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Development of a web-based emergency preparedness plan system in Korea

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Abstract−The chemical industry treats a huge quantity of hazardous and harmful flammable liquids, combustible gases and toxic materials. Therefore, there is a high potential for fires, conflagrations, explosions and toxic leaks. To minimize the possibility of such hazards, the Korean government has been enforcing an EPP (Emergency Preparedness Plan) in accordance with the Toxic Chemicals Controls Act since 1996. However, 70% of the targeted small and medium-sized enterprises are struggling with the independent implementation of EPP, and 30% of the EPP grades being used are not amenable to approval and further application. As a result, we have developed a web-based emergency preparedness plan system. The main purpose of the program is to provide a safety management system to each facility in order to enable accidents to be prevented and accidents to be immediately controlled. The program also helps government or related agencies to control a number of accidents that occur in small companies throughout the entire country.

Key words: Emergency Response Plan, Chemical Industry, Environmental Management, Hazardous Materials

INTRODUCTION

The Bhopal accident that occurred in 1984 was one of the worst disasters to ever occur in the chemical industry [4]. Since this incident, toxic chemical materials have become an issue throughout the entire world. Some countries have enacted laws and regulations that prevent chemical accidents. The PSM (Process Safety Management) of the OSHA (Occupational Safety and Health Administration) and the RMP (Risk Management Plan) of the EPA (Environmental Protection Agency) are representative and have been adopted by many countries [8]. The OSHA of the USA announced in a plan declaring the federal regulation. This became the starting point from which special laws were established to prevent major industrial accidents in the USA, and PSM regulation was enacted in November, 1992 [2]. PSM was developed to prevent similar accidents and it was recognized by chemical companies and the government as an excellent regulation that will reduce the number and severity of accidents [10]. The PSM standard has 14 major sections: employee participation, information about process safety, process hazard analysis, operating procedures, training, contractors, pre-start up safety review, mechanical integrity, hot work permits, management of change, incident investigation, emergency planning and response, audits, and trade secrets [11]. PSM has been implemented for seven years and this has allowed various examples of its effectiveness to be made. The number of major industrial accidents including the number of fatalities has fallen after PSM implementation and productivity has risen [1]. On the other hand, RMP regulation is aimed at decreasing the number and magnitude of the accidental release of toxic and flammable substances [9]. Although the RMP is similar to the PSM (Process Safety Management) regulation in many respects, the RMP is designed to protect off-site people and the environment, whereas PSM is designed to protect on-site personnel. The elements of RMP are hazard assessment, a prevention program, an emergency response program, and so on. In March 2009 the EPA also made available new Web-based software called RMP*eSubmit for facilities to use for online Risk Management Plan (RMP) reporting. To make compliance easier for small businesses, the EPA is working with industry groups to develop model risk management programs [9]. Following these safety-environmental trends, the Korean government enacted the Toxic Chemicals Control Act in 2004 to enable all people to live in a healthy and comfortable environment by preventing people's health and the environment from being harmed by chemicals and to properly control toxic chemicals. According to this law, 56 chemical materials are in Korea designated as APCs (Accident Precaution Chemicals) depending on toxicity and the amount of the material. APC refers to a chemical that has high acute toxicity, is an explosive hazard, etc., and thus is extremely likely to cause an accident or, in case of an accident, is likely to result in disastrous damage. As a result of these factors, it was agreed that an emergency preparedness plan should be developed and this was designated by presidential decree under Article 38 of this Act [6].

When an accident occurs or is expected to occur, the person who is required to submit the emergency preparedness plan shall take emergency actions to minimize damage from the accident or to prevent the accident in accordance with the emergency preparedness plan. The emergency preparedness plan consists of five categories as follows:

- A material safety database sheet of handled accident precaution chemicals: This step requires the prepareation of an MSDS for all APCs. It is one of the most important references for toxic chemicals and includes information about hazardous ingredients, physical/chemical characteristics, reactivity data, health hazard data, precautions for safety and control measures.

