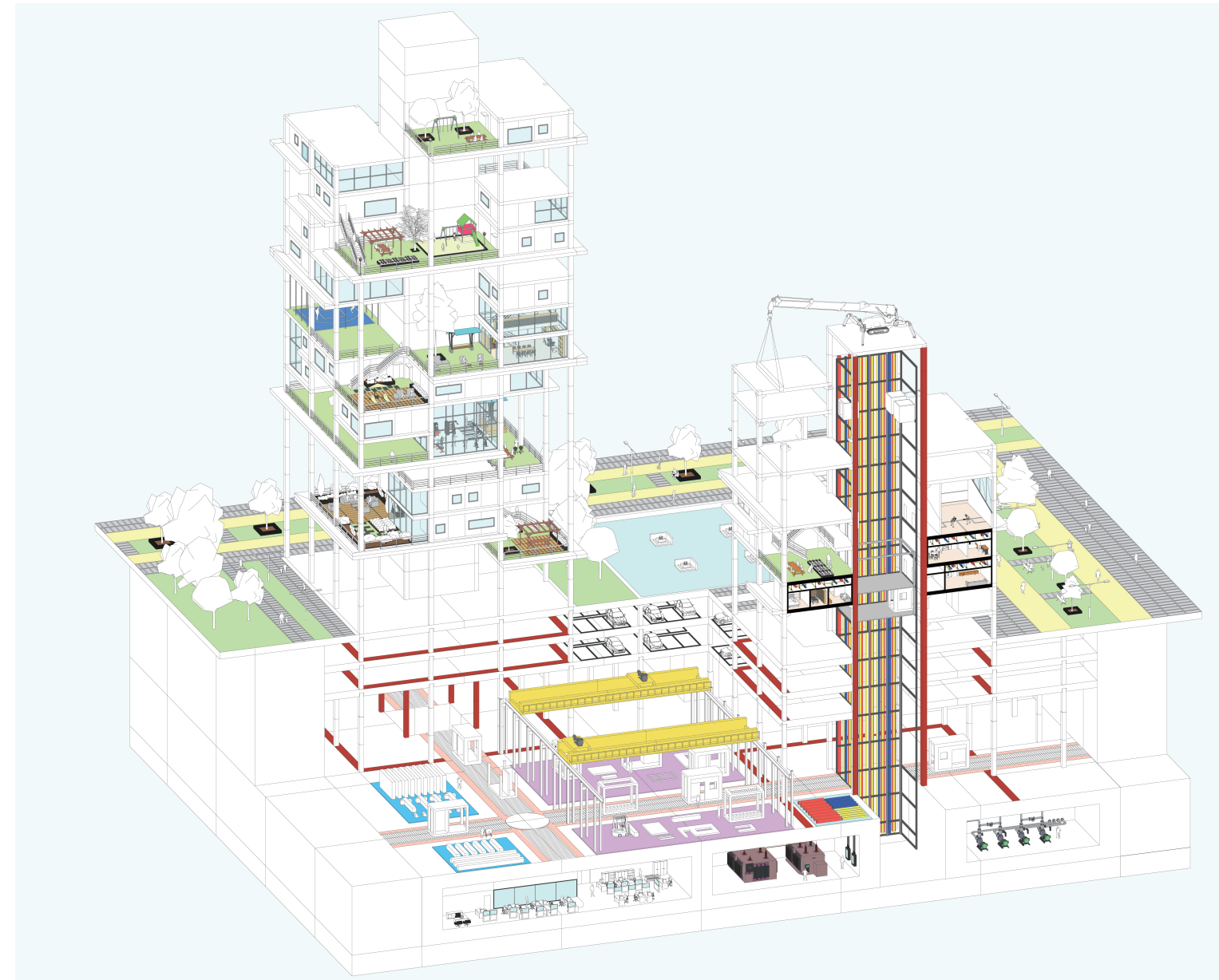
The aim of this proposal is to create a housing system that enables long-term, continuous residency through the use of an OSC (Off-Site Construction) basic framework, ultimately restoring local community relationships—what can be described as Yiwoo-Saton, where neighbors become as close as extended family. By constructing a central core first and then inserting factory-built residential modules into this core, the system secures a high level of spatial flexibility. Each dwelling unit can be reconfigured, expanded, or adjusted over time, allowing residents to remain in the same neighborhood as their household composition and lifestyle evolve.

