

Abstract**A Study on the Development of Fire Safety Evaluation Model for School Buildings**

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This study presented 『the development of a user centered school facility fire safety evaluation model』 that would support fire safety evaluation, which is globally recognized as being important in terms of school safety, to be more efficiently implemented in the school field mainly by students.

As shown in [Figure 1], the study consisted of five steps. First, actual condition survey tools were developed based on the major fire safety evaluation items derived through literature review. Second, the characteristics of domestic school facilities in terms of fire safety were developed using the survey tools. Third, an evaluation model at a level utilizable by students was developed based on the foregoing characteristics. Fourth, the applicability of the model was verified through a trial application of the model to elementary school students. Finally,

legal and institutional improvement plans and fire safety education materials were presented through a policy proposal.

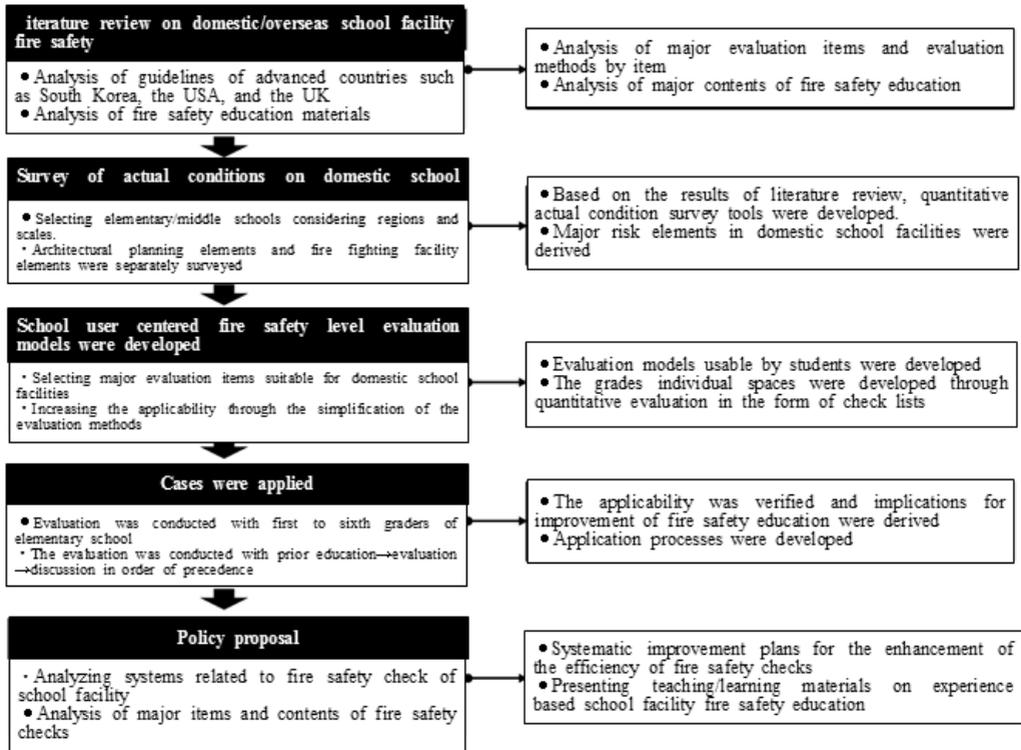


Figure 1 Study flowchart

1) Comparison and analysis of guidelines related to fire safety level evaluation of major countries

To derive those evaluation items and methods that must be considered in school facility fire safety level evaluation models, guidelines of developed countries such as the United Kingdom, the United States, and New Zealand were analyzed along with domestic guidelines.

