

A Study on Housing Performance Indicators Evaluating the level of Deterioration of Apartments

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ABSTRACT: High-rise and high-density apartment complexes have been built and supplied on a large scale in metropolis and metropolitan areas since the 1980s in order to solve housing shortage in cities. It has become necessary recently to maintain and improve those apartment complexes which have serious deterioration problems for aging more than 20 years accompanying simultaneity and a large scale.

The purpose of this research is to develop the overall evaluating indicators to measure the level of deterioration of apartments inclusively and practically in order to regenerate apartment housing as sustainable residential environments. This research is composed of a two-stage study (to develop the evaluating indicators based on a conceptual model and the measure for indicators based on an empirical study). This study is the first stage of the research developing the overall evaluating indicators.

This study was conducted by a method of literature review based on variety preceding researches and the reports related to evaluating indicators. First, the concept of deterioration of apartments was defined, and a pool of evaluating indicators of housing performance was found. The pool was developed based on existing indicators used in Korea and foreign countries and preceding studies (about components of apartment environments and residential satisfaction). Lastly, a conceptual model structured with a hierarchy was suggested. The model was composed of the categorized evaluating indicators according to the high-density and high-rise apartment situation in Korea. Those were characterized by evaluating categories such as the evaluating dimensions (physical, social, and economic), the 3 evaluating attributes according to each dimension, and the total 80 evaluating items.

Keywords: Evaluating Indicators, Level of Deterioration, Apartment

1. INTRODUCTION

1.1 Background and Purpose of Study

An apartment, which was introduced in order to solve a housing shortage issue coming from overpopulation in urban cities, has been continuously rising since the 1970s and the large scale of apartment complexes

of high-rise and high-density were constructed in great amounts with the housing development project in the late 1980s.

However, since a construction term of those high-rise apartment complexes of the 1st new city and the metropolitan area has passed 20 years, deterioration and inferiority

of constructions will be inevitable. In 10 years, the 'deterioration apartments' that had passed '25 years after completion' will be over 1.85 million households, and this forecasts that it will be the key factor of the housing market. Like this, a mass deterioration is extensively and simultaneously progressing in new cities and metropolises where apartments are crowded, thus the need of management and maintenance for deterioration apartments are becoming prominent as facing social issues like instability of the housing market.

In what condition, can apartments be considered as deteriorated? A construction term is used as an important measurement as the apartments over the 25 years of completion date are considered as deteriorated. However, there are apartments over 20 years which continuously hold high preferences and the cases where re-adaption of residents was successful as they improved specific housing performance by changing facilities. On the other hand, migrations of residents are happening in newly constructed apartments by changes of surrounding environment and family life. This shows that deterioration of apartments should be judged by comprehensive housing performance for a satisfying life as a living space of the family, which cannot be judged by only construction terms or the physical capacity. Since apartments have been developed as a residential complex form that has many buildings and welfare facilities of legal minimum environment standard, housing performance must be judged by not only the unit and building aspect but also the complex aspect.

Therefore, the deterioration of apartments must be achieved through evaluation of the housing performance and the housing performance should be achieved with social and economical evaluation including accommodation of living, construction plan, city environment and maintenance along with the physical aspects of evaluation.

Consequently, the purpose of this research is to develop the overall evaluating

indicators that can inclusively and practically measure the level of deterioration of apartments in order to regenerate apartments as sustainable residential environments. Therefore, this research is composed of a two stage study (to develop the evaluating indicators stage based on the conceptual model and to develop the measure for each indicator based on an empirical study). This study is the first stage of research developing the overall evaluating indicators based on the conceptual model.

1.2 Scope and Method of the Study

This study was conducted by a method of literature review of preceding researches and the reports related to evaluating indicators. First, a notion of deterioration of apartment was established by inquiring preceding researches and the reports related to deterioration.

Then, existing indicators used in Korea and foreign countries were compared and arranged in order to develop a pool of evaluating indicators of housing performance. In addition to those, the environment evaluation and the residential satisfaction evaluation studies which were conducted targeting domestic apartments were compared and examined, in order to reflect domestic residential conditions.

With the pool, application possibilities under the situation of domestic high-rise and high-density apartment complexes were specifically compared and analyzed based on evaluation ranges (unit, building, complex, location) and evaluation indicators were selected. The selected indicators were categorized with the evaluation dimensions (physical, social, economical), and it was embodied as a conceptual model structured with a hierarchy for evaluating deterioration of apartments.

