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HOBEM: High-rise Office Building Evaluation Model

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Abstract
Generally, high-rise building has different character from common buildings in terms of urban, architectural and engineering part. High-rise building which is naturally irreversible with this character requires a great deal of concerns in its planning and execution, and needs synthetic process between related specialty parts. The purpose of this study is on the establishment of evaluation model for high-rise office building, and its subject is as follows. (1) Theoretical consideration for the building evaluation: concept and characteristic of building evaluation, concept and evaluation factors of building performance. (2) Study for evaluation models of office buildings: main issue and current tendencies of office evaluation, office environmental evaluation system by Vischer and REN(The Real Estate Norm) by Jonge & Gray. (3) Establishment of evaluation model for high-rise office building: this study proposed HOBEM as High-rise Office Building Evaluation Model. HOBEM is composed of four parts which are user, client, performance and related facts of building. The each part is subdivided as follows, which are 6 elements of the user part, 9 elements of the client part, 24 elements of the building performance part and 16 elements of the building related part. And also, the characteristic elements of HOBEM are described as follows. First, it is a model utilized for office building planning with the evaluation result by user's point of view. Second, it is a model to include a group of people such as user, client and architect etc. who are related to building and building performance. Third, it is a synthetic evaluation model to use the survey of behavior, site and interview etc. as well as the investigation of basic data and user's satisfaction.

Keywords: High-rise Office Building; Building Evaluation Model; HOBEM

1. Introduction
In general, high-rise office buildings have the characteristics differential from other buildings in terms of city sociology, architectural planning, engineering, etc. In the city sociological aspect, it is required to consider the influence on the existing city structure and peripheral circumstances, city traffic system affected by a large number of users and visitors, city infra-structures related to the high-rise buildings; in the aspect of architectural plan, it should be reviewed of arrangement of vertical spaces and moving system, 3-dimensional connection with the existing city structures, cladding of buildings, formation as a city landmark, and others; and, finally in the engineering aspect, the structural system, machinery and electric system, disaster prevention system, construction method, and others in relation with the limited natural conditions including high gravity weight, earthquake, and wind pressure should be considered from the beginning stage of planning.

This study is to review the high-rise office building evaluation model which would be a tool to give practical help for planning the high-rise office buildings. Therefore, it is to identify the concept and features of the building evaluation and the details of the building performance as an important factor in the building evaluation, through theoretical review on the building evaluation, then to establish the basic direction for making the high-rise office building evaluation model by reviewing the main issues and representative cases and analyzing the features in the architectural planning. Finally, it is to suggest the basic concept and composition of high-rise office building evaluation model, based on such theoretical works.

2. Theoretical Review
2.1 Concept and Features of Building Evaluation
Building evaluation aiming at obtaining the knowledge on the building itself and the using methods is defined as the systematic assessment of building performance against the established objectives and requirements.

According to G. Baird et al.(1996), there are 4 frames for planning the building evaluation classified

by each role as seen in Fig.1, because managing and doing are the basic role in the evaluation and the building-related people is divided into two groups of the providers and users\(^2\).

![Fig. 1. Four role-based frameworks for building evaluation.](image)

1) User-only evaluation, in which user groups manage and do the evaluation, e.g., for operational reasons or to develop more effective use of buildings, or to determine requirements for future construction of leasing.

2) Provider-driven evaluation, in which providers plan and manage the evaluation and draw on use knowledge and experience, e.g., to test the acceptance and usability of a technical solution or product.

3) User-driven evaluation, in which users plan and manage the evaluation and employ provider groups as experts to conduct the evaluation, e.g., to fix physical deficiencies in the building that are affecting its use or the health and well-being of occupants.

4) Provider-only evaluation, in which provider groups manage and do the evaluation, e.g., for technical reasons, or to develop more efficient processes, or as a part of basic research in a research institution.

It means that the evaluators should be pluralistic including not only the users but also the architects, facility managers, equipment specialists, structure specialists, constructors, etc. for overall building evaluation, and the merits therefrom are: 1) Better match of demand and supply; 2) Improved productivity in the office; 3) Minimized maintenance fee; 4) Confidence of decision on the management and design; and 5) High return from the investment in the building and the people.

2.2 Factors of Evaluation on Building Performance

The building performance is a total value as social environment changing continuously and as architectural environment given to meet the needs of human beings. This concept of building performance advocated by John Eberhard(1965) has been a major philosophic and theoretical ground for the building evaluation\(^3\).