With regard to domestic fire safety evaluation, through an analysis considering the fact that fire safety evaluation is addressed in architecture related laws and

fire-fighting related laws, 20 items in the field of architectural planning and 32 items in the field of fire-fighting facilities were derived. Overseas guidelines included most of the contents presented in South Korea, and the following additional features could be additionally found. First, those guidelines are focused on planning rather than responses. [Figure 2] shows a case of planning presented in the guidelines of the United Kingdom, indicating that fire safety facilities such as diverse fire extinguishers and emergency exits deployed at schools were carefully identified in advance. In addition, manager inspection areas where the fire fighting facilities in the relevant areas can be easily checked, fire proof areas that enable refuge for 30 minutes, emergency escape windows, emergency lights, and even assembly places were quite exhaustively analyzed. Among them, the fire proof areas are utilized as spaces where disabled persons who cannot quickly evacuate can wait for rescue for a certain period of time as shown in [Figure 3]. Most of overseas guidelines include careful considerations of the weak in evacuation as such.

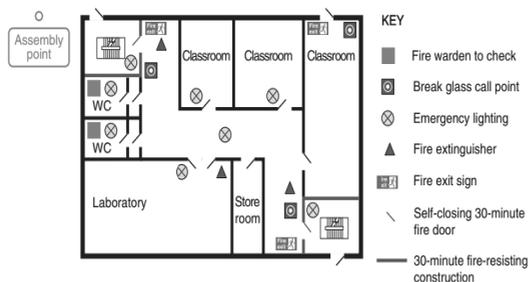


Figure 2 Example of fire fighting facility layouts (Department for Communities and Local Government(2006), p. 34)

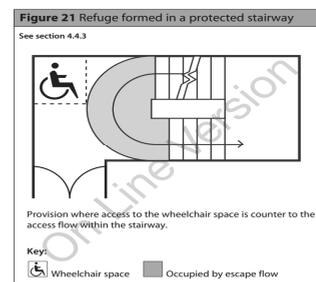


Figure 3 Example of evacuation spaces secured for disabled students (BB 100 p. 58)

2) Survey of actual conditions on elementary/middle school fire safety facilities

To more quantitatively analyze the fire safety levels of the case survey subject schools based on the results of the literature review, analysis and calculation formulas by survey item were developed as shown in <Table 1>.

Table 1 Examples of calculation formulas by case survey item

No.	Survey item	Actual condition survey calculation formula
1	Securing of effective widths of doors	(Number of rooms for which doors with at least 810mm effective widths were secured/total number of rooms)×100
2	Securing of secondary doors	(Number of rooms for which two or more doors were secured /total number of rooms)×100
3	Whether doors have a threshold	(Number of rooms without any threshold/total number of rooms)×100
4	Installation of windows on doors	(Number of rooms with windows/total number of rooms)×100
⋮	⋮	⋮
33	Installation of fire extinguishers	(Number of rooms where fire extinguishers have been installed/total number of rooms)×100
34	Height of fire extinguishers installed	(Number of rooms where fire extinguishers have been installed within 1.5m in height/total number of rooms)×100
35	Appearance of fire extinguisher	(Number of rooms where fire extinguishers free of rust or deformation have been installed/total number of rooms)×100

The survey result of each item on the area of construction plan is shown in the figure as below. The survey targeting eight schools of case study is carried out. It shows poor result of under 30% in such items as separation of dumping ground, installation of panic bar at the exit for evacuation, nonslip finishing of the path for evacuation, whether it has fire-retarded teaching aids and furnitures or not.

shown in [Figure 6], and cases where one of two doors of classrooms was locked. In addition, there were many cases where existing fire fighting facilities were not properly used such as cases where existing fire extinguishers were not properly arranged as shown in [Figure 7]. Therefore, rather than installing new fire fighting facilities additionally, existing schools should first make effort to effectively utilize facility environments and fire fighting facilities.



Figure 6 Example in the field of architectural planning



Figure 7 Example in the field of fire fighting facilities

3) Selection of evaluation items by school level through Delphi surveys

Delphi surveys were conducted with 24 experts in safety education and 23 professional fire fighting engineers to see whether or not the 15 items in the field of architectural planning and 29 items in the fire fighting facilities initially fixed through the actual condition survey should be applied to schools by level.