2. THEORETICAL BACKGROUND

2.1 The Concept on the Deterioration of Apartments

The definition of ‘deterioration’ in the dictionary is incapable of being adequate because it is old and worn-out, the deterioration housing can be considered the housing which was in normal condition at the time of completion but is in decayed condition of its performance and function as time passes.

In the laws related to housing, the deterioration condition means both when function has decayed as time passes and when function was not up to standard or was in a bad state at the time of construction.

In preceding researches¹, the deterioration of building is defined as a state which the entire building is incapable of performing because of the lowering of basic capacities like durability, safety, and functionality and with deficiency condition of each component parts of the building. In particular, deterioration of this performance in apartment is becoming a motive for remodelling, and it can be understood in perspectives of physical aging, deterioration in building capacity and change in housing needs (Kozo Kadowaki et al., 2003).

Thus the deterioration of buildings can be explained through differences between the current performance and the expected performance of the building as a reference point.

Examining the aspects of demanded performance that help grasping the deterioration status of the building, Im Sang-Don et al.(1992), Im Chang-Il(1998), Son Ui-Jung et al.(2001) suggested physical deterioration in physical aspects and social, functional, and economical deterioration in non-physical aspects. Min Byung-Ho et al.(1991), Choi Moo-Hyun et al.(1998), Seo Boong-Kyo(2000) has classified and comprehended these into physical deterioration, functional deterioration, social deterioration and economical deterioration. Mun Hong-Kil(1995), Korea Housing Institute(2000), Kang So-Yeon et al.(2004), Choi Sang-Hee(2005) classified the aspects

of deterioration in the physical, the social and the economical. As a conclusion, physical aspects and non-physical aspects must be grasped at the same time and the classification of aspects has to reflect characteristics of the target building.

For the residential environment, Moon Hong-Kil (1995) explained the idea of deterioration in different aspects of housing and home. And he argued that for the case of domestic apartments, viewing the deterioration of residential environments only on the physical aspects has to be changed. Therefore apartments should be understood in residential environment including cultural, social, psychological, political and economic elements as well as the aspects of physical space. Moreover, apartments should be considered in ranges of buildings and complexes along with units since they are developed in forms of complexes and features as an associative house where many households reside together.

Therefore the deterioration of apartments can be conceptualized as a condition which does not have housing performance that the entire building was expected because all of capacities are deteriorating based on aging of the building and incapability of each component unsatisfying residents’ demand. And, the housing performance can be understood in physical, social and economic terms as they are defined as below (Table1).

Table 1 Housing performance dimensions to evaluate deterioration of apartments

Dimension	Concept
Physical	·Basic capacities like durability, safety, and functionality ·Basic capacities of equipments supporting residential life
Social	·Attachment and satisfaction for residential environments in living place ·Adaptability of change in user’ needs
Economical	·Property value ·Cost of economical life extension (recovery of expected building performance)

¹ Min,Byung-Ho et al. (1991), Choi,Moo-Hyun et al. (1998), Im,Chang-Il(1998), Seo,Boong-Kyo(2000)

Table 2 Review of preceding indicators and researches (Quote from Cho,Sung-Heui, Lee,Tae-Kyung(2008), p.228)