The most classical concept on the building performance was advocated by Preiser et al.(1988). They categorized the evaluating factors of building performance into three types, according to the number of evaluators and the standard of performance, the size of space and the demographic characteristics\(^4\).

Today, the evaluation on the building performance is made by the integrated system for overall building facilities, and there have been lots of discussions and attempts relating to the necessity of the method to evaluate all of the objective and subjective building performance. Among others, Loftness et al.(1989) presented the easy-to-handle, but comprehensive, performance standards in dry environment, as an effort to establish the evaluation for all the performances simultaneously\(^5\). The union standards presented by him consist of 6 factors including functional/spatial quality, thermal quality, air quality, acoustic quality, visual quality and building integrity.

Such performance standards are general standards mentioned by Zeisel(1989), and the necessity of comprehensive performance standards has been on the rise since focusing on one or two performances only without considering wide range of performances has resulted in the other performances missed. He also presented the performance standards working specifically to the human senses in such integrated system, which includes physiological, psychological, sociological, economic needs. According to them, given the 'hidden cancers' in today's working and living environments, there needs to be a more redefine definition of physiological comfort, and an additional emphasis on psychological and sociological comfort.

3. Case Study on Office Building Evaluation Model

3.1 Overview

The office building evaluation has been made due to three problems in the working environment, such as health of the workers, interpersonal or environmental relationship and working efficiency (Davis & Szigeti 1986). The office building as the business facility are today's major building type, however, lots of offices provide the workers with reverse-functional inside environment, so it has been the popular target of the studies on building evaluation.

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The discussion about the building evaluation of working facility has started actively since 1960's. F. Herzberg (1966) is the first researcher who used the term "environment" as the factor influencing the working satisfaction and work performance. However, the working environment for him means the context, that is the collection of outer factors faced by the workers individually in performing the duties. These include the salary, position, company policies, managing and working conditions, etc., which is the view that the working satisfaction of the workers could not be produced independently in the environment.

Meanwhile, F. I. Steele (1983) has a different view from Herzberg, who presented 6 characteristics on the interacting relationship between the human beings and the settings, such as refuge and safety, social contacts, symbolic identification, working measure, pleasure and growth, urging that physical environment affects the behaviors of workers.

Contemporary building evaluation is being performed by classifying into 4 main directions as follows:

1) Measuring User Perception: This is to draw the simple psychological status of the users as the outcome, rather than the interaction with the users' attitude and behavior and the environmental features (Harris et al. 1981; BOSTI 1982; Spreekelmeye, 1985). Therefore, practical usefulness appears ambiguously.

2) Meeting Users Needs: Marans et al. (1981) state that the outcomes or indications of success in work environments are occupants' rating of their overall environmental satisfaction, job satisfaction, and worker performance, and that central purpose of evaluation research is to explore such connections between specific environmental attributes and people's perception of them.

3) Applying User Satisfaction: This study is focused on the suggestion of improving factors to solve the users' complaints and building problems. In this point of view, Goodricht (1982) coins the term "the perceived office" to integrate the real aspects of the worker's environment with the way in which he or she perceives them.

4) Incorporating the Context: This is to look beyond the environmental needs of individual workers to the opportunities and constraints of the organization, of which one example is the 'purpose-driven model for building assessment' by Zeisel (1985). That is, the purpose of this system is for the users to be easy to use and to be sensitive to the interest of office managing team, and to need no help in using, in which she considers the core concept of this system as environmental quality. Environmental quality means combination of the environmental factors interacting with the users of environment.

Thus, one question we have hereabout is that the factors and detailed items of this system can fully cover the basic interests in the building performance. The answer thereto depends on if they can be the detailed items of common level in measuring the office environment. However, to conclude, 7 factors of Vischer is not enough to get the universality because the position of facility managers is biasedly emphasized.

3.3 The Real Estate Norm (REN, 1996)

The Real Estate Norm (REN) is a method for evaluating office locations and office buildings which may be combined type of 'applying user satisfaction' and 'incorporating the context' among 4 aforesaid directions. This REN started in Holland in the early of 1990's, by the multinational real estate companies, DTZ Zadelhoff and Jones Lang Wootton, and the project management company, Starke Dickstra. Since these companies faced to the increasing needs for the tools to enable the objective comparison on the office facilities, they became to design a definite and clear method to grade the quality of office buildings.