Through the survey of necessity using a 5-point scales, a conclusion that all the items are necessary for elementary schools, middle schools, and high schools was derived as shown in [Figure 8]. Both groups recognized that fire fighting facility elements were generally more important than architectural planning elements. However, whereas safety education experts recognized that fire

extinguishers are the most important, the fire fighting engineer group selected fire detectors as the most necessary item.

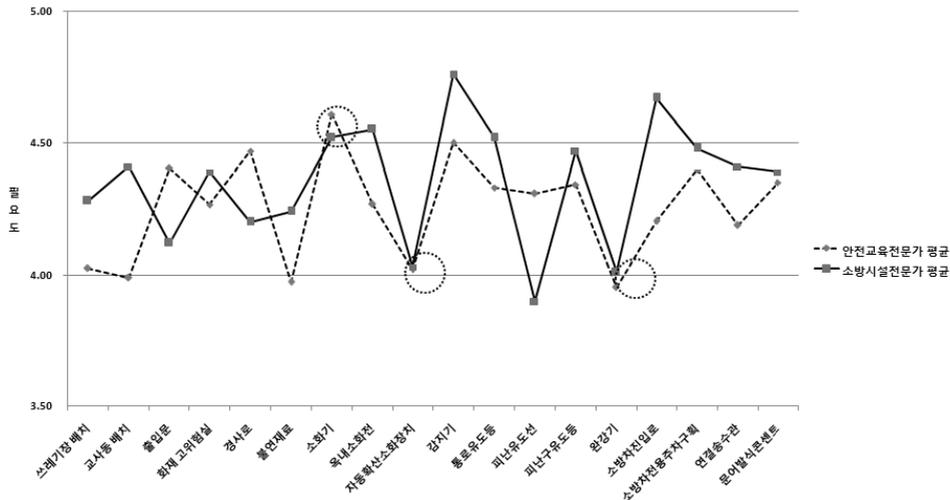


Figure 8 Comparison of the results of expert group Delphi surveys

4) Development of school user centered fire safety evaluation models

Evaluation sheets containing evaluation criteria for each of the 44 finally selected evaluation items were presented as in [Figure 9]. The evaluation sheets were made to facilitate judgment by enabling users to judge the items as being conforming, non-conforming, or unidentifiable according to the evaluation criteria, and including representative conforming cases and nonconforming cases.

Using the evaluation sheets by item, the ratios of the number of conforming items to the number of subject items by room should be calculated and evaluation scores should be given using the grade criteria shown in [Figure 10]. The grade criteria were developed to enable easy understanding of more unstable spaces out of entire spaces and to which evaluation items the unstable spaces are vulnerable, rather than evaluating accurate safety levels. That is, the evaluation gave more weight to enabling students to maximally participate in evaluating activities without

