

Indicator of Facility Performance Evaluation (FPE) for Educational Facilities of BTL Projects

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Abstract Build-Transfer-Lease (BTL) was introduced to the domestic construction market in 2005. Now, seven years later, the BTL model is most active for educational facilities. In 2011, 93 educational facility projects entered the maintenance stage. Considering the characteristics of today's BTL projects for educational facilities, the main issues are the initial performance and maintenance of educational facilities and the service-providing status for the 20-year operational management period, in relation to providing safety and convenience to students, the facility users. Seeking a solution, local education offices and departments in charge of BTL under the Ministry of Education, Science, and Technology have been exploring various methods of evaluating operational maintenance performance from various perspectives. For educational facility BTL projects, however, the appropriateness of initial operation performance evaluation, rather than considering the 20-year operational management period, is controversial in regards to sustainability. On this account, performance evaluation items in four areas—operational maintenance evaluation, facility performance status evaluation, maintenance subject evaluation, and sustainable change response evaluation—should be extracted. An indicator of facility performance evaluation is presented in this study through an AHP survey targeting experts, as part of establishing an operation performance evaluation system for educational facility BTL projects.

Keywords : Indicator of Facility Performance Evaluation, Operation Performance, BTL Project, Educational Facility

1. INTRODUCTION

Since the introduction of BTL to the domestic construction market, BTL projects, now facing their seventh year of execution, have been most active in the area of educational facilities, and about 93 educational facility projects reached the operational maintenance state as of the end of 2010. Furthermore, as projects for remodeling decrepit private school facilities (in addition to elementary and middle schools) have been included in the scope

of BTL projects since the end of 2010, the scale of the project is expected to increase. Considering the number of educational facility BTL projects in process, a study of sustainability in regards to operational maintenance is required.

Moreover, taking the specialized nature of educational facilities into account, the main issues are the initial performance and maintenance of educational facilities and the service-providing status in the 20-year operational management period, in relation to providing safety and convenience to students, who are the facility users. To this end, local education offices and departments in charge of BTL under the Ministry of Education, Science, and Technology have attempted various methods of evaluating operational maintenance performance. However, controversy has consistently arisen concerning the appropriateness of initial operation performance evaluation in regards to the sustainability of facilities.

For this reason, indicators of facility performance evaluation that consider sustainability will be presented in this study, as a part of establishing an operation performance evaluation system for educational facility BTL projects.

To develop an indicator of facility performance evaluation, domestic educational facility indicators and performance evaluation methods were considered in this study; on the basis of these, sustainable facility performance evaluation items were derived. In addition, performance indicators of existing BTL

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projects and educational facilities were analyzed, and sustainability was considered in order to establish the indicator of facility performance evaluation. To do this, key items including operational maintenance, maintenance subject evaluation, and environmental sustainability were extracted, and an AHP survey targeting experts was conducted. The sustainable indicator of facility performance evaluation is the result of considering the overall project processes and project follow-up of BTL projects, and it has the purpose of building qualitative and quantitative facility performance evaluation items and indicators in order to introduce an efficient operation performance evaluation system.

2. THEORETICAL CONSIDERATIONS

2.1 Current educational facility indicator¹

(1) Definition of education indicator

The education indicator in Korea is defined in Table 1 below, through the relationship of education statistics and the education indicator. Here, indicators are defined as figures or signs representing phenomenon or a specific idea.

Table 1. Definition of educational indicator

Type	Description
Education statistics	Represent a specific education phenomenon as a single figure (factorial statistics)
Education indicator	Represent two or more factorial statistics as a relation of arithmetic rules
	Statistical value representing various indicators that indicate a specific education phenomenon as a combination of consistent functional relations

(2) OECD education indicator

OECD education indicators (Table 2) are composed of education organization output and learning effects; financial/human resources invested in education; access to, participation in, and development of education; learning environment; and school organization. Each item includes 5~10 detailed indicators. This indicator is limited to education, but it includes no facility indicator corresponding to the educational environment.

(3) Korea international education indicator

The Korean international education indicator is composed of educational investment and output as the financial resources, teaching environment, international human resources, education output, performance, and economic effects (seven items), which are limited by education quality. Some items reflecting the education facility environment are included in different items, such as the teaching environment.

2.2 Consideration of facility performance evaluation²

(1) Facility performance³ evaluation

As it mentioned at table 1, there are few definitions of facility performance in Korea educational development institute (KEDI). In this study, we defined the concept of facility performance as “assessment serviced from schools and educational facilities to students and users and their satisfaction for the quality of services in whole type of new construction projects.”

