Sustainable renovation versus redevelopment of aged buildings, a comparative analysis of the legislative framework in South Korea

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Abstract. This research analyses, evaluates and compares the current South Korean legal frameworks and incentive programs that are related to the renovation and potential horizontal and vertical extension of existing buildings, and the construction of new buildings. The research focuses on the three different building categories and the associated urban zoning categories (i) high-rise apartment (residential), (ii) villa (residential), and (iii) mixed-use (residential, office, commercial). The research includes information about maximum building height and the number of floors, floor area ratios, building occupancy ratios, as well as building programs, safety, circulation, energy issues, and financial incentives. The results of this research illustrate the legislative framework and incentive system-based potentials and barriers for sustainable building renovations in South Korea.

1. Introduction

In order to establish the sustainable renovation of buildings in the Republic of Korea as a realistic alternative to their demolishment and the construction of new buildings, the renovation of buildings needs to be more attractive for the building owners, particularly regarding economic criteria. Sustainable renovation promotes a more rational use of existing land and constructions in producing new and affordable dwellings, as well as increasing urban density without compromising the quality of life of citizens (Sustainable Development Goal [SDG] 11 – Sustainable cities and communities). Renovation of aged dwellings allows a consistent reduction of Greenhouse Gasses (GHG) and decreased resource consumption (SDG 13 – Climate action). Furthermore, the development of renovation systems encourages new and innovative production processes aimed at the utilization of environmentally efficient, low-polluting and durable materials (SDG 9 – Industry, Innovation and Infrastructure).

The average building life of modern residential constructions in South Korea is approximately 25 years [1]. More than 60% of buildings in Korea, an increasing amount of constructions, are in requirement of extensive renovation [2]. However, current practices in South Korea for urban development of existing districts are mainly based on demolition of aged buildings rather than their renovation [3]. The government attempts to promote urban regeneration by means of sustainable building renovation through legislative frameworks, regulations and incentives. However, demolition and new building constructions continue to dominate the Korean building construction market [4].
This research compares the legislative framework and incentive systems for sustainable building renovations and new building constructions in South Korea. The comparison focuses on three case study buildings which are exemplary for three common Korean building types. The study aims at providing an overview of the existing legislation in terms of incentives for sustainable renovation and estimate the potential benefits of building refurbishment in comparison with the demolition and new construction of buildings. Accordingly, owners of aged buildings can benefit from this study because economic, social and environmental advantages of sustainable building renovations can be quantified. Public authorities could furthermore assess on the basis of this study the efficiency of legislative action for sustainable building renovation in comparison with new building constructions. Therefore, this research supports the revision and strengthening of municipal and national Korean legislations for the promotion of sustainable building renovations.

2. Materials and Methods

This research analyses, evaluates and compares the current South Korean legal frameworks and incentive programs related to the renovation and potential horizontal and vertical extension of three exemplary existing buildings, and the construction of new buildings at the same location, according to qualitative, and, as much as possible, quantitative criteria.

The analysis of the Korean legal framework for sustainable building renovations and new buildings (Section 3.1) was based on published legal codes introduced and amended until 2020. Each legal provision was summarized through its overall targets and directives. The analysis distinguished between broad-scale general directives set by national policies and specific norms mandated by municipal and local codes. Through the analysis of the legislative framework, minimum construction standards and incentive schemes for sustainable building were identified.

The findings were assigned to three case study buildings that are exemplary for typical Korean building types. In section 3.2, the legal spatial requirements for the construction of new buildings on the properties of the three existing case study buildings are compared with the existing situation. The analysis of minimum construction standards required for building renovations and new constructions related to the case study building types are summarized in section 3.3. Maximum incentives for sustainable building renovation and new construction are quantified in section 3.4. Incentive quantification methods were either grouped or differentiated according to building type and district jurisdiction. The specification of the maximum achievable monetary and non-monetary incentives is based on the highest legal requirements for sustainable building related measures. The analysis of incentives for sustainable building renovation focused on three specific incentive types: Floor Area Ratio (FAR) increase (i), vertical and horizontal building extension (ii), tax reduction and financial grants for renewable energy supply systems installation (iii). Finally, a comparative analysis of building renovations and new constructions on the three case-study building sites has been executed.