Country	Evaluating indicator	Evaluating Items	Evaluating range			
			unit	building	complex	location
Korea	[1]The Housing Performance Indicator System	- Noise-related grade(light weight crashing sound/heavy weight crashing sound/restroom noise, sound between units) - Construction-related grade (flexibility/easy to repair/remodeling and maintenance)/durability) - Environment-related grade(landscape(external environment)/sun(lighting environment)/indoor air quality/energy efficiency(heat environment)) - Living-related grade (public facilities for residents /Care for social disadvantages such as the aged) - Fire, fire extinction grade(fire, fire extinction)	○	○	○	
	[2]Green Building Certification	- Use of land(ecological merit/use of land/influence of neighboring land/composition of residential environment) - Transportation(Reduction of transportation load) : Energy(energy consumption/energy saving) - Materials and resources(economy in resources/minimization of wastes/separate collection of daily waste/recycling) - Water resources(water circulation system/economy in water resources) : Environmental pollution (prevention of global warming) - Maintenance (systematical site management/efficient construction management/efficient household management) - Ecological environment(green space within the land/ place for living beings/utilizing natural resources) - Indoor environment(air condition/thermal environment/sound environment/lighting environment/care for the aged)	○	○	○	○
	[3]재건축환경을 위한 평가방안	- Safety of structure - Functionality: building(inside of unit/public space/exterior of building) : land(use of land) : Environment(surrounding environment/residential environment(size/comfortableness/safety/prevention for disaster/corresponding to social changes)) - Convenience(heating/water supply/boiler/sewage/gas/fire extinction) : Electricity(conversion of water and electricity/electric power line/unit electricity/communication/TV public hearing/outdoor lamp/fire extinction) - Economical efficiency(repair and reinforcement cost/economical efficiency for improvement/ economical efficiency for remodeling and repair/business efficiency)	○	○	○	
Japan	[4]住宅性能表示制度	- About stabilization of structure - About safety during fire break-out - About depletion reduction - About maintenance - About thermal environment - About air quality environment - About light quality environment - About noise environment - About care for the aged - About crime prevention	○	○		
	[5]CASBEE	- Building environmental quality and performance - Indoor environment(noise & acoustics/thermal comfort/lighting & illumination/air quality) - Quality of Service (service ability/durability & reliability/flexibility & adaptability) - Outdoor environment on site(Preservation & creation of biotope/Townscape & landscape/Local characteristics & outdoor amenity) - Reduction of building Environmental loading - Energy(building thermal load/natural energy utilization/efficiency in building service/efficient operation) - Resources & materials(water resource/materials of low environment load/using materials containing pollutants or not) - Off-site environment(global warming/local environment/neighborhood environment)	○	○	○	○
U.K	[6]HQI(Housing Quality Indicator)	- Location(location) - Design: Site(visual impact, layout, landscaping/open space/routes & movement) - Unit(size/layout/unit noise control, light quality, services & adaptability/accessibility with the unit/sustainability) - external environment(building for life)	○	○	○	○
Domestic researches of actual condition	[7]A Case Study on the Evaluation of Residential Performance for Deteriorated Multi-family Housing	- building: component factor(unit/public), performance(unit), facility(unit/public) - complex: composition (building/green land/driveway and sidewalk/parking), performance(management/movement/environment), facility(facilities)	○	○	○	
	[8]A Study on Residential Quality Index Based on the Quality of Life of Super High-Rise Apartment Housing	- facility infra factor(convenience/health/safety) - visual factor(view/beauty/stability) - space usage factor - social-relation factor(social performance/social activity) - operation and management factor	○	○	○	
	[9]Residents' Attitudes for the components of Home Environment	- Social community(affection, friendliness/neighborhood relationship/closeness of friends and relatives) - Convenient facilities(transportation/planned residential site/good location/public convenient facilities) - Qualitative point(prospect for growth of investment/name value/educational environment) - Psychological amenity(atmosphere of residence/comfortableness/safety) - Leisure culture(scenery, view/usage of nature/leisure culture facilities)			○	○
	[10]A Study on the Environmental Satisfaction of Apartment Households of the Newtown in Seoul Metropolitan Area	- Location(public transportation/education/residence level of neighborhood/surrounding natural environment) - Economy(investment value/easy to sell and buy/maintenance cost) - External environment(view of complex/landscape/outdoor facility) - Convenient facilities(commercial district/public facility/meeting facility) - Maintenance(garbage disposal/reliance on crime and fire prevention/parking/defect repair) - Satisfaction degree of neighborhood			○	○
	[11]The Price Estimation of Residential Satisfaction Components	- Housing section(size/lighting/ventilation/heating/water and energy supply/exterior and color/floors/view) - Complex section(parking/entrance/garbage disposal/green landscape/playground, senior house/maintenance) - Neighborhood environment section(surroundings of complex/density condition of surrounding/air quality/public facilities/medical facilities/cultural facilities/commercial facilities/attending office and school/school group/public transportation/public administration) - Psychological behavior section(privacy protection/level of regularity awareness/neighborhood relationship/safety/street noise/ prices standard of neighborhood/voluntary try of residents/expressing social position)	○	○	○	○
	[12]Post Occupancy Evaluation for the Design and Planning of Apartment Housing in Pusan	- Physical factor(room size/room numbers/storing/finishes/arrangement/privacy) - Indoor environmental factor(ventilation/convenient worktable/electricity/room temperature/lighting/noise/view) - Social space factor(neighborhood relationship/community space/distance between building/green land/ privacy of neighborhood) - Management economical factor(management/repair/management cost/crime prevention/selling and buying/investment merit/sanitation/reputation) - Convenient facility factor(school group/transportation/commercial medical care/attending office/air pollution/traffic noise/culture/community/commercial facilities)	○	○	○	○
	[13]A Study on the Development of Housing Performance Evaluation Model for Multi-unit Residential Buildings	- Environment: location environment(convenient transportation/convenient facilities) - surrounding environment(greens/cause for environmental pollution/possibility of natural disaster) - Environment within the complex(land usage condition/landscape) - Functionality: function of complex(parking) : space function(space plan) - usage function(safety/convenience/crime prevention/manageability) - Comfortableness: thermal environment (heat insulation/adjustment of temperature) : visual environment(lighting/view) - sound environment(noise suppression /noise condition) :air environment(ventilation performance)	○	○	○	○