Facility performance evaluation, which focuses on quality among the facility management (hereafter “FM”) goals of quality, finance, and supply, provides the data that it determines construction status and it is one of the methods for systematic inspection and management. It is divided in various ways by facility performance evaluators, and it includes the POE (Post Occupancy Evaluation) method that is based on the architecture user’s satisfaction and the ORBIT (Office Research into Building and Information Technology) method that combines user satisfaction and expert building evaluation.

Table 2. OECD education indicator system

Area	Indicator
Education organization output and learning effect	1. Learning level for adults
	2. Secondary education completion ratio and higher education entrance ratio
	3. Higher education completion ratio
	4. Higher education completion and termination ratio
	5. Achievement level in science for 15-year-old students
	6. Parents’ awareness level related to school courses and science study
	7. Parents’ social and economic status and higher education participation ratio
	8. Relationship between labor market participation and education level
	9. Economic benefit of education
	10. Attraction of educational investment
Financial / human resources invested in education	1. Education cost per student
	2. Education cost for education organization compared to DP(Draft Proposal)
	3. Public and private investment scale for education organization
	4. Total education cost
	5. Scale of education spending and education subsidies for higher education organization students
	6. Income and expenses of education
	7. Efficiency of resources used for education
Access to, participation in, and development of education	1. Participation ratio of elderly people in occupational education programs
	2. School attendance ratio
	3. Studying abroad, and countries for overseas study
	4. Success rate in the transition from study to occupation
	5. Rate of adult participation in educational training during employment
Learning environment and school organization	1. Class hours for each level of school
	2. Number of students per teacher and per class
	3. Teachers’ pay level
	4. Teachers’ class hours
	5. Evaluation measuring method used in the education system
	6. Decision-making level in the education system

¹ Tae-Keun Park et al., a study on establishment of the management outcome assessment system in BTL business for a public educational facility using facility performance indicator, Mokwon University, 2011.

² Facility management guide book, Japan FM promotion communication council (edition) Korea Facility Management academy (translation), 1998

³ The author defined the concept of facility performance directly and additionally organized the facility condition assessment and the sustainable change response assessment based on the existing management outcome assessment.

(2) Required conditions in facility performance

Regarding the aspects of required conditions in facility performance of FM, physical performance items such as size, power, and air conditioning capacity, the number of elevators or their frequency of operation, maintenance costs, and operational costs and performance values combined with many conditions, such as the psychological and conscious satisfaction of facility users or social, local, and environmental functions, are evaluated. In addition, the relationships between various costs or service indicators need to be analyzed from the organization's point of view, and the person in charge of application needs to conduct a performance evaluation in consideration of the relationships among such aspects of facility performance.

(3) Comparison with facility performance evaluations

Table 3. Comparison with facility performance evaluations

Type	Description
WHO report	-“Base of Healthy Residential Environment” report published by the residential sanitation committee of the WHO (World Health Organization) -Items: safety, health, convenience, pleasantness (four items)
Pleasantness /health	-Pleasantness: It is often said that pleasantness “can be recognized but is hard to define.” It does not simply refer to one characteristic but to the synthetic of multiple values -Health: In the chart established when the WHO was organized this is referred to as not merely freedom from disease or disability but also physical, mental, and social well-being.
(Japan) facility performance evaluation	-Evaluation subject: A checklist with which an overall evaluation is made, with a sum of scores determined by researchers in universities for each item -Stabilization: Performance evaluation stabilized through discussions in architecture magazines or papers about the performance itself or the difference between performance and design and about the purpose of performance evaluation
Main target	-Site, including the building (facility site conditions, type of ownership, lease and rental conditions, operation methods, etc.) -Building facility (power, cabling, care for the disabled, energy-saving plan, disaster prevention, safety, etc.) -Indoor environment (light, sound, plants, art, etc.) -Space (area allocation, etc.) -Workplace (recommended workplace status, layout style) -Furniture/fixtures (furniture, fixtures, partitions, etc.)

3. DERIVING AND VERIFYING FACILITY PERFORMANCE EVALUATION ITEMS

3.1 Deriving performance evaluation items (plan)

In deriving facility performance evaluation items over two

phase, the first items were derived based on the evaluation criteria of requirements and on key effect factors extracted from the basic research process for current BTL projects.

- Operation plan and practice evaluation: proper activity practice status, service level, management level, etc. according to operation plan
- Operation status evaluation: indicating through performance and status evaluation for facility maintenance activity, key facilities and plants, and status evaluation
- Process evaluation: determine activity practice status according to the job manual and the acceptability of critical activities
- Satisfaction evaluation between subjects: qualitative evaluation of subjective opinions, such as mutual satisfaction between user and manager and satisfaction with the action taken in regards to operational management
- Task achievement performance evaluation: evaluating, monitoring, and inspecting the performance of critical tasks generated by the operational management process
- Profile management and utilization evaluation: utilization of the results of existing activity practices, profile information management, etc.