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Table 1. APCs (Accident Precaution Chemicals) in Korea

Name	CAS number	Name	CAS number
Formaldehyde	000050-00-0	Methyl hydrazine	000060-34-4
Formic acid	000064-18-6	Methanol	000067-56-1
Benzene	000071-43-2	Methyl chloride	000074-87-3
Methylamine	000074-89-5	Hydrogen cyanide	000074-90-8
Vinyl chloride	000075-01-4	Carbon disulfide	000075-15-0
Ethylene oxide	000075-21-8	Phosgene	000075-44-5
Trimethylamine	000075-50-3	Propylene oxide	000075-56-9
Methyl ethyl ketone	000078-93-3	Methyl vinyl ketone	000078-94-4
Acrylic acid	000079-10-7	Methyl acrylate	000096-33-3
Nitrobenzene	000098-95-3	p-Nitrotoluene	000099-99-0
Benzyl chloride	000100-44-7	Acrolein	000107-02-8
Allyl chloride	000107-05-1	Acrylonitrile	000107-13-1
Ethylenediamine	000107-15-3	Allyl alcohol	000107-18-6
m-Cresol	000108-39-4	Toluene	000108-88-3
Phenol	000108-95-2	n-Butylamine	000109-73-9
Triethylamine	000121-44-8	Ethyl acetate	000141-78-6
Sodium cyanide	000143-33-9	Ethylenimine	000151-56-4
Toluene-2,4-diisocyanate (TDI)	000584-84-9	Carbon monoxide	000630-08-0
Acrylyl chloride	000814-68-6	Zinc phosphide	001314-84-7
Methyl ethyl ketone peroxide	001338-23-4	Isophoronediisocyanate	004098-71-9
Sodium	007440-23-5	Hydrogen chloride	007647-01-0
Hydrogen fluoride	007664-39-3	Ammonia	007664-41-7
Sulfuric acid	007664-93-9	Nitric acid	007697-37-2
Phosphorus trichloride	007719-12-2	Fluorine	007782-41-4
Chlorine	007782-50-5	Hydrogen sulfide	007783-06-4
Arsine	007784-42-1	Chlorosulfonic acid	007790-94-5
Phosphine	007803-51-2	Phosphorus oxychloride	010025-87-3
Chlorine dioxide	010049-04-4	Diborane	019287-45-7

- Prevention program: This includes both the facility's prevention devices and its safety management system.
- Emergency response plan: This describes the steps to be taken by the facility's emergency employees in response to an accident involving an APC.
- Consequence analysis: This is a hazard assessment for a range of potential hazardous chemical releases, including the history of such releases at the facility. This consequence analysis consists of a worst-case scenario and the more likely but significant accident release scenario.
- The emergency plan for local community: This establishes procedures for notifying the local community and the relative public institute.

PREPARATORY RESEARCH FOR SYSTEM DEVELOPMENT

In Korea 423 plants are reporting the EPP to the Ministry of the Environment. Most of the plants are small and medium enterprises who find it difficult to write the EPP reports by themselves. To locate and determine where the problems are, we did a survey targeting safety supervisors of the companies and institutes. The survey was conducted by using questionnaires and site visits. Table 2 is an illustration of the samples of questionnaire.

Fig. 1 shows the actual condition of workplaces reporting the EPP in Korea. Most small companies are overburdened, do not have relevant knowledge, and do not have safety supervisors. To make

Table 2. Sample questionnaire

Classification	Subjects
Personalinformation	Gender, Age, Work experience, Division (Safety-Environment Management Team or Etc), Major, Educational background
Companyinformation	Address, Pottage, Number of employees, Amount of toxic material (ton/day)
Safety/Environmentalinformation	Possible incident (leak, fire, explosion etc), Cause of incident, Level of safety culture, Method of SSP report writing (Consulting or safety supervisor in company), Pros and cons of SSP, Difficulty of SSP report writing, Practical use of SSP
Opinion for systemdevelopment	System requirement, GUI, etc.