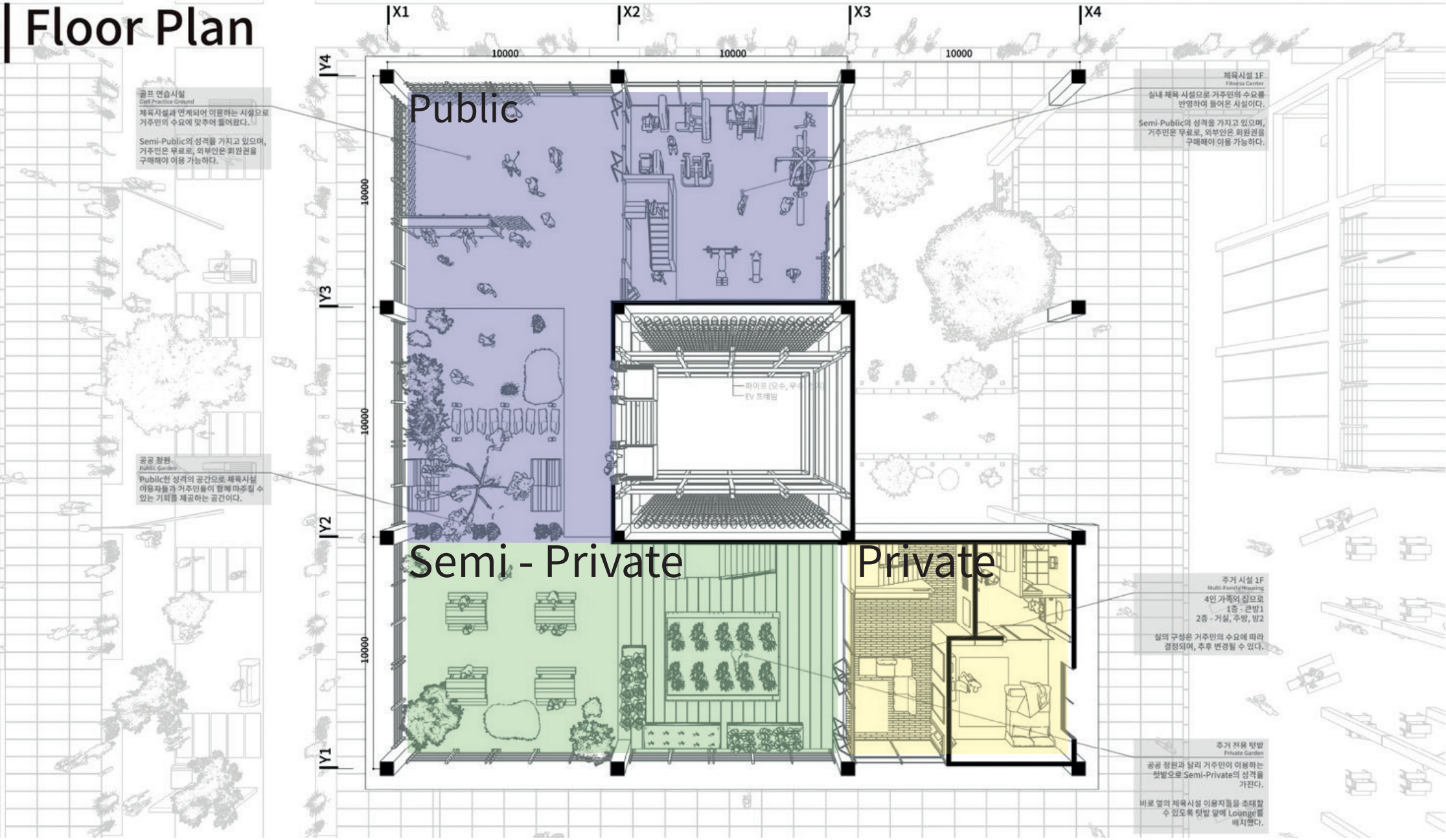
As modules are positioned in different directions at each level, the assembly process naturally creates terraces and semi-open shared spaces that encourage daily encounters and informal interaction among residents. Additionally, the ground level—freed from structural load-bearing requirements due to the modular system—can be designed as small parks, play areas, or community facilities, providing accessible and open public spaces for the wider neighborhood.

