Research Article

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Development of a Recommendation System for Occupational Safety, Health and Environmental Management for Higher Education Institutions in Thailand

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Abstract

A recommendation system is a tool that plays an important role in many applications such as the world wide web. The main objective of this research was to develop a recommendation system for occupational safety, health and environmental management in higher education institutions. A website-based recommendation system for occupational safety, health and environmental management in higher education institutions was developed with various computer languages (HTML version 5, CSS version 3, and JavaScript language as PHP 5.6 only). The supporting database was developed and managed using MySQL version 5.6 and phpmyadmin version 4.9. Administrators (Admin) and system users (User) could access the site at http://www.phbuu.com/occhealth/index.php/auth/login.

Suitability and satisfaction was assessed in a sample of 55 respondents, including faculty members who are responsible for Occupational Health and Safety program curriculums as well as instructors from other disciplines. After we developed a recommendation system, we invited instructors both from the field of occupational health and safety and from other disciplines to use the system. We compared their overall satisfaction with the system and its specific aspects. Data analyzed using the Mann-Whitney U test showed that overall satisfaction was high for both groups. There was no difference in the overall satisfaction with the system between instructors in occupational health courses and those from other fields. Therefore, the recommendation system we developed for the management of occupational safety, health and the working environment for higher education institutions is suitable for all instructors working in higher education institutions.

Keywords: Recommendation system, Higher education institutions, Occupational safety, Health and environmental management, Computer program

What was Known

- Many higher education institutions have hazards in the workplace and do not have an occupational health and safety management system

What's New and Next

- We developed a recommendation system for safety management which all education institutions can conveniently use
- Further research could investigate factors affecting the implementation of safety management systems in higher education institutions

Introduction

Recommendation systems have become extremely common in recent years. They help the user to find out data and settle on choices when they do not have the required learning to judge a specific item. They are a subclass of the information filtering system which seeks to predict what a user gives to an item or social element by using a model built from the characteristics of an item (content - based approach) or the user's social environment (collaborative filtering approach)[1].

According to the Occupational Safety, Health and Environment Act B.E. 2554 (A.D. 2011), "The central administration, regional, provincial administration, local government administration and other enterprises prescribed in the Ministerial Regulation under paragraph one shall provide standards for administration and management on occupational safety, health and the environment on its own working unit of not lower than the standards on occupational safety, health and the environment under this act"[2].

The university is a government bureau that must follow no less than what the law stipulates, with regards to the management of safety, occupational health and the environment. Some universities in Thailand are starting to pay more attention to performance. There are currently 155 higher education institutions in Thailand with more than 200,000 academic and support personnel[3]. This nature of work is considered to have some unsafe working practices. For instance, teaching at some faculties includes laboratory practice. In the chemical laboratory, there is a risk of fire and chemical accidents[4]. There could be no plan to prevent chemical accidents[5]. In addition, most laboratory workers are unaware of the safe handling and practices of laboratory work[6,7]. A study by Panumasvivat et al[8] found that a total of 33 accidents were reported in fiscal year 2019, with most of them in scientific laboratories. It was followed by accidents outside of the room, inside of the building, and outside of the building, respectively. Examples of the types of accident that occurred were fire, chemical spills, short circuits, and personal accidents. Kashyap and Nandan[9] found that the nature of accidents occurring in higher education institutions included electrical hazards due to ungrounded equipment, fire, exposure, vapor, and slipping. Therefore, the results of such studies show there should be better safety measures.

A study by Patipat and Meepradit[10] found that only four higher education institutions disclosed their safety performance online. In a study on the problem of school safety management, it was found that there was a lack of budget, personnel, knowledge, understanding, and skills in safety management in educational institutions, and executives were uninterested[11]. However, a study of the effect of selected occupational health and safety management practices on job satisfaction of employing university campuses in Nakuru town, Kenya, found that safety operations must still be performed in order to comply with the law and safety management. Occupational health also influences job satisfaction[12].

The main objective of this research was to develop a recommendation system for occupational safety, health and environmental management in higher education institutions. By exploiting a model built from content - based approaches, we used collaborative filtering approaches to guide the implementation of safety standards and facilitate access to information and ease of implemention.

Materials and Methods

Ethical approval

This study obtained ethical clearance from the Ethics Committee of Faculty of Public Health, Burapha University, Thailand (number IRB 010/2019).

System design and development

The design and development of a recommendation system for the management of occupational safety, health and work environment for higher education institutions in Thailand used the following system architecture.

a. In this study, there were two data parts in the system. Part 1, beyond law, was obtained from the delphi technique[13]. Part 2 was related to the occupational safety, health and environment act of law B.E. 2554, which was reviewed by five experts, i.e., government agencies, state enterprises and private sectors, in order to design the recommendation system. The results showed that the expert evaluation received a good score for content compatibility.

b. The computer languages used to develop the display of the website pages, were HTML version 5, CSS version 3 and JavaScript language in the form of web applications (Web Application), with a link to evaluate the results with a manual for the implementation of safety, occupational health and work environment management standards for higher education institutions (all four manuals).

c. The computer language used in the development phase was PHP (PHP Hypertext Preprocessor or Personal Home Page).

d. The database was MySQL version 5.6 and phpmyadmin version 4.9.