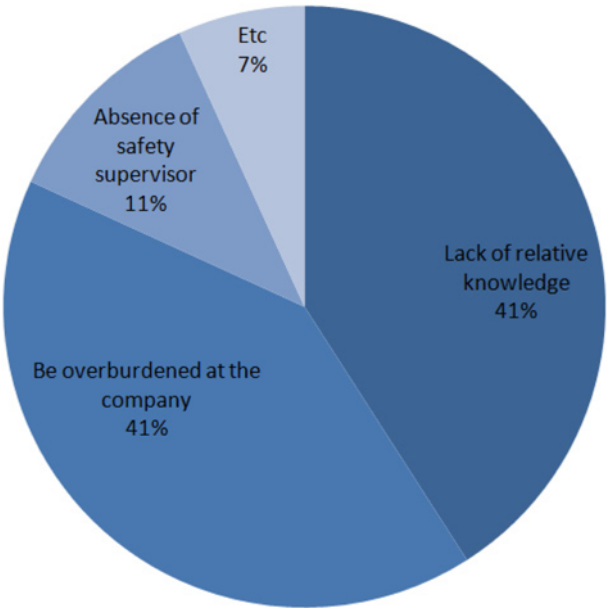

Fig. 1. Results of the questionnaire: What is the most difficult about writing the SSP report?

it convenient for the user, we need to develop a web-based emergency preparedness plan system that takes into consideration the working conditions at these companies.

NEW WEB-BASED EPP SYSTEM

The web-based EPP system provides a tool aimed at managing, analyzing and making the emergency plan convenient. It can be run directly from inside a web browser that must support the interactive interface. Also, it is compatible with a variety of operating system, web browsers and computer specifications. As a result, we utilized Adobe Flex and the MySQL DBMS (Database Management System) for system efficiency. The system consists of six models.

1. User Registration and Login Module

Information security is one of the most important concerns for companies. So we have installed a password system that makes information in the SSP system secure. We also have developed functions that import existing working document files or create new SSP reports.

2. MSDS (Material Safety Database Sheet) DB Module

This provides relevant safety information for materials. We used the KOSHA (Korea Occupational Safety and Health Agency) MSDS to provide reliable data. The user inputs the name of the material in the start-up screen of the system and thermodynamic and safety information is automatically generated.

3. Network of Emergency Contact Addresses DB Module

This module provides a network of emergency contact information for hospitals, fire stations, police stations, and public institutes near the plant, for example. To generate this information, the user need only input the address of the company in the start-up screen. This module provides useful information about the accident to the user, and it also has an SMS function that connects with government-related organizations.

4. SSP (Site Security Plan) Report Module

This module includes all items that make up the emergency preparedness plan. To make the program user friendly, we provide a general template. Fig. 5 shows the step of informing about the structure of the safety management division. In this step, the user can insert the data in a template similar to the interface of MS Office.