In this way, the OSC-based system functions not only as a method to shorten construction time or improve efficiency but as a spatial framework that supports evolving patterns of life while preventing social fragmentation. Ultimately, the core intention of this design is to establish conditions that allow people to stay in their community for a long time and to rebuild the social bonds that naturally emerge from sustained coexistence, stability, and dimensional accuracy across the modular assembly.



05. Drawings





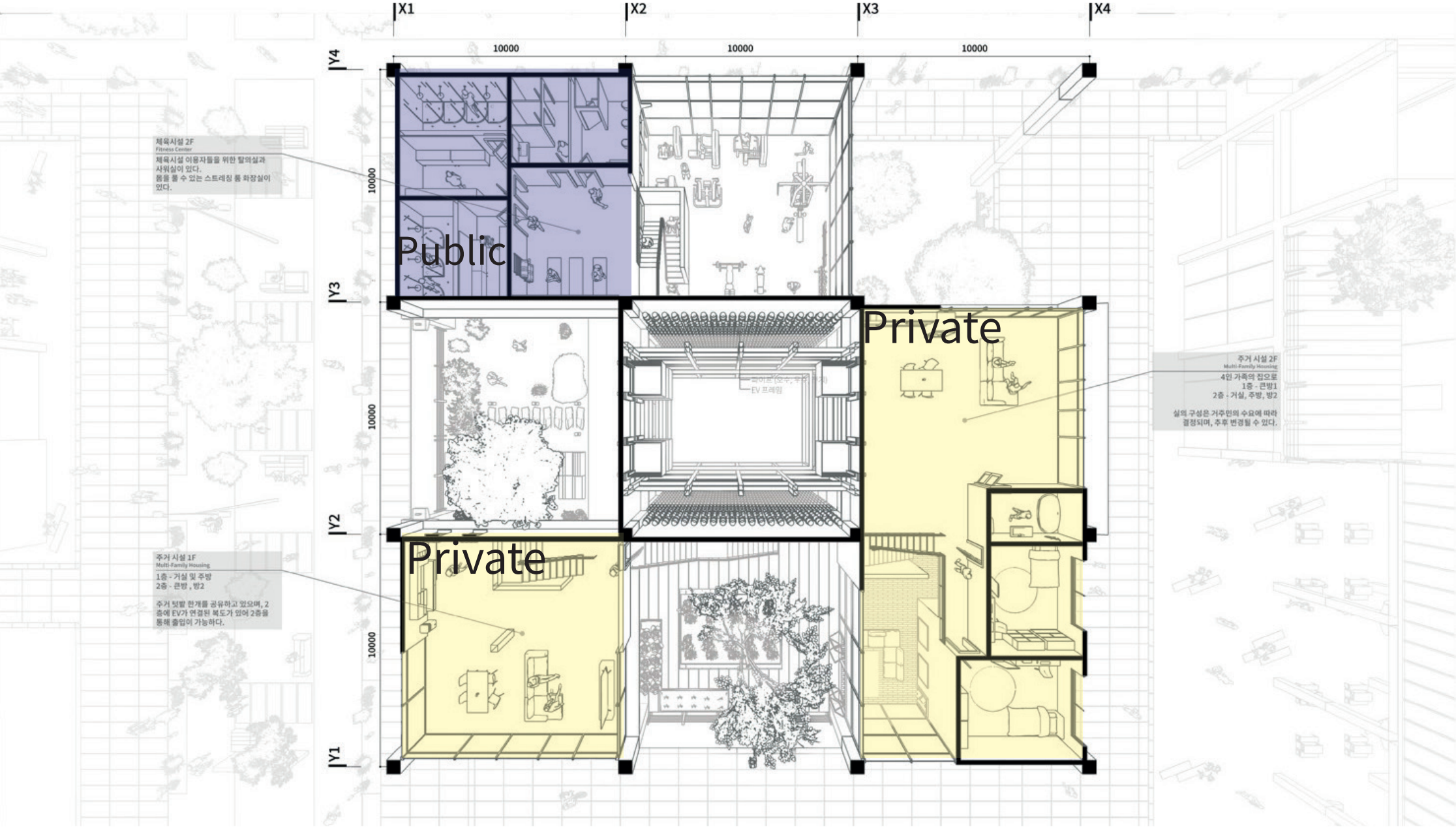
1F Plan

This floor plan organizes the ground level into a clear gradient of **Public** → **Semi-Public** → **Private** spaces, creating a smooth spatial transition and supporting community interaction.

The public walkway at the bottom connects directly to an open community garden, inviting both residents and local visitors. Moving inward, a semi-public courtyard and shared gardens provide everyday communal space for residents, forming the social heart of the site.