The second deriving phase introduces sustainability and the ability to respond to change; some items were modified and complemented, but the existing first items were maintained to the extent possible. Operation/maintenance evaluation and maintenance subject evaluation are subdivided and matched with existing operation performance evaluation items, and connectivity with the rapidly changing educational environment is considered by adding facility performance evaluation and sustainable change response evaluation.

- Operation and maintenance evaluation : plan, practice and evaluation of operation/maintenance
- Facility performance/status evaluation: key structure unit/finishing status, facility performance of critical facilities by work type, evaluation of the environment cleanliness, etc.
- Maintenance subject evaluation: satisfaction evaluation by maintenance subject for facility users, authorities in charge, and the operational company.
- Sustainable change response evaluation: evaluation of the ability to respond to the rapidly changing education environment

Considering the characteristics of the public educational facility BTL project, problems related to facility performance/status evaluation resulting from physical deterioration that requires measures beyond consistent operational maintenance activities will inevitably occur after 10 years. Therefore, as shown in the figure, the availability of the facility after the BTL project period needs to be considered, and this usefulness should be applied to the facility performance/status evaluation.

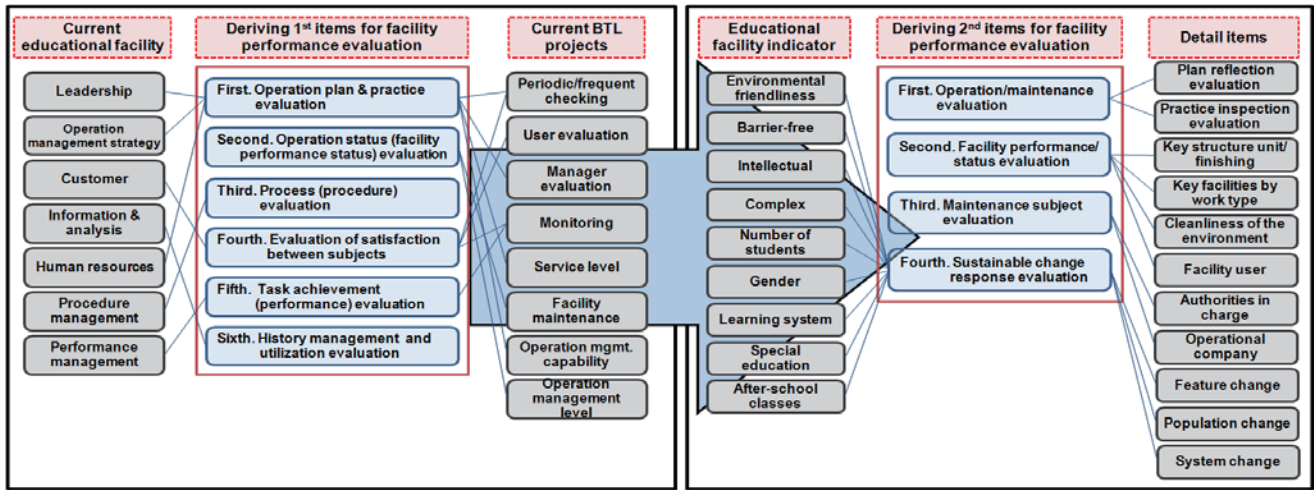


Figure 1. Facility performance evaluation items in BTL projects: extraction of first and second times

3.2 Deriving detailed items for facility performance evaluation

For facility performance evaluation items, step 1 was divided into four items: operation/maintenance evaluation, facility performance/status evaluation, maintenance subject evaluation, and sustainable change response evaluation. For each evaluation item, detailed evaluation factors were composed for steps 2~4.

(1) Operational maintenance evaluation

Operation/maintenance evaluation can be divided into evaluation of how the plan is reflected and practical inspection and evaluation; the evaluation of how the plan is reflected, according to the evaluation factors, is divided into an operation management plan and a maintenance plan. Practical inspection and evaluation is divided into operation/maintenance practices and inspection and evaluation. Detailed evaluation factors are presented in Table 4.

Table 4. Detailed factors of operational maintenance evaluation

Evaluation	Evaluation factor	Detailed evaluation factors
Plan reflection evaluation	Operation management plan	Operational management practice capability
		Operational cost-saving plan
		Integrated management plan
		Operational management monitoring plan
		Safety and disaster prevention plan
		Cleaning and environmental sanitation plan
		Operational manager manpower plan
	Maintenance plan	Maintenance practice capability
		Operational cost-saving plan
		Integrated facility management plan(in BAS)
		Maintenance plan (including the latest construction methods and facility devices)
		Maintenance monitoring plan
		Facility safety plan
		Appropriateness of Value engineering(VE) and LCC(Life Cycle Cost) analysis

Table 4. Detailed factors of operational maintenance evaluation (Continued)