Performance Indicator System and Green Building Certification, Japan's the Housing

2.2 Reviews on the Performance Evaluation of Apartments

This study analyzed the development purpose, contents and composition features of typical performance evaluating indicators: Korea's the Housing

Performance Indicator System and CASBEE, and England's HQI (Table2).

Efforts to evaluate total performance for residential environment are rising as the

previous housing performance evaluation system was done only with physical aspects. In Japan, the Housing Performance Indicator System that is stressing the environmental features like an earthquake is in operation.

CASBEE is in development as a total evaluation system for sustainable housing, but it is identified that there are limits in social and cultural aspects of performance evaluation because it only focus on environmental performance as a green building. In case of England, HQI tries to evaluate qualitative aspects of residential environment which are the social and economic aspects of evaluation as well as the physical environment. Thus, the system can adjust details according to the changes of time. However, there is a limit in evaluating the deterioration of domestic apartments because of the complexity of measurement in actual application, and difference in housing development method between two countries.

The apartment needs different performance evaluating indicators compared to general buildings to embody an expected residential performance of its social, psychological and economical property as well as its physical property. In fact, comparing a recycling plan of old apartment houses in Germany, Japan and Korea, Germany and Japan considered both physical deterioration and social deterioration as a judging standard of reconstruction while Korea, on the other hand, considered only physical deterioration standard(Safety diagnosis) (Hyun, Taek Soo et al. 2000).

Also, this study examined preceding studies about residential satisfaction and POE for understanding perspectives of residents' demands. In the range of evaluation, to understand characters by composition scale of apartments including units, buildings, complex and location area around the apartment, preceding research examined. Therefore, the deterioration evaluating indicator has to be developed including various properties of housing

environment in three- physical, social and economical- dimensions of evaluation.

3. THE DEVELOPMENT OF DETERIORATION EVALUATING INDICATORS OF APARTMENT

3.1 Conceptual Model of Deterioration Evaluation

It was found that performance evaluation indicators and residential quality indexes have had a common hierarchy structure system through previous studies in Korea and foreign countries. This reflected the system in which people respond to their environment totally and emotionally before analyzing and evaluating the environment as a specific aspect.

In order to make effective decisions about the complicated problem of apartment deterioration evaluation, this study composed evaluating indicators with multi-levelled of hierarchy structure applying the advantages. (Figure1)

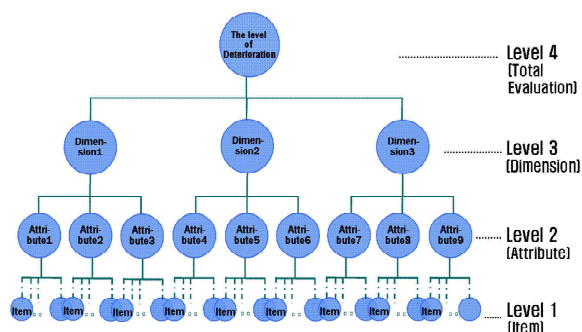


Figure1 Performance evaluating model of hierarchy structure

Hierarchy structure is a method in which related evaluating items are assembled in a level or category and then ranked. All items in lower level become evaluating factors of the category in the upper level. Evaluating models composed of hierarchy structure are advantageous because both summed up results and separate detailed results can be produced (Kim,Sun-Sook et al., 2004, p. 268).

When we carry out performance evaluation of apartment complex on the

basis of the evaluation model, first a performance level is measured by each evaluation item of the lowest level. And its attributes are added up according to characteristics of each item and its dimensions are synthesized according to characteristics of each attribute. If the performance level evaluated as above is evaluated lower than the expected performance level, it is judged to be deteriorated. So it needs regeneration activities. At this time, various regeneration programs can be proposed according to the evaluation results by each evaluating dimension, each evaluating attribute and each evaluating item (Figure2).