A fitness and indoor community zone is placed on the upper side, visually connected to the outdoor garden while primarily serving residents. At the center, a core with modular lounge and elevator hall anchors all circulation and enhances spatial clarity.

The private residential unit on the lower-right ensures privacy while remaining linked to adjacent greenery.



2F Plan

This second-floor plan continues the organization of spaces through a clear hierarchy of semi-public and private zones.

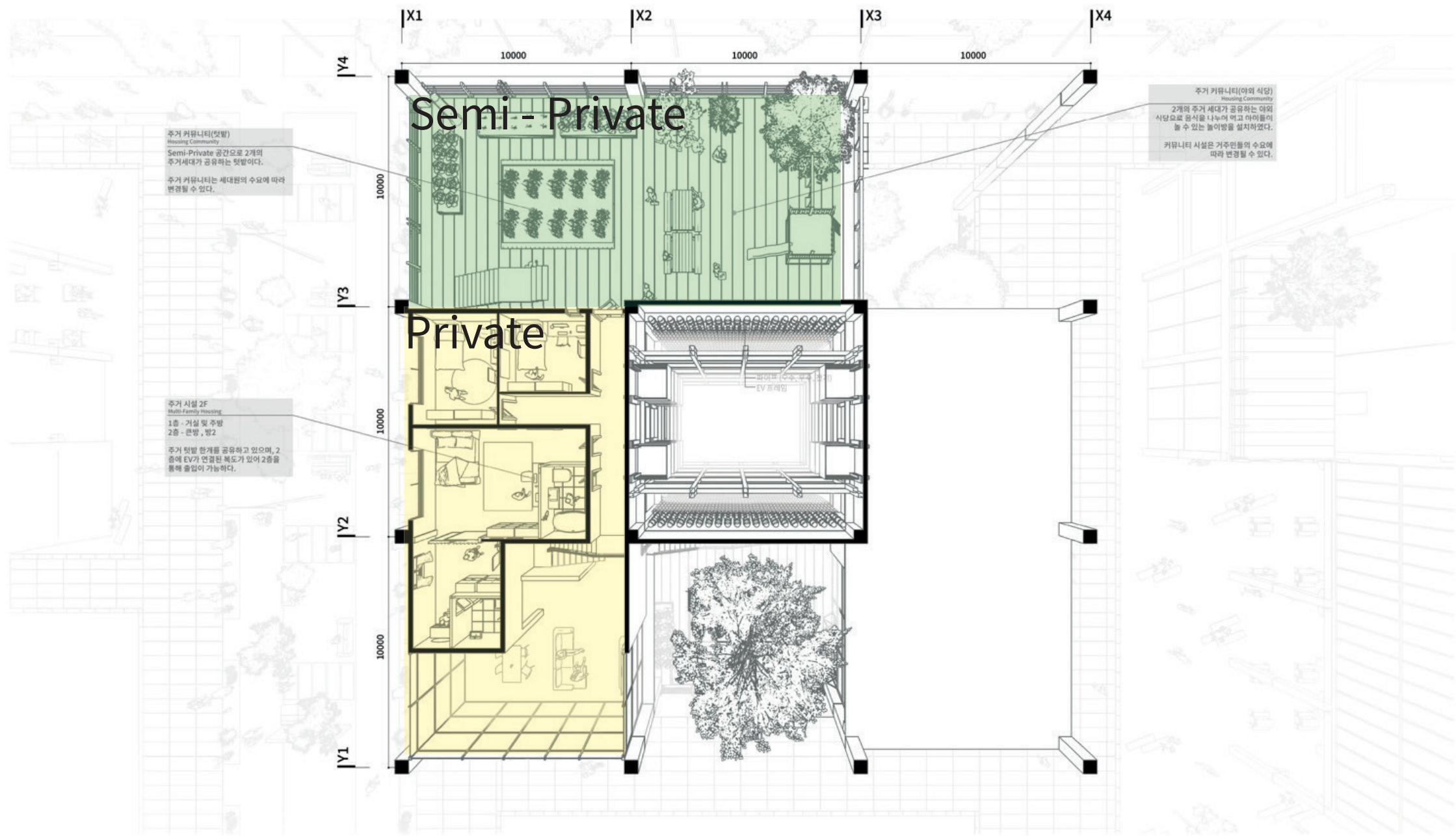
A shared indoor fitness area occupies the upper zone, offering exercise and stretching spaces for residents while maintaining visual openness toward the exterior. Adjacent to it, a cluster of changing rooms and shower facilities supports these active programs.