Evaluation	Evaluation factor	Detailed evaluation factors
Inspection and evaluation practices	Operation/maintenance practices	Task fulfillment status compared to operational maintenance plan
		Suitability of managing staff allocation
		Daily activity record and its correctness
		Task fulfillment status compared to monthly/quarterly report
	Operation/maintenance inspection and evaluation	Actions taken for the matters pointed out
		Task fulfillment status compared to operation/maintenance plan
		Performance evaluation check and inspection
		Performance evaluation assessment

(2) Facility performance/status evaluation

This is an evaluation factor that involves an inspection of the facility status of key structure units and finishing states in a building and of critical facilities for each work type, including mechanical facilities, communication/ electric systems, and firefighting facilities. Detailed evaluation factors are presented in Table 5.

(3) Maintenance subject evaluation

Prevention and follow-up for facility and environment are the same evaluation factors in satisfaction evaluation of the maintenance subjects of the facility user, the authorities in charge, and the operating company. In particular, the authorities in charge present an evaluation action item that allows action to be taken after the evaluation inspection of the facility user and the operating company.

Table 5. Detailed factors for facility performance/status evaluation

Evaluation	Evaluation factor	Detailed evaluation factors
Key structural finishing	Structure	Status of main internal structure units 1) ceiling 2) floor 3) wall 4) stairs
		Status of main external structure units 1) rooftop 2) outer wall 3) fence

Table 5. Detailed factors for facility performance/status evaluation
(Continued)

Evaluation	Evaluation factor	Detailed evaluation factors	
Key structural finishing	Finishing	Status of internal finishing materials mgt. 1) ceiling 2) floor 3) wall 4) windows 5) stairs	
		Status of exterior finishing materials mgt. 1) rooftop 2) outer wall 3) floor 4) windows 5) stairs	
		Additional facilities mgt. 1) fitness equipment (facilities) 2) various work structures	
Key facility by work type	Mechanical facility	Status of elevator and dump water facility mgt.	
		Proper role of heating insulation	
		Status of organization according to usage purpose 1) mechanical room 2) electric room 3) broadcasting room	
		Noise, vibration, and operational status of equipment 1) air blower 2) pump 3) freezer 4) air conditioner (rotary equipment) 5) piping 6) ducts	
		Control setting and actual status of diverse control equipment, manager's understanding of control systems	
		Management status according to regulations related to the gas facility	
	Electric/communication system	Electric/communication system	Normal function for every switch, acceptability of room illumination with fluorescent lamps
			Usage and maintenance status of computer network and internet within the school
			Noise, vibration, and operational status of equipment (all kinds of equipment in the electric room)
			Establishment of a management plan for the emergency generator, periodic testing Power, cabling, care for the disabled, energy-saving plan, disaster prevention, safety
			Acceptability of fire management plan Manager's awareness of details
			Management status according to legal regulations related to safety management
Firefighting facility	Firefighting facility	Status of disaster prevention facilities (fire signal receiving board, firefighting facility, emergency light for shelter)	
		Operational status of firefighting facilities (self detection, warning alarm, fireplug, water spray, connective watering, etc.)	
		Cleaning status 1) toilet 2) floor 3) wall body	
		Cleaning status 1) entrance 2) corridor 3) stairs	
Cleaning and environmental sanitation	Cleaning	Cleaning status 1) special classroom 2) management room 3) other rooms	
		Cleaning status 1) equipment 2) piping 3) ducts (water leakage, air leakage)	
		Cleaning status 1) rooftop 2) drainage hole 3) playground drain way	
		Cleaning status 1) playground 2) outdoor space	
		Cleaning status 1) outer wall 2) external windows and doors	
		Cleaning and management status 1) dumping ground	

Sanitation	Sanitation	Status of the implementation of preventive measures (sterilization, killing insects and rats) required by disease control organizations, authorities in charge, or the school Implementation status of cleaning and sterilization according to the work plan
	Disaster prevention	Safety inspection and disaster prevention plan 1) mechanical facility 2) electricity/communication 3) fire extinguishing facility
	Safety	Facility monitoring/facility monitoring by work type (IBS, etc.)/monitoring by bundling schools Negligence related to risk factors at facilities near the school