The basic structure of REN is as follows. REN consists of two headings, such as location and building, and 2 subheadings are under the location including the peripheral circumstances and site, and 3 subheadings are under the building including the general area, working area and facility area. Those 5 subheadings are divided into more specific and detailed items to affect the quality, so total 135 detailed items are considered in the office building evaluation under REN.

REN might enlarge the area of evaluation by including the aspect of location as well as the building itself. However, the basic viewpoint of REN is to reduce the discrepancy between the demander and Vischer belongs to the category of 'applying user satisfaction' of 4 aforesaid directions, which is basically organized by 7 factor-analyzing dimensions and 22 detailed items thereof.

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Therefore, practical usefulness appears ambiguously.


The office environment evaluation system by

11) The evaluation methods similar to REN are STM (Serviceability Tools and Methods) made by ICF in Canada, and BQA(Building Quality Assessment) made by CBPR in New Zealand. For the details of those, see pp. 53-68 of Building Evaluation Techniques. McGraw-Hill by Baird, Gray, Isaacs, Kernohan & Mclndoe (1996)
supplier through exact evaluation on the value of the real estate of office building. Therefore, it is considered that the viewpoint of REN is limited in terms of feedback of the evaluation result to the office building design.

4. Establishment of High-rise Office Building Evaluation Model

4.1 Architectural Planning Characteristics of High-rise Office Building

(1) Block Planning
High-rise office building gives a big effect to the existing city structures and peripheral circumstances due to size and height of the building itself. Therefore, in planning the site layout, the building site and the environmental influences to the adjacent buildings should be considered carefully, together with the particulars for long-term city plan. In particular, since the building-to-land ratio of high-rise office buildings is approximately 30-60% which is relatively wider than other type buildings, it needs the outer space plan considered of the connection with the city structures. In the environmental terms, diversified review is needed on the influence of sunlight to the adjacent buildings, change of air current by building wind, disturbance of electric wave, road congestion by increase of traffic volume, increase of noise, etc.

(2) Plan Planning
① Working Area
The working space is the place in which the users work or have the conferences, spending most of time in the workplace. The working space of high-rise building needs to secure the flexibility of space to adapt the enlargement or reduction of size according to the change of organization, change of spacial structure or change of working environment, etc. Meanwhile, the importance of conference space for in-company communications and cooperative works of teams is increasing.

② Resting Area
The place to alleviate the stress and recharge is needed for doing the creative works. The biggest complaint of the office workers is boring working environment. Particularly in case of high-rise office building, it further needs the plan for appropriate resting place due to inconvenience access to the ground outdoor space.

③ Public Space
In planning the public space, the core plan composed of the elevator, stairway, toilet, etc. is most important. The core system specially have the direct relationship with the plane type of the office, and it is also related directly with the effective area of reference floor, size of building and number of floors, vertical moving system of the users, elevator system, building structure system, utility system, facility maintenance, etc.

(3) Circulation System Planning
High-rise office buildings are required to plan the moving system of vehicles and pedestrians systematically due to busy traffic of visitors as well as tenants. There are many cases that other commercial functions of subsidiary facilities are added to the business functions. In such cases, the access should be separated for each purpose, and circulation of service vehicles should not be mixed with other vehicles. At the part of low floors closely related with the street environment of city, moving lines should be spread by considering the accesses by the pedestrians and vehicles and organic connection of spaces12. Generally at the top floor, the facilities for panoramic views including the observatory, restaurant, etc. are located. In this case, separate access and elevator are planned.

(4) Sectional Planning
The sectional plan is divided into overall sectional plan and detailed sectional plan for each floor, which is required to consider the effective division of overall sectional structure according to the combined use and the relation with the appearance, decision of proper ceiling height, establishment of appropriate pillar span and beam height, relation with air-conditioning and plumbing plan, decision of floor height for IB, etc.

(5) Elevation Planning
The elevation of high-rise building gives decisive influence to the total image and symbolization, and is a critical factor in terms of city scenery. The elevation will receive the combined influence by the technical factors including the structure and facilities, curtain wall system, etc. and the human factors such as locality, tradition, etc., together with the time and spatial aspects existing in the site. In the recent time, climate-friendly elevation types have been appearing with the increasing interest in the nature-friendly environment13.

(6) Disaster Prevention Planning
In case of high-rise building, the distance and time to reach the ground refuge floor are extended, so that the measures for fire is important. Also, as the rescue and fire-fighting activities outside of the building are limited, it is required of total review on the prevention, detection, report, refuge, fire-fighting, rescue, prevention of combustion, etc. In addition, the building structure system, outer wall system, lightning facilities and others should be considered to prepare for the disasters.