3. Results

3.1. Korean legal framework for sustainable building renovations and new constructions
The main legislative norms promulgated by the Korean government addressing sustainable construction practices are presented in Table 1. Relevant codes have been selected for the city of Seoul, where the case-study buildings are located. In principle, normative and codes developed for local jurisdictions overrule directives emanated on the national or municipal scale with specific norms. Conversely, where no specific regulations are defined, national or municipal codes apply.

| Name of legislation | Year of enactment | Sustainable building related requirements |
|---------------------|-------------------|------------------------------------------|

Table 1. Analysis of the legislative framework for building renovation
5-year “Low Carbon, Green Growth” (LCGG) economic development plans [5]

| Framework Act on Low Carbon, Green Growth (LCGG) [7] | 2010 (most recent amendment: 2020) | National legislation: LCGG 5-year economic plan directives legislative formulation. |
| --- | --- | --- |
| Green Buildings Construction Support Act [8] | 2012 (most recent amendment: 2020) | National legislation: definition of sustainable construction standards and relative incentives, GHG emissions and energy demand monitoring; institutionalization of Green Standard for Energy and Environmental Design (G-SEED) and Building Energy Efficiency Certificate (BEEC) systems for sustainable building certification. |
| Seoul Metropolitan Government ordinance on the support of construction of green buildings [10] | 2014 (most recent amendment: 2019) | Metropolitan legislation: incentives and tax schemes for sustainable buildings; enforcement of minimum sustainable construction standards; building permits relaxation for renovation and new constructions. |
| Seoul Green Building Design Standard guidebook [11] | 2013 (most recent amendment: 2019) | Metropolitan legislation: technical definition of minimum construction standards for new and renovated buildings. |
| Building Renewable Energy project support guideline [12] | 2014 (most recent amendment: 2019) | Tax incentives for acquisition of renewable technologies; Zero Energy Building (ZEB) program; Renewable Energy Points (REP) scheme for buyback of surplus renewable energy domestic production (feed-in tariff). |
| District Unit Plan (DUP) [13] | 2011 (most recent amendment: 2019) | District regulation for sustainable new and renovated buildings; incentives for sustainable constructions. |

3.2. Exemplary case study buildings for three typical Korean building types

The three selected case study buildings represent the three most typical building types in South Korea. The so-called “villas” are residential buildings below 5-stories with a portion of 33.3 % of the existing residential buildings. Apartment buildings occupy 49.2 % of all existing housing buildings. Mixed-use buildings including commercial, small/medium industrial, office and residential functions, cover 17.7 % of all buildings in the Republic of Korea [14]. Table 2 illustrates the specifics of the three case-study buildings and the legally required constrains to building development. The legal requirements for existing buildings specify the existing state of the case study buildings. The legal requirements for new building specify the requirements for the construction of a new building on the property of the existing building after its complete demolition. Legal requirements for new building are applied for the extension and renovation of the existing buildings.

Table 2. Case study building description and spatial analysis according to legal requirements

| Criterion | Building Type 1 - Villa | Building Type 2 - Apartment | Building Type 3 - Mixed-use |
| --- | --- | --- | --- |

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### Table 3

| District status   | Semi-residential area | 2nd Class - Residential area | 3rd Class - Commercial area |
|-------------------|-----------------------|------------------------------|-----------------------------|
| District          | Gwangjin              | Gwanak                       | Nowon                       |
| Site area (m²)    | 178.50                | 3,701.10                     | 586.00                      |
| Number of floors  | 3 above-ground        | 12 above-ground (50 % of floor underground) | 2 above-ground 1 underground |
| Total building gross floor area (GFA in m²) | 249.26 | 6,379.84 | 722.00 |
| Floor Area Ratio (FAR in %) | 139.65 | 172.23 | 123.20 |

#### Legal requirements

| Type                   | Villa New building | Villa Existing building | Apartment New building | Apartment Existing building | Mixed-use New building | Mixed-use Existing building |
|------------------------|--------------------|-------------------------|------------------------|-----------------------------|------------------------|-----------------------------|
| Maximum Building Coverage Ratio (%) | 60.00              | 46.24                   | 60.00                  | 29.72                       | 50.00                  | 41.12                       |
| Standard FAR (%)       | 300.00             | (360.00)                | 200.00                 | (230.00)                    | 175.34                 | (287.50)                    | 123.20                      |
| Maximum building height (floors)* | 40.00 m            | 8.60 m                  | 250.00 m (25)          | 36.00 m                     | 77.00 m (35)          | 6.5 m                       |
| Maximum building distance from public road border (adjacent building sites) in m | 0.50 (1.50)        | 2.00 (1.50)             | 3.00 (3.00)             | 2.57 (13.36)              | 0.50 m (1.50)         | (1.50) (< 9 m; ½ h if h > 9 m) |
| Amount of parking places on property, required per GFA | 1 per 400 m² | 1 per 65 m² | 110 per | 1 per 134 m² |

*Subordinated to the requirement of ensuring more than 2 h/day of un-shaded sunlight for neighboring buildings between 9 am and 3 pm.