At the center, the vertical core (EV hall) remains the primary circulation anchor, connecting all programs around it.

The left and central portions feature semi-public gardens and a double-height green void, extending the landscape experience vertically and creating visual continuity with the first floor.

On the right, the plan incorporates flexible multi-residential units, which can accommodate various household types through adjustable internal layouts. The units maintain privacy while staying closely linked to shared amenities.

Overall, the second floor strengthens



3F Plan

This upper level combines semi-private communal spaces with flexible multi-residential units.

The rooftop garden and terrace at the top provide a semi-private outdoor community zone where residents can gather, garden, and relax. The space supports various communal programs and enhances vertical continuity with lower floors.

Below, a series of modular residential units accommodate different living arrangements, each organized around efficient shared circulation. Units maintain privacy while remaining closely connected to the central core.

At the center, the EV hall continues to anchor all movement through the building, extending the clear circulation structure established on the lower floors.

Overall, this floor emphasizes

| Master Plan



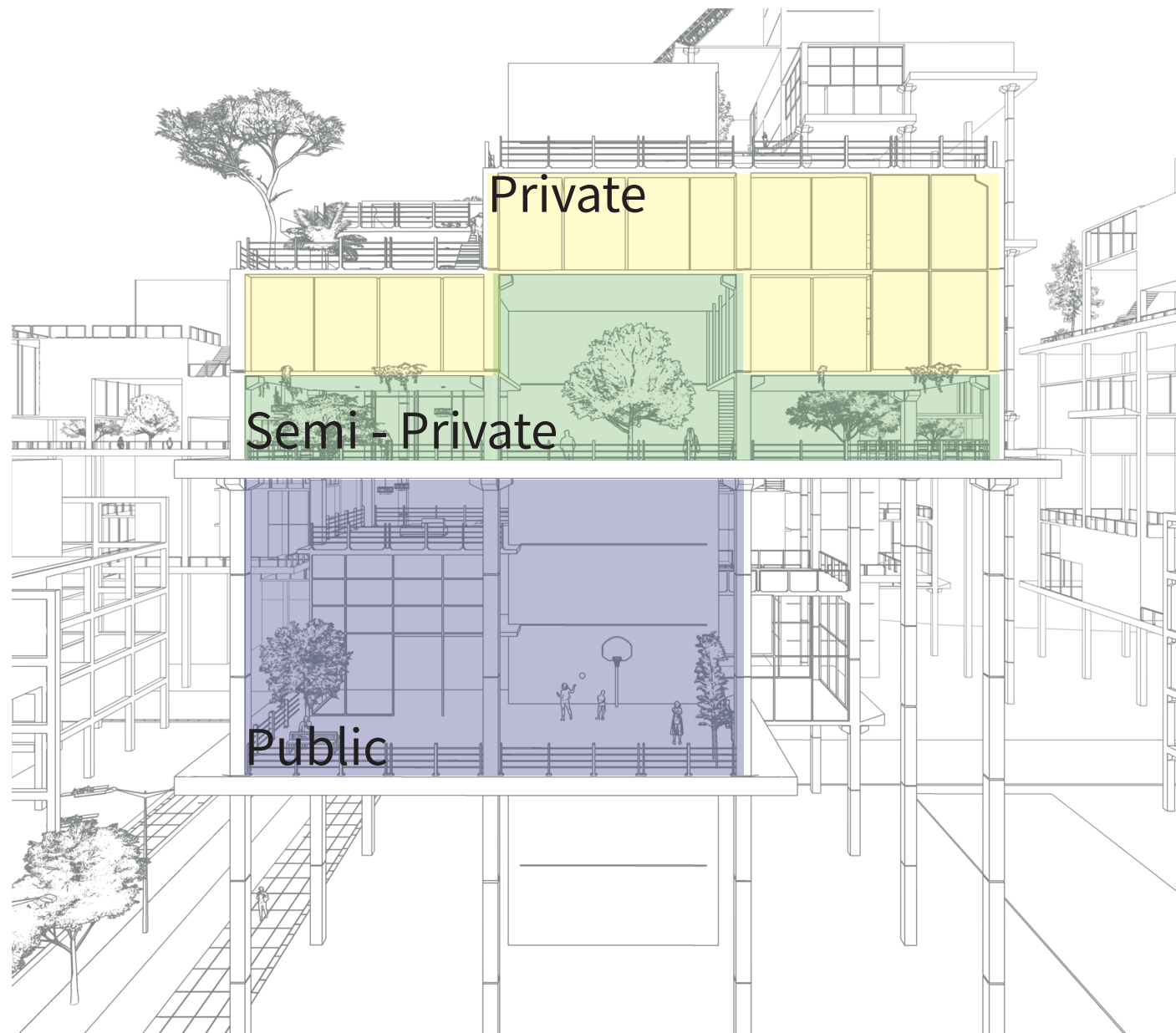
4.2 Master Plan

This master plan enhances urban connectivity and community life by introducing a **linear park system** and a **pedestrian-oriented axis** across the existing block structure. The main east-west and north-south corridors are reconfigured into low-speed, pedestrian-priority streets that promote walkability and safer daily mobility.