4.2 Basic Structure of Model
To perform the building evaluation successfully, a frame of systematic analysis should be established first. HOBEM(High-rise Office Building Evaluation Model) presented in this study is largely composed of 4 parts


as shown in Fig. 2.

![Fig. 2. Basic Structure of HOBEM.](image)

The first one is the user part. The importance of this part is proved by the research on the office building through the users' experience that the knowledge on building performance and method to improve it would be produced, together with more general knowledge on working methods and social behavior of the people influenced by building environment. Whereas, the demographic characteristics such as the age, sex, position, income level, etc. of the users are important factors in finding the satisfaction, preference, behaviors, etc. by classes. The norms for evaluation on the specific setting may vary by classes, depending on the taste, physical features, age, etc. of the users. Also, it needs to find the interrelation of various activities made in the given space by classifying them by types and environments, but the researcher personally needs to conduct the behavioral research on the activities made in physical environments, together with the questionnaire research. This is needed as the progress to prove the voluntariness of questionnaire research, as well as the meaning of supplementary research on the aspects not expressed by the users.

The second one is the owner part. The owners of the office buildings would be included in the providers' group as mentioned by Baird, etc. The important items in this part are the requests of the owners as the providers of the building.

The third one is the building performance part. The building performance is total value of the building. As discussed above, the evaluation factors on the building performance is very different, depending on the purpose, target, scope, etc. of study, however, it may be integrated into 3 types of evaluation factors on the building performance including technical factor, functional factor and behavioral factor, suggested by Preiser et al.(1988), in the viewpoint that HOBEM presented in this study is the user-oriented evaluation system.

Finally, the fourth one is the building-related part composed of physical evaluation targets. The evaluation targets in HOBEM are largely classified into location and building, according to the classification of REN by Jonge and Gray. Since one building consists of multiple settings, it is required to classify by uses, but to consider the overall aspects of the building in evaluation and analysis. It enables to find the partial problems of the building, and which is the most critical problem among them. Table 1 shows the high-rise office building evaluation model established based on the above basic concept.

### 4.3 Composition of HOBEM

1. **User Part**
   
   In HOBEM, the user part is researched by two methods, questionnaire research and behavioral research. The questionnaire research is to get direct responses from the users regarding the environments, and the behavioral research is to find unconscious expression for which the frame is suggested in this study.

   The frame for behavioral research as composed as Table 2 is to analyze the relation between the users' characteristics and their behavioral characteristics for each setting of office buildings, to extract the positive factors and negative factors shown in each setting, and to determine or analyze the compatibleness of various activities.

2. **Owner Part**
   
   Most of building evaluation models have neglected the building and the owner parts. However, all the buildings reflect the requests of the owners. The requests of the owner take the important role in making the decision of designing and implementation of the building, so review of this part should be done for reasonable and accurate evaluation on the building.

   In generally, the requests of the owner are proposed or changed by stages of design, which are provided to the designer in 9 categories such as ① purpose of construction ② building type ③ main function and use ④ quality of building ⑤ size of building ⑥ extension plan ⑦ budget and schedule ⑧ using method of building and ⑨ other requirements

3. **Building Performance Evaluation Factor Part**
   
   In HOBEM, 24 evaluation factors are established, including 6 technical factors, 11 functional factors and 7 behavioral factors.
1) Technical Factors

① Lighting Environment - Level of lightness of the environment in terms of facilities and equipment without living inconvenience or criminal anxiety in the office.

② Acoustic Environment - Level of calmness of the environment in terms of giving no disturbance by noise to the working.

③ Air Environment - Level of pleasantness of the environment in terms of design of ventilation facility and openings without living difficulty due to air pollution in the office.

④ Thermal Environment - Level of warmness and pleasantness in terms of heating and air-conditioning facility and openings without working difficulty due to thermal change of outside while working in the office.

⑤ Hygiene - Level of convenience of cleanliness of the environment in terms of hygienic facilities without living discomfort due to working trouble of facilities, air pollution in the office.

⑥ Workmanship - Level of comfort of the environment in terms of finish work without living trouble in the office.

⑦ Fire Safety - Level of safety of the environment in terms of architectural structure and construction, contingency facilities and refuge plan.

2) Functional Factors

① Accessibility - Level of easiness of access by the user from the outside to the office.