Table 6. Detailed factors for maintenance subject evaluation

Evaluation	Evaluation factor	Detailed evaluation factors
Facility user	Prevention: facility	Facility management suitable for an educational environment 1) buildings, structures, attachments
		Availability of indoor facilities
		Facility maintenance
	Prevention: environment	Facility manager's training status
		Environment management suitable for an educational environment 1) temperature 2) illumination 3) sanitation (cleaning status) 4) water supply (water supply, warm water, drainage) 5) power 6) gas
		Inspection and quick service response
Follow-up	Satisfaction with the receipt and processing of reports of inconvenience	
	Quick replacement	
	When abnormal function is reported.	
Authorities in charge	Prevention: facility	Facility management suitable for an educational environment 1) buildings, structures, attachments
		Availability of indoor facilities
		Facility maintenance
	Prevention: environment	Facility manager's training status
		Activity report
		Plan for the provision of other services
Corrective maintenance	Reflection of cultural features	
	Plan to satisfy social functions	
	Plan to satisfy user demand	
Operational company	Evaluation action	User convenience and safety
		Inconvenience reporting and record
		Action taken after the evaluation and inspection of facility user and operating company
	Prevention: facility	Facility management suitable for an educational environment 1) buildings, structures, attachments
		Availability of indoor facilities
		Facility maintenance
Prevention: environment	Facility manager's training status	
	Activity report	
	Services provided, method, practicing plan	
Prevention: environment	Action to reduce energy costs in building (Proper lighting, water leakage, etc.)	
	Environmental sanitation and cleaning plan	

Table 6. Detailed factors for maintenance subject evaluation (Continued)

Evaluation	Evaluation factor	Detailed evaluation factors
Operational company	Prevention: environment	Environmental management suitable for an educational environment 1) temperature 2) illumination 3) sanitation (cleaning status) 4) water supply (water supply, warm water, drainage) 5) power 6) gas
		Monitoring implementation plan
	Prevention: safety management	Attire and attitude of security personnel, outsider access control after school, and proper school management during holidays
		Practicing given job regulations, including lock system check and patrol
Corrective maintenance	Appropriate action in the event of power failure and water cut-off (secure emergency generator, water supply, etc.) Process of inconvenience reporting and record	

(4) Sustainable change response evaluation

In the sustainable change response evaluation, evaluation factors reflect the perspective of long-term operational maintenance.

Table 7. Detailed factors for sustainable change response evaluation

Evaluation	Evaluation factor	Detailed evaluation factors
Feature change	Environmental friendliness	Status of renewable energy utilization
		Eco-friendly environment (Temperature, humidity, light, water, etc.)
	Barrier-free	Utilization ratio compared to the design
		Consider availability
	Intelligence	Ubiquitous education environment
		Introduce building mgmt. automation system Automate school administration
	Complex	Space shared with local residents (Parking lot, playground, etc.)
		Provide complex facilities, etc.
Population change	Number of students	Room allocation according to declining population
		Change and utilization of other facilities
		Utilize special classrooms, etc.
Gender	Change room allocation (Toilet, women's lounge, etc.)	
System change	Learning system	Training course change (Seventh training course, etc.)
		Teaching method change (Ubiquitous mode, electronic materials, etc.)
	Special education	Facility management for the disabled (Ramps, etc.)
		Relaxation and welfare facilities Special programs, etc.
	After-school classes	Supplement special classrooms Arrange places for special training (English towns, etc.)

For feature changes, approaches not only from existing ubiquitous technology development and complex facilities but also from the aspects of eco-friendliness, renewable energy utilization, and energy conservation are attempted, and characteristics of

users are considered in terms of achieving a barrier-free structure. In addition, national demographic factors such as the low birth rate are considered. Factors for responding to school environment changes, including training course changes, special education, and after-school classes, are included.

4. DEVELOP A SUSTAINABLE INDICATOR FOR FACILITY PERFORMANCE EVALUATION

With the derived contents from the detailed items of facility performance evaluation presented above, weights of diverse facility performance evaluation factors were analyzed using the AHP (Analytic Hierarchy Process) method, and the indicator of facility performance evaluation was presented in order to eventually develop an operation performance evaluation system.

As a part of the operation performance evaluation system for current educational facility BTL projects, the accurate analysis of performance evaluation items in operation and maintenance should be a precondition for evaluating the acceptability of facility performance evaluation items and for preparing indicators. Accordingly, an attempt has been made to derive factors that affect operational maintenance performance evaluation and to analyze cause-and-effect relationships of individual factors by constructing a facility performance evaluation model.

4.1 AHP survey overview and analysis

(1) Overview of AHP expert survey and analysis

The AHP expert survey was conducted during two weeks, from September 20th to October 1st of 2010, via email. The survey targeted 30 people—authorities in charge, project participants (operational companies), and project evaluation members (professors, etc.) experienced in education facility BTL project operation and maintenance and performance evaluation were selected in advance to form a group of experts. In addition, detailed items were modified based on the results of extracting facility performance items for an operation performance evaluation based on the expert opinions given in this survey

