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## Sustainable Renovation Strategy for Officetels in Korea

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### Abstract

This paper discusses how so-called officetels in Korea can be renovated in a sustainable way. A sustainable renovation strategy in terms of social, environmental and economic aspects of sustainability is developed for an exemplary officetel building as a starting basis for sustainable renovation of officetel buildings in Korea. An officetel (a portmanteau word of 'office' and 'hotel') is a Korean building type. Officetels are multi-purpose buildings with residential and commercial units. The success of officetels can be related to the demand of people to find small-scale accommodations in livable urban areas with mixed uses and near to working places. The focus of this research is to identify the following sustainability related problems of officetels: (1) Social aspect: The regulatory framework needs to be adjusted for balanced development between residential areas and non-residential areas; (2) Environmental aspect: Officetels have a high energy demand for heating, cooling and ventilation compared with other residential building types; (3) Economic aspect: In contrast to demolition and new construction of buildings, a sustainable renovation would increase the economic value of officetel buildings with comparable low monetary investment effort. The sustainable renovation strategy for officetels would significantly contribute to sustainable urban development in the Republic of Korea.

**Keywords:** officetel, Korean housing, renovation strategy, urban sustainability, energy efficiency

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### 1. Introduction

In the early 1980s, there was a demand of the Korean Society to offer residential uses in areas in which generally no residential buildings were allowed to be built. Accordingly a building type with the name 'officetel' was developed. Officetels are multi-purpose buildings with residential and commercial units which could support business and commercial functions by meeting the demand for housing in commercial areas (Yi et al., 2002). The first officetel was built in Seoul, Korea in 1985. In 1995, the number of officetel buildings was only 6,475. The numbers increased to 21,041 buildings in 2000, 159,791 buildings in 2005 and 232,911 buildings in 2010. In 2016, officetel buildings made up about 2 percent (380,152 buildings) of all Korean residential

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building type units (Lee, 2011). It can be expected that the demand for renovation of officetel buildings will increase sharply in the 2020s considering the short average Korean building lifetime of 20 years. Renovation of old buildings has been a major strategy in Korea for extending the average building lifetime (Yoo, 2015, Kim, 2003). A longer building lifetime is an important factor for reducing building related resource consumption because building practices around the globe are a major consumer of resources and energy, while producing significant emissions and waste (Salzer et al., 2016). However, currently there is no specific renovation strategy addressing the problems and improvements of existing officetels in Korea. Problems of officetel buildings related to social, economic and environmental sustainability aspects, such as low energy efficiency and high resource consumption have not been addressed yet. Thus, this paper aims to frame a strategy for sustainable renovation of officetels, which would significantly contribute towards sustainable urban development in the Republic of Korea.

## 2. Method

This research analyzes the need for sustainable renovation of officetels. Firstly, a selected Korean officetel building which is exemplary for this building type in Korea is analyzed. The analysis addresses the properties of building structure, components, building uses and programs, energy consumption and legal issues. This research is based i) on a case study building analysis; and ii) on the review of publications addressing aspects relevant to the building analysis. The findings of the analysis are evaluated according to sustainability criteria. The evaluation results are the starting basis for the development of a framework for the sustainable renovation of officetels in Korea. The renovation strategy to be developed and applied to the exemplary officetel building will address social, environmental and economic aspects of sustainability. The proposed strategy will be based on recent research findings regarding the sustainable redevelopment of buildings and urban areas.