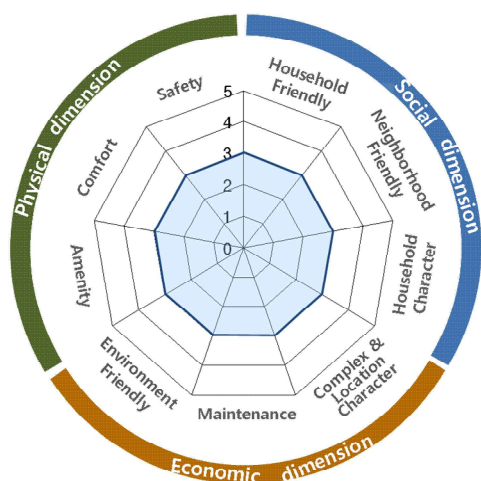


Figure 2 The conceptual model of deterioration evaluating

This study suggested the 5 point ordinal scale measure in performance evaluating criteria for deterioration of apartment. For this 5 point scale mostly has been used in prior researches on the performance evaluating including Japan's CASBEE. In a composition of 5 point ordinal scale, quantitative and qualitative analysis results for the evaluating items is divided 5 levels and 1 point give for the each level. 1 is the minimum and 5 is maximum level.

In this, deterioration of apartment is state of current performance doesn't come up with expected performance, so 3 level of 5 level is established as the expected

performance. Thus, if the evaluation result is higher than 3, the apartment is healthy. If lower than 3, the apartment is in deterioration state by lower performance than standard level and regeneration activities are required. These criteria can evaluate not only general deterioration but also dimensional or attributive evaluation. Also, it is easy to grasp deteriorated attributes or dimensions by providing a radar & bar chart showing evaluation results.

Such evaluating conceptual model could be a useful tool for the regeneration of apartment complexes to make sustainable residential environments. The composition of deteriorating attributes or dimensions on the target apartment complex can suggest proper regeneration activities (Figure3).

For example, since evaluating results of the level of performance of target apartment complex vary based on items, in case of type A, deterioration is progressing in only physical dimension, and so type A is a program that includes regeneration activities for physical dimension. In type B, because deterioration is progressing in physical, social, and economical dimensions, it can be a program type that includes regeneration activities for all 3 dimensions.

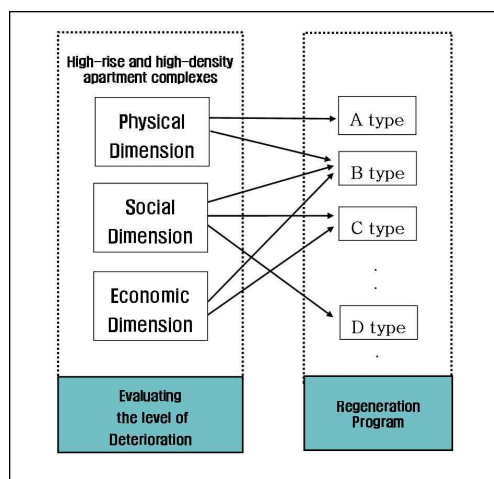


Figure 3 Connection with evaluating model and regeneration program

3.2 Selection of Evaluating Items

Evaluating items used once or more in preceding researches and related literature

were abstracted and made a pool of indicators with total of 488 items which can be used for deterioration evaluation of high-rise apartment complex. These items were combined if the same aspects were repeated or expressed differently. Some expression of items were adjusted to make clear contents of the evaluation of deterioration. Then these items as performance indicator for apartment deteriorating evaluation were categorized into physical, social and economic dimensions (Table3).

In each dimension, evaluating attributes were grasped by sorting based on items similarity. Items of physical dimension were categorized into 3 evaluating attributes: comfort, convenience, and safety. Items of social dimension were categorized into household friendly, neighborhood friendly and household character. Items of economic

dimension were categorized into the complex and location character, maintenance, and environment friendly.

In physical dimension, comfort attribute includes 21 items, convenience includes 10 items, and safety includes 12 items.

In social dimension, household friendly attribute includes 5 items, neighborhood friendly 9 items and household character 4 items.

In economic dimension, complex and location character attribute includes 8 items, maintenance 8 items and environment friendly 3 items.

Performance indicator for deterioration evaluating is composed of 3 dimensions and 9 subsidiaries attributes, which are composed of 80 related items.