- Survey overview

Table 8. AHP survey overview

Type	Evaluation items
Objective	Derive facility performance indicator through acceptability and weight evaluation for the operation performance evaluation item of the education facility BTL project
Targets	Professors carrying out BTL-related research, individuals and experts who have participated in the BTL project, and hands-on work from the Korea Educational Development Institute across the country
Method	Survey distribution and collection through email
Period	Questionnaire distribution: Sep. 20 th , 2010 to Oct. 1 st , 2010 Questionnaire analysis: Oct. 11 th , 2010 to Oct. 25 th , 2010 (two weeks + two weeks)
Return ratio	Collected 26 copies of a total of 30 copies (87% collection ratio, 25 copies analyzed)

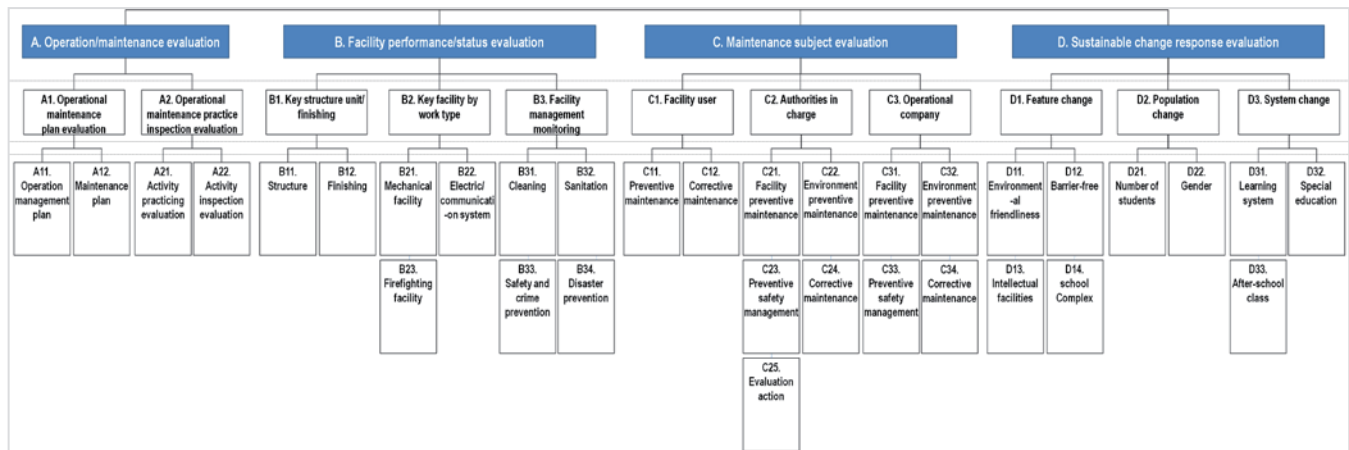


Figure 2. a AHP three-step hierarchical structure for the indicator of facility performance evaluation

Furthermore, survey request and questionnaire collection were conducted with 30 respondents, including experts who participated in the survey. Of 26 collected questionnaires, 25 were analyzed; that questionnaire was excluded⁴ on account of the consistency of the responses.

(2) AHP hierarchical structure setting

To develop the indicator of facility performance evaluation, a critical item in the operation performance evaluation system of the educational facility BTL project, the AHP analysis method was utilized. In addition, a hierarchy evaluation model for developing a sustainable indicator of facility performance evaluation was made and is displayed in the diagram.

The goal of evaluation is to derive the optimal items and indicators in order to determine the indicator of facility performance evaluation and operation performance evaluation items - that is, the factors in step 1 are divided into the following four items: operation/maintenance evaluation, facility performance/status evaluation, maintenance subject evaluation, and sustainable change response evaluation. Completion of the model was conducted through a computer program; Expert Choice 11 (EC 11), which was developed with the current AHP analysis tool, was used.

The hierarchical structure for the indicator of facility performance evaluation (operation performance evaluation item) in steps 1~3 of the educational facility BTL project is presented in Figure 2.

4.2 Weighting analysis for each hierarchy

Weights for each item were calculated by utilizing the AHP method, and the geometric average method composed of a single individual comparison matrix was used; in this method, the geometric averages of evaluation values from all evaluators are calculated and merged for each element in an individual comparison matrix prepared by the evaluator, and this is taken as another element.⁵ In addition, indicator values were calculated

based on a total score of 1,000, with a calculation formula of corresponding weights \times total score.

(1) Step 1

By analyzing evaluation factors from the expert group through the AHP survey, the following weights were calculated in step 1. The corresponding weights were allocated.

- A. Operation/maintenance evaluation: 0.312
- B. Facility performance/status evaluation: 0.475
- C. Maintenance subject evaluation: 0.115
- D. Sustainable change response evaluation: 0.098

(2) Step 2

Through analysis of the weights of facility performance evaluation factors in step 2, a practice inspection evaluation item was calculated with a higher weight than that of the plan evaluation in A. operation/maintenance evaluation; weights were calculated for key structure units and finishing in B. facility performance/status evaluation.