## 3. Results and Discussion

*3.1. History of officetels* - Historically, all types of architecture have emerged with reflection on social needs. In Korea, the demand of the Korean Society to offer residential uses in non-residential areas resulted on the emergence of officetels in Seoul in the 1980s (Yi et al., 2002). Officetels do generally not consist of offices and hotels but accommodate residential (small apartments) and non-residential (office and commercial) building uses. The development of officetels can be divided in five main periods: (1) In 1985, the first officetel was built in Seoul. At the very first time, officetels started to flourish. The reason was the economic benefit for the owners. Officetels were not regarded as second homes per household. Accordingly owners of one "normal" home and one officetel did not need to pay taxes on two homes but only one. This resulted in the activation of a real estate market for officetels (Yi et al., 2002). (2) In 1988, the Korean government set a couple of legal standards to limit the officetel market in order to not disturb the development of apartments in exclusively residential areas (Yi et al., 2002). For that reason, the officetel market went through the first slump until 1995. (3) In 1995, legal standards related to officetels were relaxed for the demand of construction companies planning New town development and officetels with improved housing functions (such as an adjustment of a plan layout of officetels which fitted the lifestyle of single-person households better) increased sharply especially in downtown Seoul until 1997. (4) In the wake of the 1997 International Monetary Fund (IMF) financial crisis, the officetel market went through the second slump (The vacancy rate of officetels in Seoul was up to 22.7% during this period) such as all the other fields in Korea did until 1999 (Lee, 2011). (5) From 1999 to the present, many types of officetels, many with improved housing functions, have been built. This resulted in the succession of business ventures in the officetel market (Yi et al., 2002). With a growing number of people who demand small-scale accommodations in livable urban areas with mixed uses and near to working places, also the demand for officetels in Korean cities has increased (Jung et al., 2013).



### 3.2. Sustainability aspects of officetels

3.2.1. *Social aspects of Sustainability* - Officetels are used for both residential and non-residential purpose, but officetels are classified in Korean building codes legally as office buildings. Therefore, the number of officetels for residential use increased in commercial areas. This development is in contrast to the zoning plan in Korea, which separates residential areas from non-residential areas. Furthermore increased residential uses contribute to a growing diversity of user groups (such as singles and young couples), building uses, and time space utilization. To solve the legal and policy issues that are related with the design, construction and use of officetels, the legal and regulatory framework needs to be adjusted with consideration of balanced development between residential areas and non-residential areas (Jang and Kang, 2012).

3.2.2. *Environmental aspects of Sustainability* - Compared with apartments, which is the most common housing type in Korea, officetels have a poor environmental performance. On the scale from 0% (very bad) to 100% (excellent) officetels perform bad in the categories “good ventilation” (22.98% of 100%), “low dust pollution/good air quality” (22.47% of 100%), “low noise pollution” (19.54% of 100%), and “affordable maintenance fee” (15.73% of 100%) (Jung et al., 2013). Officetels have a high energy demand for heating, cooling, lighting, and ventilation compared with apartments. Furthermore existing officetels are not equipped with sustainable energy, water, and waste systems. Therefore, officetels need to be renovated in order to improve the environmental sustainability, particularly regarding the comfort and health of indoor environments, energy efficiency, energy productivity, water efficiency, waste reduction and the use of sustainable materials.

3.2.3. *Economic aspects of Sustainability* - 65 percent of the officetels in Seoul were built in the early 2000s (Choi et al., 2007). Considering the average lifetime of 20 years for Korean buildings (Yoo, 2015), it can be expected that the demand for renovation of officetel buildings will increase sharply in the 2020s. In contrast to the demolition and new construction of officetels a sustainable renovation would increase the economic value of such buildings with comparable low monetary investment effort. Savings in monetary service cost after the renovation could finance the renovation process. Particularly an energy efficient renovation would result in significant savings of energy costs, which are responsible for the majority of building service costs.

### 3.3. Analysis of the Exemplary Officetel building

The selected exemplary officetel building is located in Jongno-gu, Seoul. This building is considered to be comparable regarding the general design, building construction, components, and energy consumption with officetels, which were designed in the period 2001-2004. This is the period when most officetels were constructed in Seoul [Table.1] (Jeong, 2007). In the following sections the building is analyzed regarding the building design, the type and properties of building construction and building components and energy consumption.

Table 1. Basic information regarding the selected exemplary of officetel building

Classification	Content	Classification	Content
Location	Naesu-dong, Jongno-gu, Seoul	Structure	Reinforced concrete structure
Building name	Morning of Gyeonghui Palace	Exterior wall finish	CRC panels
Site area	19,994.60m <sup>2</sup>	Interior wall finish	Concrete tiles
Building footprint area (BCR)	9731.18m <sup>2</sup> (53%)	Building height	66m
Gross floor area (FAR)	190,757.87m <sup>2</sup> (658%)	Story height	4m
Exclusive area rate	50%	Stories (underground)	16 (5)
Building use	Residential, commercial	Project year	2004