② Space Size - Level of feeling by the worker about the environmental space, including the size of room, width of pathway, ceiling height, low or excessive use of the space.

③ Location of Room - Level of comfortable use due to location of the room arranged in the office.

④ Shape of Room - Level of comfortable use due to shape of the room arranged in the office.

⑤ Room Layout - Level of comfort in use due to room layout in the office.

⑥ Flexibility - Level of efficiency in terms of convertibility, variousness, applicability of the office space.

⑦ Furniture - Level of comfort in terms of type and quantity of the furniture installed in the office space.
Circulation - Level of convenience in use in terms of speed, operation type, number of passenger and cargo elevators in the office building.

IB - Level of efficiency of high-tech facilities installed in the building in relation to direct works in the office building.

View - Visual quality composed of the complex environment around the office building and the physical environment of the building itself to view such complex environment.

Naturalness - Level of experience to contact the nature by the users in the office, including trees, water, soil, outer air.

3) Behavioral Factors
   1) Way-finding - Level of responding to the environment for the user to identify the own location in the office and to find the place at ease.
   2) Territoriality - Appearing in the type of defense to the spatial invasion and privatization as a behavioral type relating to the space occupation by an individual or group in the office.
   3) Social Interaction - Responding behavior for the worker to selectively control the approaches to himself in the office.
   4) Crowding - Level of excessiveness of undesirable social contacts, as the psychological status of the worker feeling in the life with other people in the office.
   5) Image - A behavior responding to the environment through the eyesight of the user including the impression or feeling from the office environment, symbolic feature shown by the office environment.
   6) Aesthetic - Responsive behavior through the eyesight of the user, as the level of pleasantness to the beauty of finishing material, color, interior design of the office.
   7) Security - Level of feeling to be safe against the risk or crime from the outside in the office life, including safety against breakage and theft of the property.

The above-mentioned 25 evaluation factors need to be subdivided for each evaluator group(users' satisfaction/researchers' survey). That's why one evaluation factor is enabled of reasonable and composite analysis by classification of the users' satisfaction and researchers' survey and supplementation thereon.

4) Evaluation Target Part
   The evaluation target in HOBEM is largely divided into location and building, of which the location is subdivided into the site and its surroundings, and the building into the typical floor, lobby, subsidiary facilities.
   1) Location
      It is to evaluate the physical conditions, accessibility, view, natural sense, image, etc. of the environment and the site.
   2) Typical Floor
      It is to evaluate the functional factors of working area, meeting area, resting area, public area and others.
   3) Lobby
      It is to mainly evaluate the functional and behavioral factors of the lobby and the sky lobby which is the elevator transferring space.
   4) Subsidiary Facilities
      It is to evaluate the top floor generally used for the observatory and restaurants and the subsidiary area used for shopping mall, restaurants, grocery shops, etc. It is to also evaluate the functional factors of the underground parking lot, space for other use, utility space, outdoor space and entire building.

5. Conclusion
   This study aimed at establishing the evaluation model of high-rise office building. For the purpose, theoretical review on the building evaluation was made first, and, based thereon, it was analyzed of the concept and characteristics of building evaluation, the concept of building performance, and the evaluation factors of building performance. Next, it was researched on the main issues of office building evaluation and recent various trends, and office environmental evaluation system by Vischer and REN model by Jonge and Gray as the representative examples, through review on the office building evaluation models. Finally, HOBEM as the high-rise office building evaluation model was presented, which is largely composed of 4 parts, those are, user part, owner part, building performance part and building-related part. In detail, the user part is subdivided into 6 factors, the owner part into 9 factors, the building performance part into 24 factors, and the building-related part into 16 factors.

Such characteristics of HOBEM can be explained as follows: First, it is a model to reflect the results of evaluation onto the office planning, as the evaluation in the viewpoint of the user basically. Second, it is a model involved by various concerned people including the user, owner, and designer. Third, it is a total evaluation model using the behavioral research, field inspection, interview as well as the basic data research and the users' satisfaction research.

Meanwhile, the future tasks under this study would be classified into the inner part and outer part of the model, of which the inner part is required of the work to involve all the people relating to the building and its performance by adding the constructor part, and to enhance the reliability of and sophisticate the model by increasing the importance of evaluation factors and the weighed value, through practical building evaluation, and the outer part is required of enlarging and developing the model by considering the trend of times that the use of high-rise building is getting mixed.

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