#### 3.3. Analysis of minimum construction standards required for building renovations and new constructions

The Seoul green building design standard guidebook regulates building renovations and new constructions for the three case-study buildings districts. The regulations in the standard guidebook are mandatory for building projects of 500 m² and more. Standards for building renovations and new construction are differentiated in four distinct classes: A, B, C and D. Table 3 presents a summary of the standard classes applicable to the three reference building types. Minimum standards mandate which baseline level of sustainable building certifications G-SEED [15] and BEEC [16] must be reached for both new and renovated buildings. The G-SEED certification evaluates sustainable building interventions such as GHG-emission reduction throughout building materials life-cycle adopting a point-based system. G-SEED classes range from Green 4th (lowest level: 50 points or higher) to Green 1st (highest level: 74 points or higher). The BEEC assigns the building’s primary energy (PE) demand for heating, cooling and hot water to specific classes, ranging from the weakest to the strongest.
class 7 (PE demand of 420 kWh/[m²a] or less) to the most demanding class 1+++ (PE demand of 60 kWh/[m²a] or less).

Table 3. Legally mandated minimum construction criteria for new buildings related to the three case study building types

| Minimum construction standard                      | Building Type | Building Type | Building Type |
|---------------------------------------------------|---------------|---------------|---------------|
|                                                   | Villa         | Apartment     | Mixed-use     |
| New construction/Expansion of renovated buildings | D             | C             | D             |
| Renovated buildings                               | D             | D             | D             |

| Legally binding criteria                          | Class C minimum standard | Class D minimum standard |
|---------------------------------------------------|--------------------------|--------------------------|
| Minimum U-values (W/[m²K])                        | Exterior walls: 0.17; Roof: 0.15; Base slab: 0.17; Windows: 1.00 (mandated by national norms) | Exterior walls: 0.38-0.42 (for residential)/ 0.56-0.62 (for non-residential); Roof: 0.10-0.11; Base slab: 0.13-0.15 |
| G-SEED Level                                      | 4 in all 26 sub-categories | 4 in 13 sub-categories |
| Heating and cooling technical systems             | Installation of decentralized systems with certified low NOx emissions; Installation of energy monitoring devices (e.g. meters for gas, electricity and heat) | |
| Ventilation technical systems                      | Installation of Particulate Matter (PM) filters – Standard KSB6141-2017: 90 % capture rate for PM 10/2.5; installation of heat recovery systems |
| BEEC Level (PE demand in kWh/[m²a])               | Above 1 (120-150 or less) | Above 2 Villa: 150-190 or less Mixed-use: 260-320 or less |
| Cumulative installed PV-system capacity (mandatory renewable supply rate on total PE) | 37.01 kW (10.50 %) | Not mandatory |

3.4. Analysis of sustainable building incentives for new and renovated buildings

Based on the analysis of maximum applicable incentives for the construction of new buildings and the renovation of buildings, renovation scenarios for the three analyzed building types have been developed. The specification of the scenarios is based on the highest formulated sustainability criteria and the related achievable monetary and non-monetary incentives. For the calculation of the applicable incentives, the Gwangjin District Unit Plan (DUP) applies to the case of the villa type. Conversely, the Seoul green building guidebook defines incentive schemes for the apartment and mixed-use types. Table 4 presents the quantification of maximum incentives for new building constructions and building renovations.

Table 4. Overview and calculations of incentive and sustainable renovation strategy criteria for the three case study building types according to municipal and district regulations

| Incentive criteria | Renovation strategy - criteria | Villa | Apartment | Mixed-use |
|--------------------|--------------------------------|-------|-----------|-----------|
| G-SEED score       | 1st Green (above 74 points)    | Total incentive: FAR + (Standard FAR x 0.4) | Combined G-SEED level above 1st Green and BEEC level 1+++:
|                    |                               | Incentive Breakout: | Standard FAR + 9% |
| BEEC level         | Energy efficiency level 1+++ (PE demand below 60) | FAR x 0.4 |           |