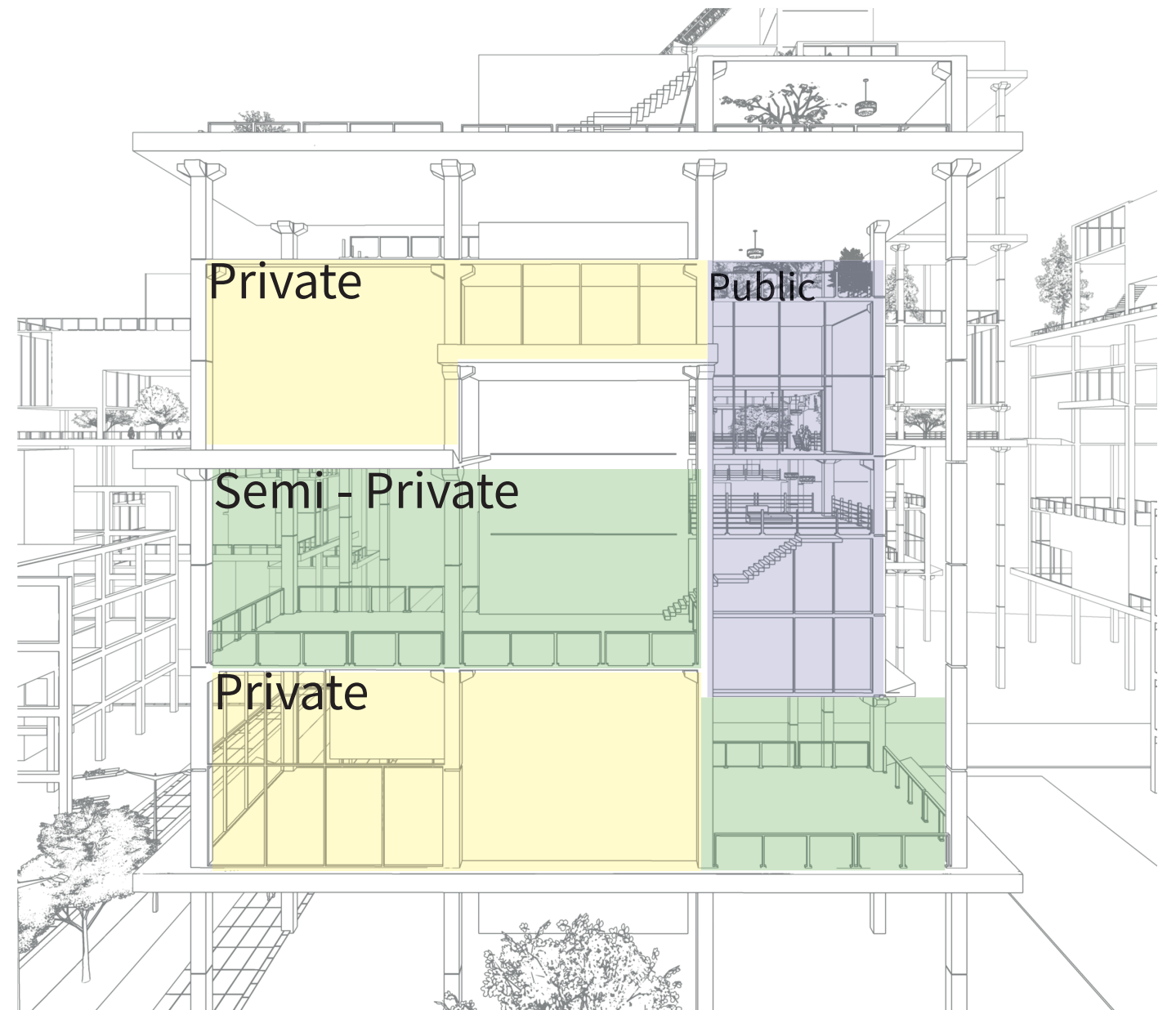
Each block incorporates a network of **pocket parks, small pavilions, and vertical green spaces**, creating intimate community hubs within the previously fragmented city fabric. These small open spaces are strategically linked, encouraging continuous pedestrian flow, everyday social interaction, and an extended urban ecological system.

Construction and maintenance efficiency are also considered through designated access paths for **OSC-based modular building systems**, ensuring safe and streamlined operations throughout the district.





Before



After

5.6 Modular Frame Connection

This section illustrates how a residential building evolves over a span of 30 years, continuously reorganizing its internal programs to meet shifting user needs and lifestyle patterns. In the initial stage, the building follows a conventional vertical hierarchy: public spaces occupy the lower levels, semi-private areas form an intermediate layer, and private residential units are placed at the top. This configuration supports early community formation, where public zones on the ground floor serve as shared activity hubs while the upper floors provide private living areas for individual households.

After 30 years, however, the spatial program has been reshaped in response to demographic changes, aging populations, and new patterns of daily use. Public spaces gradually shift upward, transforming into shared lounges, community rooms, or care-related facilities, while the lower levels expand into larger private residential units as household needs evolve. The semi-private layer remains flexible, acting as an adjustable buffer zone that expands or contracts depending on residents' living patterns and the community's needs.

This long-term transformation is enabled by the structural adaptability of the OSC-based modular system. Modules can be replaced, rearranged, or reconfigured over time, accommodating fluctuations in household size, new family structures, and increased care demands for aging residents. As a result, the building does not simply age but instead evolves as a living urban organism, continuously adjusting to the lives of its residents and supporting the gradual reformation of community ties over decades.