The weight of the operational company was calculated to be very low in C. maintenance subject evaluation, which may indicate that awareness of the importance of the operational company was insufficient. Moreover, a lower weight was allocated to D. sustainable change response evaluation than to other items, which may indicate that changes of the evaluation system were not adequate in relation to performance requirements.

(3) Step 3

In the analysis of the weights of facility performance evaluation in step 3, activity inspection and evaluation (0.124), key structure (0.119), activity practice evaluation (0.095), and key finishing (0.095) exhibit high weights; many items in maintenance subject evaluation and sustainable change response evaluation exhibit low weights.

⁴ In the weight calculation, if the consistency indicator (CI) is 0.1 or more or the inconsistency ratio (CR) is 10% or less, the respondent's survey result is considered unacceptable and is excluded from the calculation.

⁵ There are three possible approaches to merging evaluation values from multiple evaluators in the AHP method when the reciprocal feature is required. Because a change may occasionally occur between final results, the

geometric averaging method that most accurately maintains the AHP method was used. -The geometric average method (Aczel & Saaty, 1983), which keeps the reciprocal feature in a matrix, obtains merged weights through numerical averaging with calculated weights and through geometrical averaging with calculated weights.

Table 9. Facility performance indicator weighting analysis results

Step 1	Weight	Step 2	Weight	Step 3 - Evaluation factor	Weight	Indicator value
A. Operation/maintenance evaluation	0.312	A-1. Plan (reflection) evaluation	0.093	A-1-1. Operation management plan	0.032	32
				A-1-2. Maintenance plan	0.061	61
		A-2. Practice inspection and evaluation	0.219	A-2-1. Activity practice evaluation	0.095	95
				A-2-2. Activity inspection and evaluation	0.124	124
B. Facility performance/status evaluation	0.475	B-1. Key structural unit/finishing	0.214	B-1-1. Structure	0.119	119
				B-1-2. Finishing	0.095	95
		B-2. Key facility by work type	0.168	B-2-1. Mechanical facility	0.059	59
				B-2-2. Electric/communication system	0.037	37
				B-2-3. Firefighting facility	0.072	72
		B-3. Facility management monitoring	0.093	B-3-1. Cleaning	0.006	6
				B-3-2. Sanitation	0.017	17
				B-3-3. Safety and crime prevention	0.028	28
				B-3-4. Disaster prevention	0.042	42
		C. Maintenance subject evaluation	0.115	C-1. Facility user	0.061	C-1-1. Preventive maintenance
C-1-2. Corrective maintenance	0.020					20
C-2. Authorities in charge	0.043			C-2-1. Facility preventive maintenance	0.009	9
				C-2-2. Environment preventive maintenance	0.017	17
				C-2-3. Preventive safety management	0.009	9
				C-2-4. Corrective maintenance	0.002	2
				C-2-5. Evaluation action	0.006	6
C-3. Operation company	0.011			C-3-1. Facility preventive maintenance	0.002	2
				C-3-2. Environment preventive maintenance	0.005	5
				C-3-3. Preventive safety management	0.003	3
D. Sustainable change response evaluation	0.098	D-1. Feature change	0.045	D-1-1. Environmental friendliness	0.020	20
				D-1-2. Barrier-free	0.012	12
				D-1-3. Intelligent facility	0.005	5
				D-1-4. School complex	0.008	8
		D-2. Population change	0.031	D-2-1. Number of students	0.019	19
				D-2-2. Gender	0.012	12
		D-3. System change	0.022	D-3-1. Learning system	0.011	11
				D-3-2. Special education	0.007	7
				D-3-3. After-school classes	0.004	4
		Sum of facility performance indicators (average of 25 indicators)				

4.3 Weighting analysis final result

- Quantification of facility performance indicators

The indicator of facility performance evaluation for developing the operation performance evaluation system for an education facility BTL project is shown in Table 9. A more practical operation performance evaluation can be expected if this result is applied as evaluation criteria for operation performance evaluation.

4.4 Deriving the priority of operation performance through the facility performance evaluation model

This study attempted to derive operation performance priority for an educational facility BTL project by introducing facility performance indicators that consider sustainability in the operation performance evaluation stage. This formula is an evaluation model for the indicator of facility performance evaluation and suggests a priority-deriving formula.

$$BTLPEI_f = f(A_i, A_j, A_k, A_l \dots)$$

$$BTLPEI_i = (OMA_i + PCA_i + OMUA_i + SCA_i)$$

Where BTLPEI⁶ is related to

- A_i: Alternative Project i
- OMA_i: Operation/Maintenance Analysis of Indicator): operation/maintenance evaluation result value
- PCA_i: (Performance/Condition Analysis of Indicator): facility performance/status evaluation result value
- OMUA_i: (Operation/Maintenance User Analysis of Indicator): maintenance subject evaluation result value
- SCA_i: (Sustainable Correspondence Analysis of Indicator): sustainable change response evaluation result value

In the weights and priority evaluation model derived earlier, while scoring standardization needs to be applied through the database(DB) of each unit project, because standard indicators for evaluation by the facility project units of BTL projects were different, this processing was considered outside of the scope of this study owing to insufficient data.