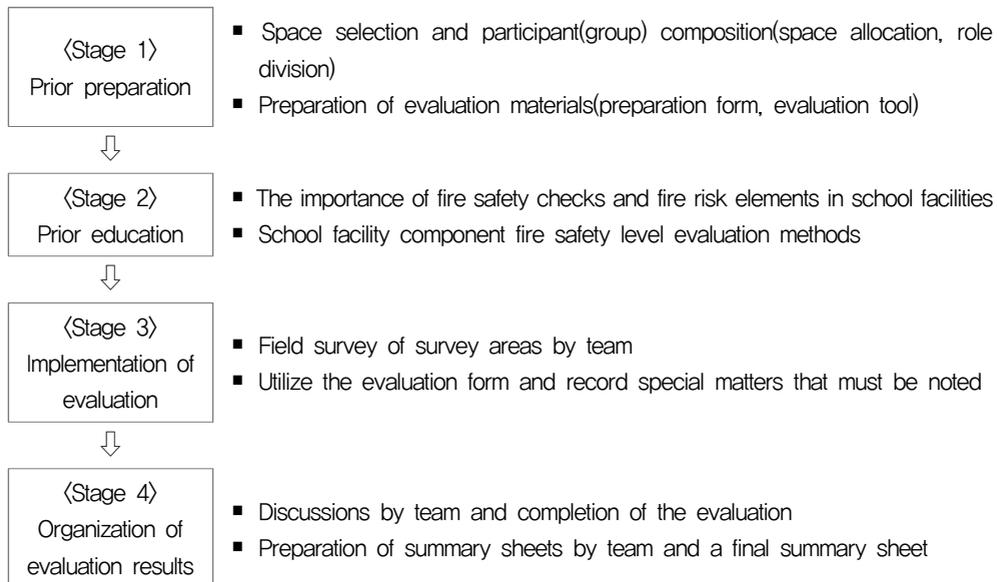


Figure 11 Evaluation flowchart

After implementing prior education centering on the positive effects of fire prevention through fire safety checks and evaluation methods, groups by grade carried out evaluation [Figure 12]. Finally, after completion of the evaluation, the results of evaluation were organized by group[Figure 13].

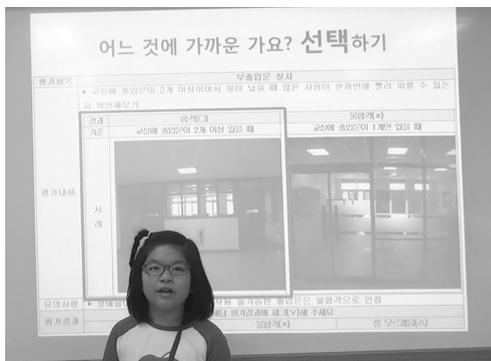


Figure 12 Stage to carry out evaluation



Figure 13 Stage to organize evaluation results

The fifth and sixth graders smoothly conducted the activities in general and accurately checked all items. The third and fourth graders did not evaluate some items presumably because of insufficient evaluation time rather than the lack of cognition. The first and second graders were identified to have limitations in terms of body conditions and sentence comprehension. However, it could be seen that the checking of fire safety elements of relevant school facilities through the evaluation activities enabled more fruitful safety education commonly for all graders [Figure 14]. As shown in [Figure 15], in this study, the cases of trial applications were produced as videos to enable more smooth applications in school fields.



“Now I know that there are many fire safety devices at a school and later I can quickly evacuate in case of fire”

Figure 14 Case of presentation

As shown in [Figure 15] the video of evaluation activity was made. It was used as reference when the evaluation which was developed by this study was conducted. The teaching and learning materials as shown in [Figure 16] were developed and suggested. These materials could be used in case of safety education by using time for school safety education and creative experiential activities.



Figure 15 평가 활동 동영상



Figure 16 교수·학습 자료집

6) Policy proposal

Based on the results of the study, the following three policies were proposed.

The first proposal is regarding the integration of the operation of fire safety checking works of those school fields where similar fire safety checks are conducted as shown in <Table 2> to reduce fire safety checking works in school fields.

Table 2 Fire safety check related systems

Existing	Ground	Period	Subjects
Day of school safety checks	<ul style="list-style-type: none"> ▶ Article 66-3 of the Framework Act on the Management of Disasters and Safety(Day of national safety, etc. ▶ Three year master plan for prevention of school safety accidents(2016-2018) 	The 4 th of every month	<u>School managers, teachers, students, etc.</u>
School facility safety management	<ul style="list-style-type: none"> ▶ Article 7 of the Act on the Prevention of and Compensation for Accidents at School(School facility safety management standards) 	Report to the superintendent of education at least once per year	<u>School principal</u>
One-stop checks of school safety	<ul style="list-style-type: none"> ▶ Three year master plan for prevention of school safety accidents(2016-2018) 	Once per year	<u>Experts by area</u>

Existing	Ground	Period	Subjects
Fire fighting facility checks	▶ Article 25 of the Fire-Fighting System Installation Business Act	Appearance check: once per month Operational check: once per year Comprehensive check: once per year	<u>Fire fighting manager (or professional contracted company)</u>

The second proposal is regarding the [Attached table 3] Improvement(proposal) of school facility safety management standards to the enforcement rules of the Act on the Prevention of and Compensation for Accidents at School, which becomes the standards for daily fire safety checks in school fields based on the results of the study.