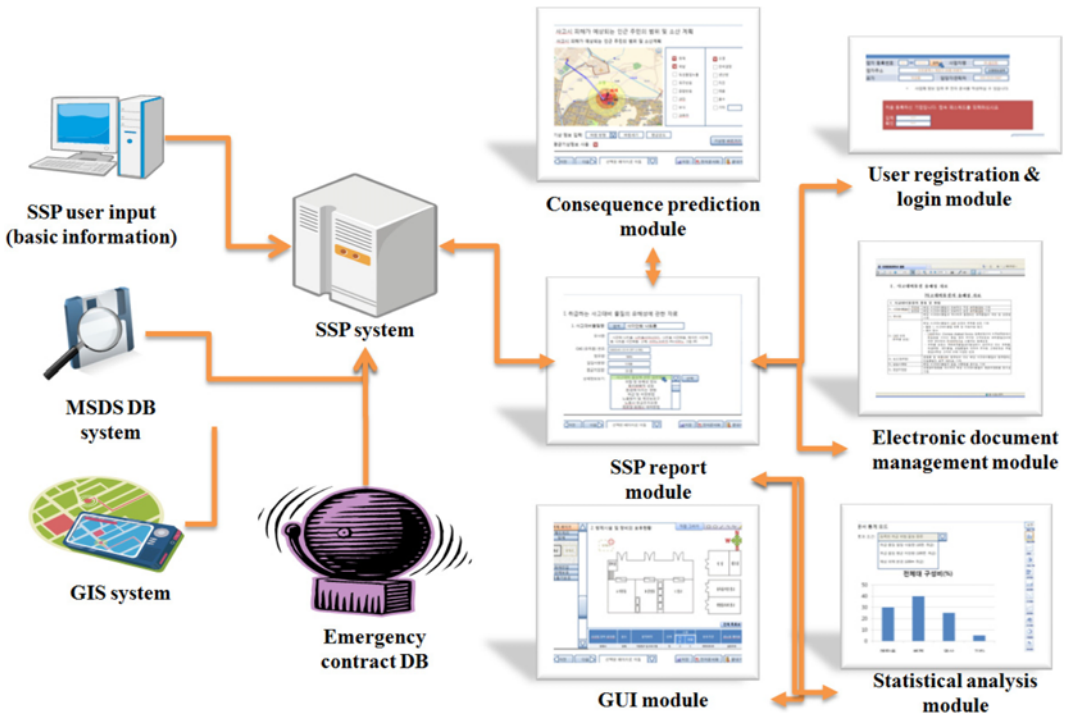

Fig. 2. Flowchart of the SSP system modules.

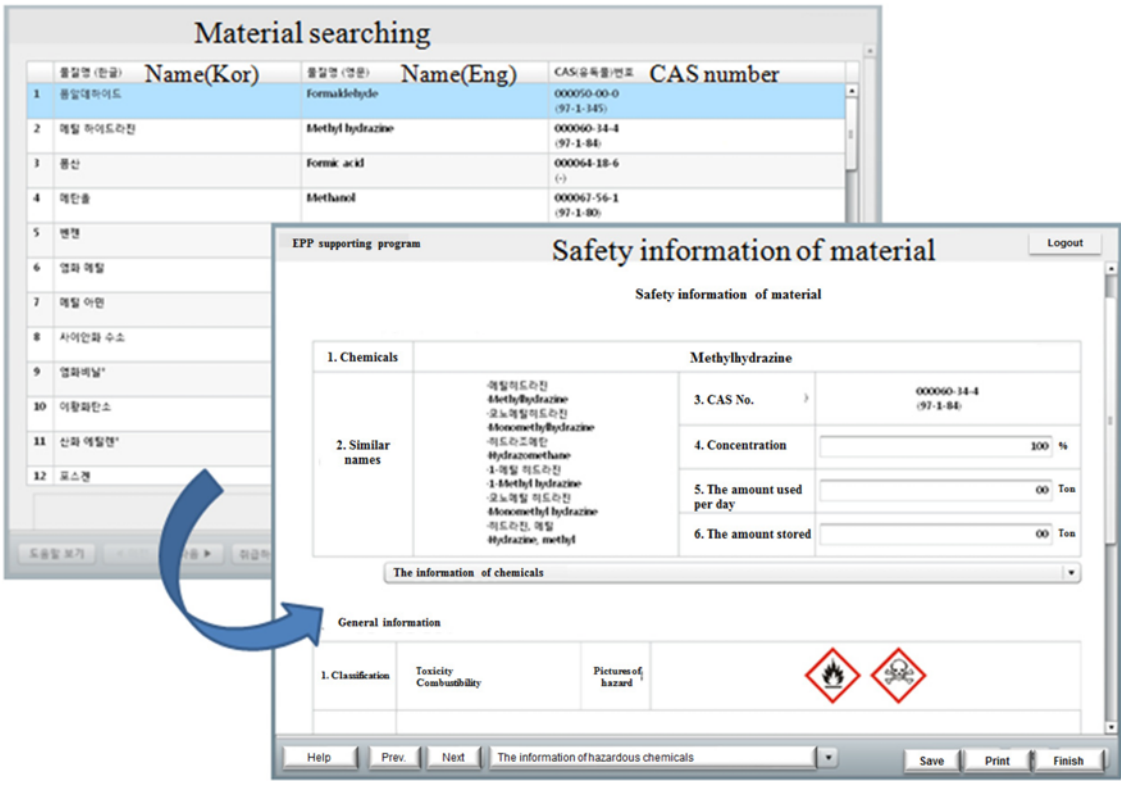

Fig. 3. MSDS (material safety database sheet) module.