3.3.1. *Building design and layout* - The plan layout of the exemplary building is based on a rectangular block layout. The total building height is 66m with 16 floors above ground and 5 floors below ground, and the average story height is 4m. The lower 2 floors consist of a compact building with minimum building depth of 13m to maximum 21m from one façade to the opposite façade. The use is commercial. The upper building part from 3-16 floor (16 stories) consists of residential buildings with a depth of 21m from one façade. The

others are arranged around two courtyards with varying distances of minimum 37m to maximum 96m to the opposite buildings. The 5 floors below ground (B1-B5) consist of a fitness club, a driving range, a welfare center for senior citizens and underground parking lot. There are seven types of unit plans (47m<sup>2</sup>, 53m<sup>2</sup>, 54m<sup>2</sup>, 60m<sup>2</sup>, 87m<sup>2</sup>, 94m<sup>2</sup> and 107m<sup>2</sup>) and 60m<sup>2</sup> unit is the most abundant unit plan in the exemplary officetel building. Officetel units on one floor are generally accessed via a middle corridor [Fig.1].

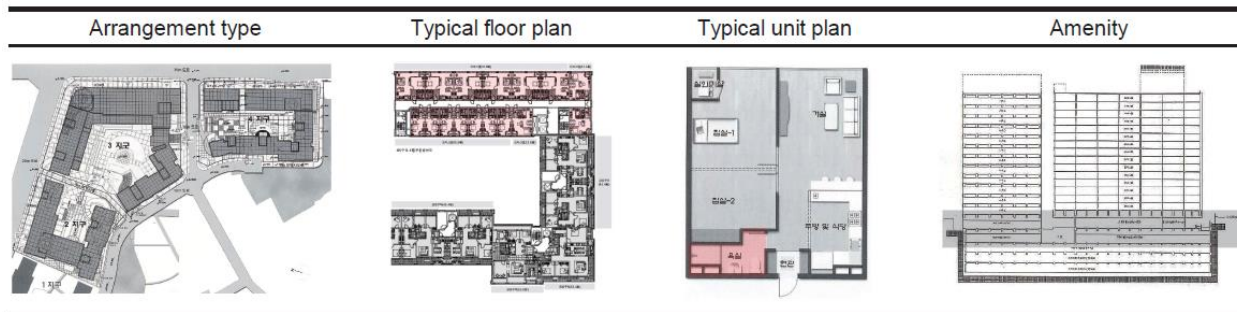


Fig.1. Architectural drawings of the exemplary officetel building

**3.3.2. Building construction and components** - The structure of the exemplary officetel building is based on columns, beams, slabs, core walls and stairways consisting of in situ reinforced concrete. Exterior walls consist of the following layers from outside to inside: CRC panels (cellulose fiber reinforced concrete panels, 50mm), reinforced concrete (180mm), insulation (50mm) and gypsum plasterboard (10mm). Windows of the exemplary officetel building are mainly aluminum-framed windows with 16mm double glazing, with 6mm cavity between the panes. Interior walls consist of the following layers from outside to inside: light weight concrete panel (100mm), gypsum plaster (10mm) and concrete tiles (15mm). Slab and stairways consist of in situ reinforced concrete. The base slab consists of the following layers from outside to inside: Concrete tiles (15mm), Aerated concrete (40mm), Insulation (50mm) and reinforced concrete (150mm). The interior flooring consists originally of concrete tiles and panels with wood grain pattern. The roof consists of the following layers from outside to inside: Cement mortar (30mm), topping concrete (85mm), waterproofing, Insulation (50mm), reinforced concrete (150mm) and gypsum plasterboard (15mm) [Table.2]. In order to analyze the transmission heat losses through the building envelop, the U-values for the exterior wall, base slab, roof and windows have been calculated in Table 2. According to the results, the building envelop components of the exemplary officetel have high heat losses compared to the Korean Energy Saving Design Standard for non-residential buildings [Table.3]. In order to improve the energy efficiency of the exemplary officetel building, the heat transfer of the building envelop components should significantly decrease.