⁶ The Priority order of Performance Evaluation Indicator in BTL Projects

5. PILOT TEST TO VERIFY INDICATOR OF THE FACILITY PERFORMANCE EVALUATION

Pilot tests were conducted on two projects that had been operated and maintained for five years. The results indicated that, for facility conditions among the four sub indicator items, both projects showed lower scores than had been shown in existing performance evaluations.

Table 10. Results of pilot tests conducted on two facility projects

Type	K elementary School	D elementary/middle Schools
existing performance evaluation systems	920	890
	+High service quality and user satisfaction +Appropriate maintenance was conducted +Few complaints(based on a full score of 1000 points)	
New performance evaluation systems	887	794
	Facility condition indicator and a high score were given in satisfaction evaluation	No facility condition indicator and sustainability at all
	+Facility condition indicators are somewhat low +Sustainability has not been sufficiently considered +For operating company evaluation, satisfaction with works is high (Consciousness is somewhat insufficient) +Since operating funds were insufficient, these schools were concerned about facility conditions after the eventual transfer of control.	

In table 10, since services are maintained at a certain level, scores at a certain level were received in existing performance evaluations. However, somewhat lower scores were received in the this facility performance evaluations that applied this indicator to consider facility conditions in comparison with the numbers of elapsed years. Efforts to respond to changes in school facilities were not considered at all, and sustainability-related issues were considered as being outside the contracts for which schools should be responsible.

Pilot tests were conducted on the performance evaluation indicator. Based on the results, it was found that in most of educational facility in BTL projects, educational facilities cared about the service to be provided under contracts made at the beginning of projects rather than the management of facility conditions, and emphasized only the role of operators and managers before the transfer of control.

Since the extent of performance in comparison with plans and the evaluation of stakeholder satisfaction were similar to the existing indicator, the applicability of the new indicator was judged to be sufficient. However, some opinions held that since facility condition evaluation may involve different subjective views, experts in condition evaluation should be cultivated. The need for detailed plans to use this facility condition evaluation indicator and plans to apply this facility condition evaluation indicator to existing operation performance evaluation systems was apparent.

6. CONCLUSION

Educational facility BTL projects facing their fifth year of operation and maintenance have been evaluated in regards to operation performance based on the performance requirements

presented in the negotiation process. However, considering the sustainability of educational facilities after operation and maintenance periods of 20 years or more, persons in charge of BTL projects in the education office, as well as educational facility managers, are demanding the introduction of quantitative standards for qualitative items—such as facility status and performance, inspection items, and indicators—along with management that is acceptable for the requirement level. In addition, although various evaluations are conducted for operation and maintenance plans in the project selection stage, problems caused by service quality performance-oriented evaluation are expected in the operation performance evaluation stage.

For this reason, performance evaluation items and indicators in four areas, operational maintenance evaluation, facility performance status evaluation, maintenance subject evaluation, and sustainable change response evaluation, were developed as part of the establishment of an operation performance evaluation system in the educational facility. Contrary to expectations, facility performance status evaluation took a higher weight than operational maintenance evaluation or maintenance subject evaluation. The lowest weights were found in sustainable change response evaluation, despite the fact that the BTL project has been underway for more than 20 years. This is because the sustainability of educational facilities must be considered, but predicting the related changes is difficult.

Moreover, an evaluation model for the indicator of facility performance evaluation presented in 4.4 is suggested to extract factors that influence the operation performance evaluation result and to specify the relationship between factors. Utilizing this weighting analysis of evaluation factors in operation performance evaluation results enables an improvement in the priority selection method, where facility status and change response items in conformance with existing performance requirements are reflected for operation of the performance system.

The utilization plan for the facility performance indicator, from the results of this study, was suggested as follows.

- First, it was considered that more work-oriented management outcome assessment could be expected by utilizing quantified contents of the facility performance indicator reflected in a summary of the existing outcome assessment as an assessment standard for the management outcome assessment.
- Second, this study suggested the introduction of the facility performance indicator at the maintenance VE stage to maintain the level of maintenance management at the optimal demand level, as much as the performance of the facility was reduced.
- Third, this performance evaluation indicator would be used at the time that a business performer transferred the facility to the competent authorities after 20 years of SPC's management.

The indicator of facility performance evaluation suggested in this paper should be taken as an initial step in developing the operation performance evaluation system of education facility BTL projects. Additional studies are required in regards to introducing the maintenance VE system for future operation and maintenance system construction or educational facility BTL projects.

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