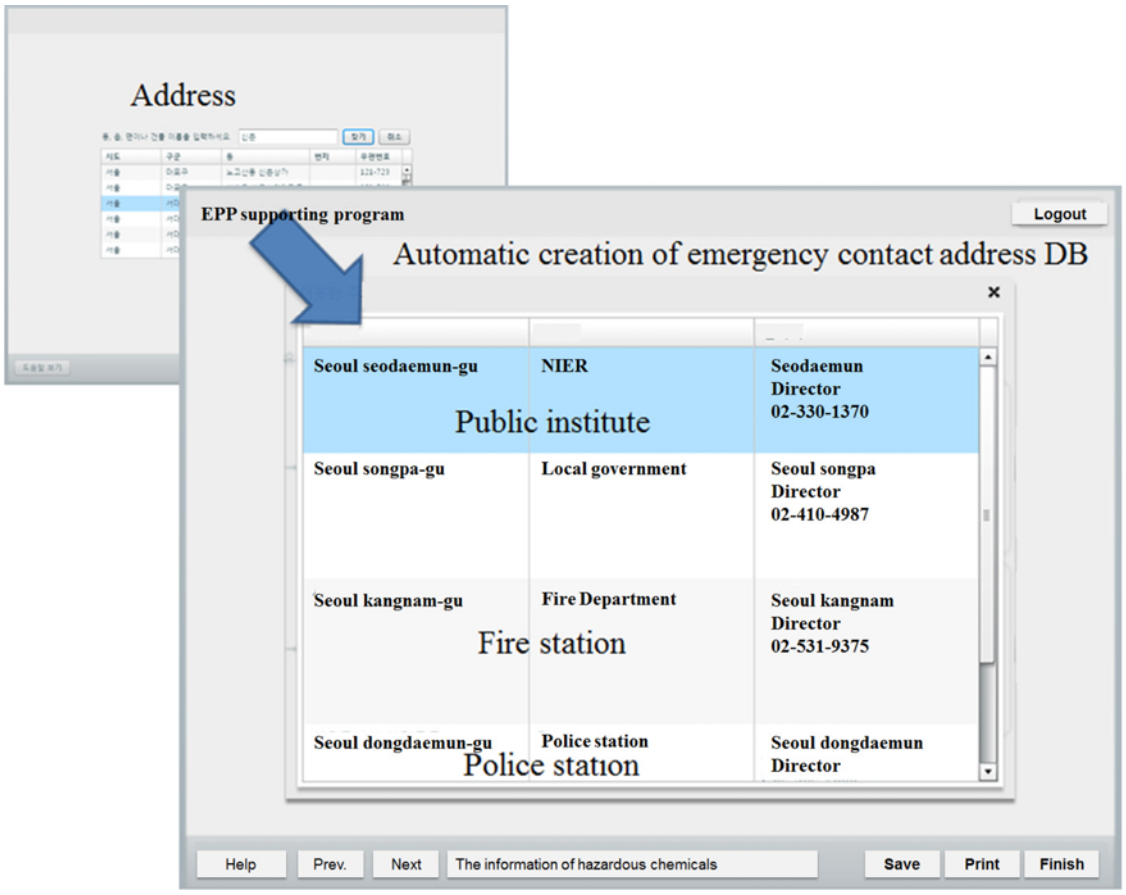

Fig. 4. Network of emergency contact addresses DB module.