4. CONCLUSION

Table 3 Evaluating items of apartment deterioration

Evaluating Dimension	Evaluating Attribute		Evaluating Item	
Physical Dimension	comfort	Environment Performance	thermal environment	. Indoor heating(room temperature control, heating cost) . Heat insulation of the openings
			sound environment	. Heat insulation performance(construction condensation protection)
			light quality	. Level of equipment noise . Sound insulation performance between units(wall, floor)
			air quality	. Indoor sun lighting . Level of indoor daylighting(orientation)
		facilities performance	ventilation condition	. Ventilation condition of kitchen . Ventilation condition of bathroom
			water supply & drainage condition	. Water supply & drainage condition . Electric power & electrical supply condition
	Convenience	complex composition	communication service(telephone, internet)	. Gas & heating pipe condition
			elevator performance	. Planned residential place(including complex size and type) . The building-to-land ratio
			all floor space-to-land ratio	. The all floor space-to-land ratio . Landscape green condition(green space ratio)
	Safety	space composition	room size	. Room size . Optimum level of story height
			room layout	. Room layout . Exclusive area ratio
		route & movement system	garbage disposal condition & facility	. Garbage disposal condition & facility . Accessibility of move & fire truck
Social Dimension	Household Friendly	surrounding safety	road plan in complex (vehicles, pedestrians, entrance, etc.)	. Road plan in complex (vehicles, pedestrians, entrance, etc.)
			prevention level of depletion (construction etc.)	. Prevention level of depletion (construction etc.) . Sink
	Neighborhood Friendly	support	service life	. Service life . Crack(condition of indoor water leakage and crack)
			reinforcing bar & concrete corrosion	. Reinforcing bar & concrete corrosion . Public space finishes condition (apartment outer wall etc.)
			foundation subsidence	. Foundation subsidence . Window frame or balcony rail condition
	Household Character	safety to disaster	resistance level to earthquake (prevention of construction damage & collapse)	. Resistance level to earthquake (prevention of construction damage & collapse)
			resistance level to wind(window solidity for rainstorm)	. Resistance level to wind(window solidity for rainstorm)
	Household Character	surrounding safety	flooding possibility & countermeasure	. Flooding possibility & countermeasure . Fire, fire extinction (fire resistance & refuge facility)
			safety for a traffic accident	. Safety for a traffic accident . Safety for crime
			barrier-free planning(complex/unit)	. Barrier-free planning(complex/unit) . Privacy
Economic Dimension	Complex & Location Character	welfare facilities	capacity of various household(floor plan reflected in Dink, Sink, Tonk and household character)	. Capacity of various household(floor plan reflected in Dink, Sink, Tonk and household character)
			green and rest facilities	. Green and rest facilities . Social welfare facilities
			management facilities	. Management facilities . Play and leisure facilities
	Maintenance	neighborhood participation	identity of neighborhood unit	. Identity of neighborhood unit . Attitude to disorder of neighboring environment
			neighborhood participation	. Neighborhood participation . Community program
			capacity of self-sufficiency(24 hours living place & one-stop facilities)	. Capacity of self-sufficiency(24 hours living place & one-stop facilities)
	Environment Friendly	countermeasure management & service	change of social stratum composition (standard of income and educational attainment/unit size)	. Change of social stratum composition (standard of income and educational attainment/unit size)
			family life cycle(a formative period /a growth period /decline period)	. Family life cycle(a formative period /a growth period /decline period)
			own house ratio	. Own house ratio . Population movement(residence period)
	Environment Friendly	easy of management	sale price(price change)	. Sale price(price change) . Rent (price change)
			remodeling unit ratio	. Remodeling unit ratio
			reputation of apartment complex (name value of construction company, external appearance of apartment, etc.)	. Reputation of apartment complex (name value of construction company, external appearance of apartment, etc.)

Evaluating indicators that can inclusively and practically measure the level of deterioration of apartments in order to regenerate apartments as sustainable residential environment. This study is the first stage of the research developing the overall evaluating indicators based on the conceptual model.

The study grasped the concept of apartment deterioration and proposed the conceptual model of apartment deterioration evaluation by structuralizing it in a hierarchical way, and extracted items of deterioration evaluation indicator through literary review of preceding researches.

The evaluation indicators were identified as total 80 evaluating items with three attributes by each dimension on the basis of three dimensions (Physical, social and economical) in the hierarchical conceptual model.

The measure development stage including weight of deterioration evaluating indicator should be made progress through case studies in the future. And that study needs a plan to collect all opinions including residents as users since residents' attitude can have reality more though most of the preceding researches carried out only a survey of specialists.

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