Table 2. Basic information regarding Heat transmission coefficients of building envelop components

Classification	Components (layers from outside to inside)	U-value
Exterior wall	CRC panel (50mm), Concrete (180mm), Insulation (50mm), gypsum plasterboard (10mm)	0.74 W/m <sup>2</sup> K
Windows	16mm aluminum framed windows with double glazing (with 6mm cavity)	3.10 W/m <sup>2</sup> K
Roof	Concrete (85mm), Insulation (50mm), Concrete (150mm) gypsum plasterboard (15mm)	0.65 W/m <sup>2</sup> K
Base Slab	Concrete tiles (15mm), Aerated concrete (40mm), Insulation (50mm), Concrete (150mm)	0.59 W/m <sup>2</sup> K

**3.3.3. Energy consumption** - Data regarding heating and cooling energy consumption of the exemplary officetel building was not available. Therefore, the energy consumption of the exemplary officetel building could only be analyzed based on the amount of consumed electricity and gas. This data was compared with the energy consumed by other building types. Figure 2 shows that the electric energy consumption of officetels is generally higher than the one of apartments, and lower than the one of offices. The gas consumption of officetels is in contrast lower than the one of apartments and higher than the one of offices [Fig.2]. The reason for these consumption patterns can be found in the mix of residential and non-residential building uses. The total amount of electric energy consumption of the exemplary officetel building in 2016 was 2,119,402 KWh



and the average electric energy consumption per m<sup>2</sup> was 11.1 KWh. Electricity is used for multiple purposes such as cooling, lighting, ventilation, appliances for refrigerating and freezing and the operation for elevators and pumps. The electricity use for lighting was comparable high because the 24 hours occupancy level of officetels is higher than the one of apartments and offices. The total amount of gas consumption of the exemplary building in 2016 was 3,308,885 KWh and the average electricity consumption per m<sup>2</sup> was 17.3 KWh. Gas is used for multiple purposes such as heating, hot water production for bathing, cleaning, computer audio, TV and appliances for cooking. Gas consumption of the exemplary officetel is significantly higher than electric energy consumption. Regarding gas energy use pattern, the demand of heating and cooking was comparatively high because current officetels accommodate more residential than business functions and space. In order to decrease energy consumption of the exemplary officetel building, the use of gas energy for heating, hot water production and cooking would need to be significantly reduced.

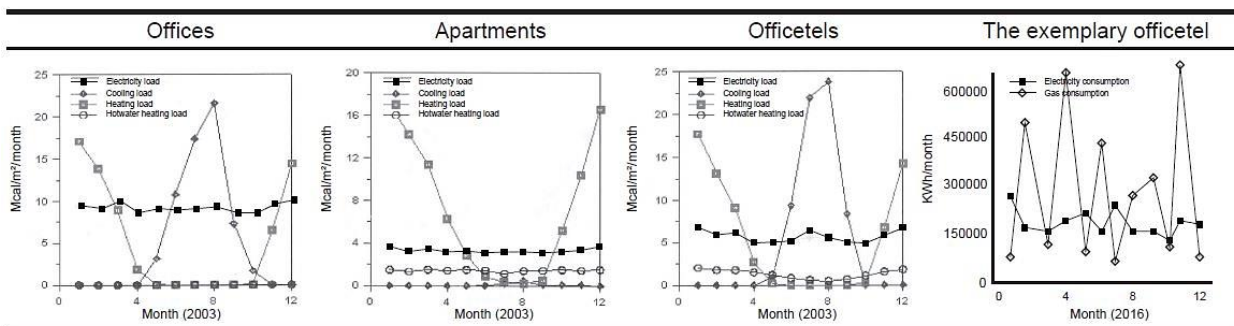


Fig.2. Energy consumption of the exemplary officetel building

3.3.4. *Ventilation & Natural lighting* - Compared to other types of housings in Korea, most officetels have a much more centralized and compact type of plan layouts. The aim is the maximization of the floor area ratio (FAR), and the minimization of publicly used areas. Due to comparable high building depths officetel have also comparable small façade and window areas in relation to the provided floor (Kim et al., 2014). In the floor plan layout of the exemplary officetel the compact and deep plan layout is well illustrated. Accordingly, the officetel units have very poor natural ventilation properties. Cross-ventilation from one façade to the opposite façade of the building is not possible. The ventilation system of the exemplary officetel building is based only on mechanical ventilation. The demand of mechanical ventilation in a household causes a lot of energy consumption of electricity and an increase of affordable maintenance fee. Accordingly the current ventilation system contributes to high energy demand for ventilation. In order to reduce the energy demand and improve the ventilation system of the exemplary officetel building, the building would need to be considered to have a new type of plan layouts with efficient natural ventilation system.