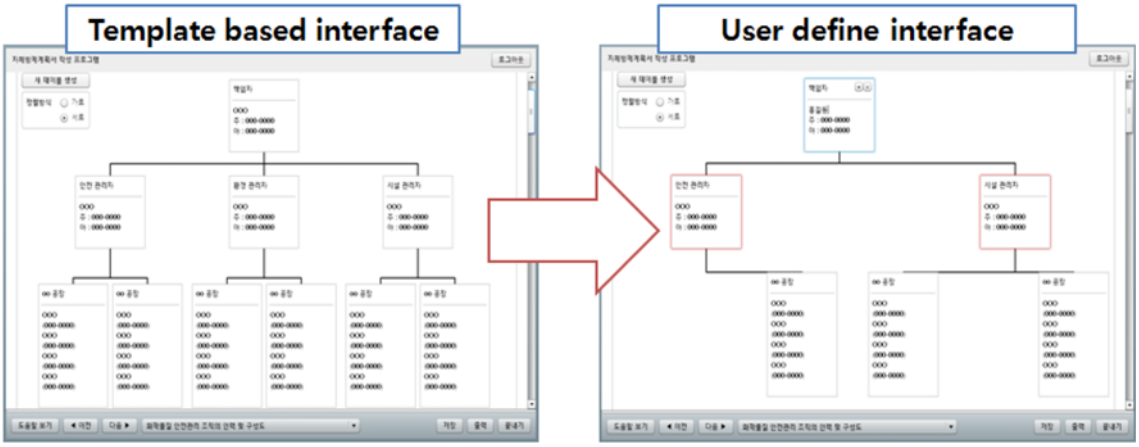

Fig. 5. Step of constructing the safety management division hierarchy using a template.

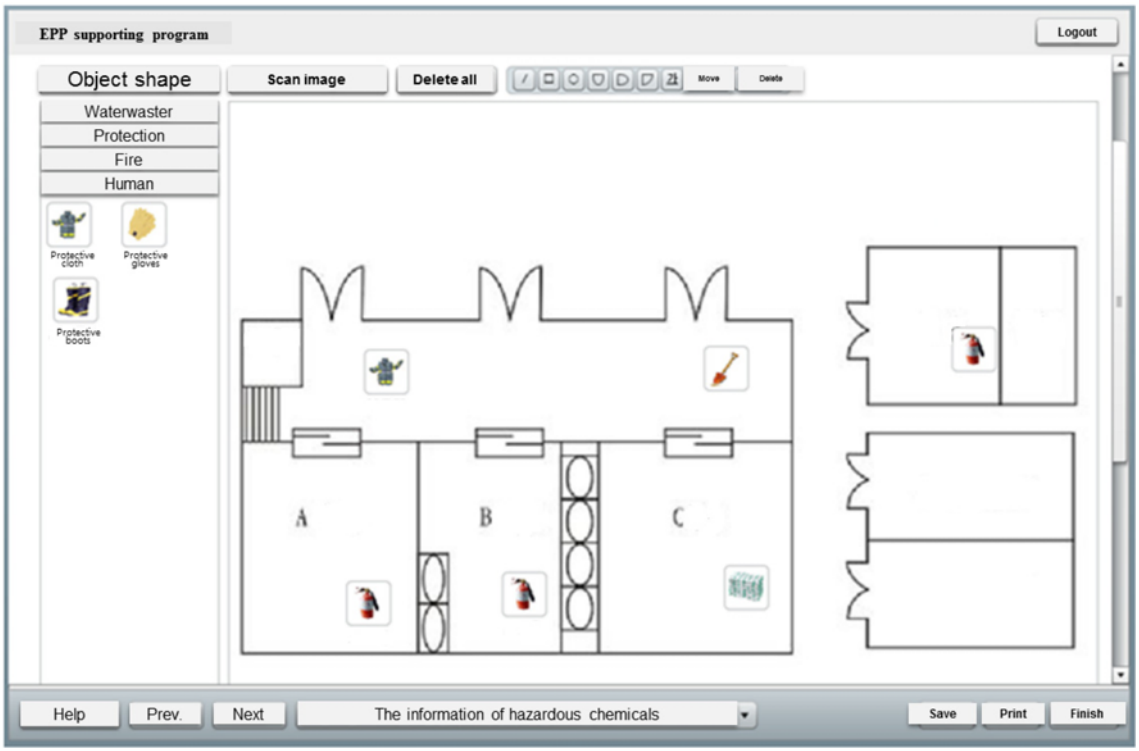

Fig. 6. Step of describing prevention facilities and equipment.

We have also developed a system that directly inserts a form in image format that can utilize established safety documents. Finally, we can add the data to the electronic document (in pdf format) accordingly.