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| **Renewable energy supply rate (PV-systems)** | kWh/m²a) | **G-SEED**: + 36 %; | **Standard FAR + 15%** (applies if ZEB level 1 is reached) |
| Zero Energy Building (ZEB) level 1 (highest): 100 % PE demand coverage ratio (minimum ZEB level: 5 – 20 to 40 % PE demand coverage ratio) | | BEEC: + 24 %; ZEB (renewable energy supply ratio on PE demand > level 5 - 20 %): + 36 %; Bonus for highest classification in all three criteria: + 24 % |
| **Ratio of recyclable building materials** | 25 % or more of used material recyclable and low LC impact | Not applicable | Standard FAR + 15% (Criteria applies only to construction materials for expansion or new building) |
| **Wastewater infrastructure** | Re-use guaranteed for a minimum of 10% of the annual volume | FAR + (Standard FAR x 0.04) | Not applicable for renovation Included as part of G-SEED evaluation criteria for new buildings |
| **Rainwater management infrastructure** | Decentralized system (up to 2% of the site area) | FAR + (Standard FAR x 0.04) | Not applicable |
| **PV system integration – acquisition incentive** | Minimum system capacity ≥ 3 kWP (apartment >37 kWP) | 560,000 KRW/kWp (max. incentive: 5,600,000 KRW) | 660,000 KRW/kWp (max. incentive: 5,600,000 KRW) |
| **PV-feed-in tariff (FIT)** | Applicable through authorized resellers and production of energy surplus | 167 KRW/kWh | 217 KRW/kWh |
| **Vertical extension** | Applicable through FAR incentives | Regulated by the DUP (Table 2 - height and border limits) | 2 (Enforcement Decree of Housing act) |
| **Horizontal extension** | Applicable through FAR incentives | Up to 30 % of floor usable area above 85 m²/ 40 % below 85 m² | Regulated by DUP and municipal norms (Table 2 - height and border limits) |
| **Tax reductions - exclusive for new buildings** | BEEC 1+++ and G-SEED 1st grade, ZEB level 1, GHG reduction of 55 % compared to standard buildings | Not applicable | Acquisition tax: 10 % Property tax: 10 % per 5 years |
| **Incentive sum** | **Villa** 360.00 % (393.20 m²) | **Apartment** 230.00 % (2138.12 m²) | **Mixed-use** 287.50 % (962.80 m²) |
According to the analysis of incentive schemes, new building and renovation scenarios with maximum incentives have been compared in Table 5. The results show that new buildings may be realized with a higher FAR and higher number of floors by altering the building typical floorplan and distance from adjacent constructions in accordance with existing regulations (see Table 2). Furthermore, as illustrated in the incentive sum overview in Table 4, laws limiting the vertical extension of existing apartments limit only renovated constructions, and higher amount of floor achieved with new building.

| Incentive/spatial index | Villa Renovated | Villa New | Apartment Renovated | Apartment New | Mixed-use Renovated | Mixed-use New |
|------------------------|---------------|---------|------------------|----------|-------------------|-------------|
| Ratio of FAR incentive built | 20.97 % | 100 % | 100 % | 100 % | 24.99 % | 36.35 % |
| Total GFA | 331.74 | 642.46 | 8517.96 | 8517.96 | 962.66 | 1072.00 |
| Number of floors | 4 | 5 | 14 | 16* | 4 | 5 |
| Building height | 11.20 | 13.50 | 42.00 | 48.00 | 12.00 | 15.00 |
| Min. distance from adjacent shaded buildings | 1.50 | 2.65 | 11.00* | 20.00 | 1.50 | 7.00 |

*New apartment excludes horizontal extension executed for the renovation scenario. GFA increment in excess of the 2 maximum floors allowed for renovation determines building horizontal extension.

4. Discussion

The results of this research illustrate that existing building extension through sustainable construction incentives for renovation is limited by the regulation in terms of building height and distance from adjacent buildings (Table 2). Accordingly, highest sustainability criteria cannot be reached, since only a ratio of the total sum of sustainable incentives can be realized, as indicated in Table 5. Furthermore, apartment vertical extension is limited by existing regulations for the case of renovation. Conversely, new buildings can maximize economic value by increasing the number of floors against horizontal extension. Additionally, as discussed in Table 4, new buildings are incentivized by exclusive property and acquisition tax discounts. Therefore, applicability of renovation incentives for sustainable building construction depends specifically from the existing building contexts. Furthermore, new buildings allow to redefine both building footprint and floor-type to maximize construction volume adjusting construction limits to existing contextual constrains. This study presented a methodology to analyze building sustainable construction scenarios based on three distinct parameters: existing building
regulations limiting construction extension (i), sustainable construction certification systems (ii) and incentive schemes for building sustainable construction (iii). Based on the three parameters, the comparative analysis and quantification of incentives for new and renovated building scenarios allow the calculation of potential spatial expansion, economic benefits and environmental performance improvements to be quantified. Building codes, sustainable building certification and incentives schemes are at the base of building regulations in an increasing number of countries. Therefore, the analytical and comparative method can be adopted to discover differences and best practice in multiple national contexts and for different common building types. The calculation of incentives can be additionally executed for urban districts with uniform building types to identify potential synergies between single renovation interventions. Accordingly, the analytical method propose can encourage multiscale analysis of sustainable construction to develop integrated solutions for urban regeneration.

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