Officetels have comparatively short distance between neighboring buildings. The low proportion of window areas and deep floor plan layouts compared to residential buildings (Kim et al., 2014) result in poor natural day lighting properties. These building properties are caused by the legal classification of officetels as office buildings according to the Korean building codes. Accordingly livability performance criteria and requirements are less addressed than in residential buildings. In order to improve natural lighting properties of existing buildings, measures for enhancing the penetration of daylight to indoor need to be applied in the framework of building renovations. Such regulations should for instance concern the minimum height and distance of adjacent buildings, floor plan layouts, as well as the positioning and proportion of window areas.

3.4. *Evaluation & Suggestion* - According to Korean Energy Saving Design Standard for non-residential buildings, the U-values of the exemplary officetel building's building envelope are quite high. The heat transfer through the components would need to be improved by more than 200%, in order to meet the minimum requirements for Passive Houses [Table.3]. According to the Korean energy roadmap, the energy efficiency of new buildings needs to be improved during the period of 2012 to 2025. From 2025, non-residential buildings

should have an energy saving rate of 60%. However, no specific benchmarks for the area wide minimization of the energy demand and resource consumption of non-residential have been suggested. From 2025 the Korean energy road map requires all new buildings to have Net-Zero Energy consumption. In order to achieve this goal, the minimization of energy demand and the building integrated production of renewable energy are required. Accordingly, the maximum U-values for new officetel building envelope components should meet the requirements for Passive Houses by 2025. Sustainable renovation concepts for officetel buildings should therefore aim for the same benchmarks as new constructions from 2025. The application of officetel renovations according to the Passive House standard with building component U-Values of suggested benchmarks for officetels in 2025 [Table.3] is expected to facilitate up to 90% reduction of heating and cooling energy demand compared with exemplary officetel building.

Table 3. Evaluation of the selected exemplary officetel building (U-value)

Passive house (U-value)	Korean Energy Saving Design Standard (for non-residential)	The exemplary officetel building (U-value)	Suggested benchmarks for officetels in 2025
Exterior wall ( $\leq 0.15$ W/m <sup>2</sup> K)	Exterior wall ( $\leq 0.27$ W/m <sup>2</sup> K)	Exterior wall ( $\leq 0.74$ W/m <sup>2</sup> K)	Exterior wall ( $\leq 0.15$ W/m <sup>2</sup> K)
Roof ( $\leq 0.15$ W/m <sup>2</sup> K)	Roof ( $\leq 0.18$ W/m <sup>2</sup> K)	Roof ( $\leq 0.65$ W/m <sup>2</sup> K)	Roof ( $\leq 0.15$ W/m <sup>2</sup> K)
Base slab ( $\leq 0.15$ W/m <sup>2</sup> K)	Base slab ( $\leq 0.23$ W/m <sup>2</sup> K)	Base slab ( $\leq 0.59$ W/m <sup>2</sup> K)	Base slab ( $\leq 0.15$ W/m <sup>2</sup> K)
Windows ( $\leq 0.80$ W/m <sup>2</sup> K)	Windows ( $\leq 2.10$ W/m <sup>2</sup> K)	Windows ( $\leq 3.10$ W/m <sup>2</sup> K)	Windows ( $\leq 0.80$ W/m <sup>2</sup> K)

#### 4. Conclusion

Based on the findings in this paper, it can be concluded that the improvement and sustainable renovation of officetels would significantly contribute towards sustainable development in Korea. However, no specific renovation strategies have been developed yet. Also benchmarks for the sustainable renovation of existing officetels have not been defined. In order to develop such strategies and benchmarks, an exemplary officetel building was analyzed and evaluated in terms of social, environmental and economic sustainability aspects.

Benchmarks for U-Values of building envelope components in the framework of building renovations were suggested based on the analysis of existing building components and the Passive House standard. The need for changing the existing housing unit plan layout of officetels in order to improve livability has been identified. Furthermore the reduction of energy consumption and the improvement of environmental performance of existing officetels need to be addressed in building renovation concepts. The legal and regulatory framework related with the design, construction and use of officetels needs to be addressed and improved in order to facilitate a more sustainable design of officetels. The identified issues and proposed strategies are starting basis for the development of a framework for the sustainable renovation of officetels in Korea.

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