In the case of pictures of prevention facilities and equipment, there are many inconsistencies in the program. So we have applied a GUI having helpful functions related to drawing and input. Users can describe a variety of prevention equipment shown in Fig. 6.

The input of an available period can be performed by users. The inserted available period may be used as a means of providing information about prevention equipment that would be the last entry or the life. If a variety of different pieces of prevention equipment must be input, the program has the functionality of providing an entire list and interface to the users. If the user selects an item from the list, the prevention equipment list will be shown automatically on the picture. When the user drag-and-drops it from the prevention equipment list to put the equipment in the program, the numbers of pieces of equipment will automatically show up in the program.

5. CA (Consequence Analysis) Module

The risk assessment in SSP report has assumed a worst-case accident scenario by calculating the maximum radius of damage. Therefore this module provides the user with the results of a worst-case accident scenario. When developing the CA module, we compared existing CA tools like K-CARM and ALOHA to discover what problems there were with the existing CA tools. We cannot expect users to draw exact results from these tools which are suitable for use only

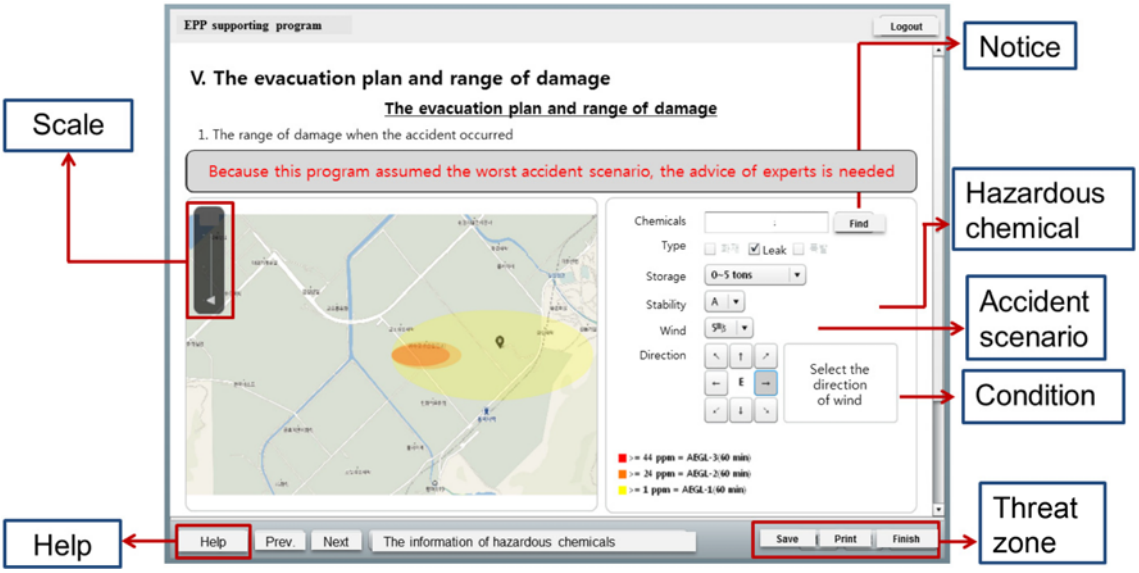

Fig. 7. CA (consequence analysis) module.

by experts. To solve these problems, we tried to minimize the options by considering the regional characteristics like the climate so that the possible accident scenarios and chemical quantities could be classified. Also, we put the results of possible accident scenarios in the module.

6. Administration Module

This module is divided into three modules: prevention control, statistics, and management and admission. It automatically controls the validity period by putting the prevention equipment into a database. The program informs the administrator whenever updates are required.

CONCLUSION

We suggest a user-friendly safety management system which is suitable for small and medium-sized workplaces. To reflect user requirements, we searched for areas that are in demand by interviewing safety supervisors at workplaces and government agencies. We also collected information regarding similar systems of support programs.

As a result, we have developed a web-based emergency preparedness plan system. The main purpose of the program is to provide a safety management system to each facility in order to enable accidents to be prevented and controlled immediately. The program is also helpful for the government and related agencies to control a number of accidents in small and medium-sized companies throughout the entire country.

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