▶ Table 3 ▶ Improvement(proposal) of school facility safety management standards(Attached table 1 to the enforcement rules of the Act on the Prevention of and Compensation for Accidents at School)

Division	Existing	Change(proposal)
Automatic fire detecting facilities, etc.	C. Rooms shall be installed with detectors suitable for their uses(classroom·boarding house· cafeteria, etc.).	C. All rooms shall be installed with detectors suitable for their uses(classroom·boarding house·cafeteria, etc.); provided that, smoke detectors with an alarm generating function should be installed.
Indoor fire hydrant facility, etc.	A. Fire extinguishers shall be installed at least at one place per classroom and at least one place per 20m of walking distances in the corridors and stairways	A. Fire extinguishers shall be installed at least at one place per classroom and at least one place per 20m of walking distances in the corridors and stairways; provided that, the fire extinguishers shall be arranged in unified places such as the vicinity of doors without any obstacle so that they can be quickly used when any fire has occurred.
	Newly established	D. Appropriate numbers of fire extinguishers should be arranged in spaces with high loaded fire loadings (fire loadings of books, computers, etc. excluding facility elements such as finishing materials) such as libraries, teacher' s rooms, and computer rooms.
Evacuation facility	Newly established	D. In the case of classrooms and special classrooms, at least two doors that can be opened always should be secured per room for easy evacuation.

Division	Existing	Change(proposal)
		E. All doors on evacuation routes should be always maintained to be openable and should be free from obstacles. F. Roads with effective widths of at least 4m and effective heights of at least 4.5m should be secured in the surroundings of schools and in school sites to facilitate fire engine entries.

The third proposal is regarding the 『Teaching/learning materials on students centered school facility fire safety check』, which will enable students and teachers to smoothly implement experience based fire safety checks in school fields as shown in [Figure 16] while emphasizing the necessity of prevention centered school fire safety education. In addition, as shown in [Figure 17], the 『Guide to major contents to be checked in school fire fighting facilities for fire fighting safety managers』 was included in the materials so that fire fighting safety managers can more actively participate in fire inspections conducted by professional consignment organizations.

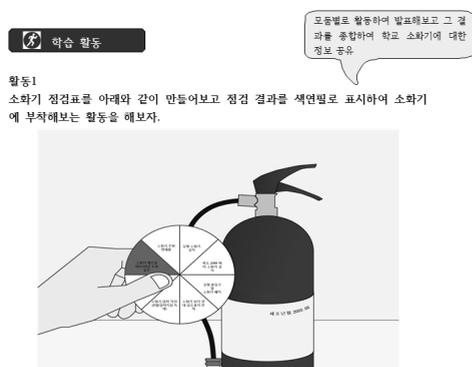


Figure 17 Learning activities (proposal) for the item of fire extinguisher

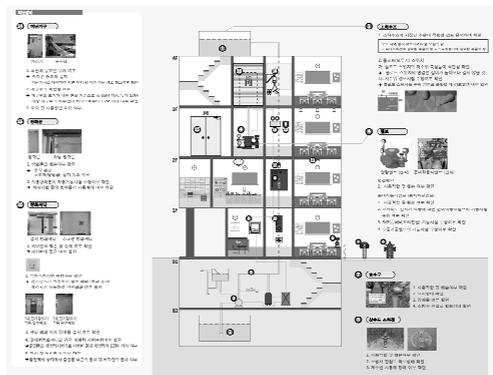


Figure 18 Guide to major contents of checks

□ Key words : school safety, fire safety, fire inspection, fire prevention, safety education, school fire, school facility