System satisfaction assessment

The researchers requested permission from Burapha University to publicize the study and collect data. The researchers clarified the research proposal with the individuals directly, and the respondents only participated on a voluntary basis.

Full-time lecturers (n=55), who were affiliated with an occupational health course or equivalent at higher education institutions in Thailand, were recruited to provide user satisfaction appraisal of the system.

a. There were a total of 43 institutes, which had 5 lecturers per curriculum, with a total of 215 people[14].

b. A total of 30 institutions were willing to participate in this research. The sample group used in this research was 30 full-time lecturers in higher education institutions (1 lecturer from 1 institute) that offered occupational health courses or an equivalent. This first group were responsible for an occupational health course or equivalent. A second group of participants was composed of 25 instructors who were not responsible for occupational health programs but who were working in the same place as the first group which was selected by purposive sampling.

c. The research tools used in this research were as follows:

1) Satisfaction assessment forms which the researcher used to assess the suitability of the recommendation system and satisfaction with the use of the recommendation system. The assessment form was divided into three parts: part 1 general information, including sex, employment status (being a full-time teacher in an occupational health course or equivalent, and affiliated). Part 2 assessed the suitability of the recommendation system, and part 3 assessed satisfaction with the use of the recommendation system. The assessment scale had five levels of estimation scale, namely: strongly agree, agree, neutral, disagree, and strongly disagree. The calculated mean was interpreted using a Likert scale. A tool for evaluating the use of the recommendation system for occupational safety, health and environmental management for higher education was created using Google forms. The consistency of the questions with the content and objectives (IOC) was assessed by five experts with an average consistency index of 0.73.

Data collection and data analysis

We initially contacted eligible candidates by telephone and explained the nature of the research. We asked whether they would be willing to cooperate and, if so, then sent them a link (URL) to a referral system for the management of safety, health and environment for higher education institutions. The recommendation system sent the satisfaction assessment form, using Google forms to the sample group via e-mail.

The researcher analyzed descriptive data (mean, standard deviation, and percentages) from responses collected by comparing the satisfaction of the group of instructors in charge of the Occupational Health Program or its equivalent. The Mann-Whitney U-test was also utilized to analyse data from the group of instructors who were not responsible for courses related to occupational health.

Results

The design of a recommendation system for occupational safety, health and environmental management for higher education institutions begins with the determination of administrative rights and general user rights. As can be seen in Figure 1, the user initially registers and logins to access the system. Then, the user fills out the information in the assessment form. After that, the system will evaluate and display a manual for the operation of safety management according to the working environment of the system user. This user-case figure led to the design of a class diagram to show the system's storage. It consists of five main parts: 1) user information, 2) questions and choices information, 3) manual information, 4) assessment structure (template) to create an assessment framework related to questions and manuals that will be used in the assessment, and 5) assessment to collect detailed responses. A more detailed description of the class diagram for the recommendation system is shown in Table 1.

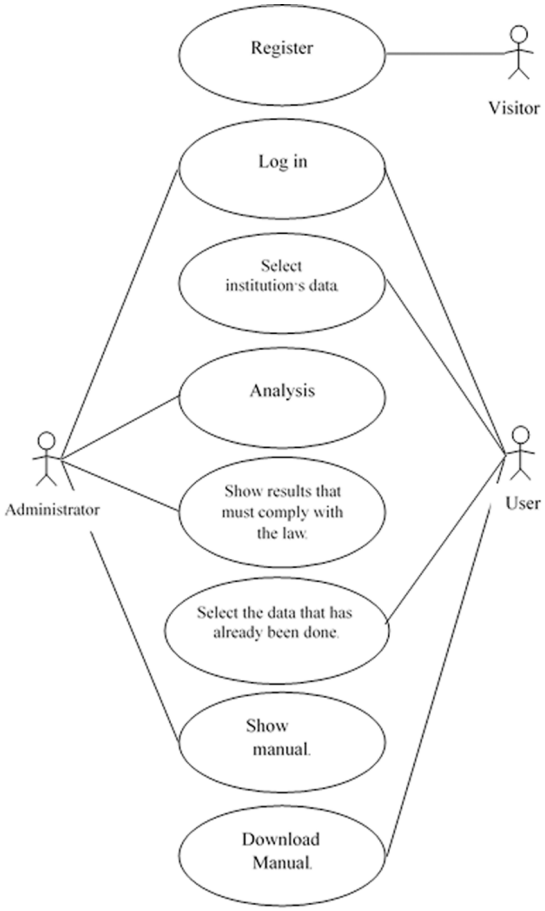


Figure 1 A user-case diagram showing the operating system of the recommendation system for occupational safety, health and environmental management for higher education institutions

Table 1 Description of the class diagram of the recommendation system for occupational safety, health and environmental management for higher education institutions

Class name	***Details***
User information	
User	Store your email address and password (encrypted) to use login
User_profile	Store information of users who have signed up to access the system
User_groups	Store user and user rights relationship with two rights: System administrators and general workers
Group	Store details of user groups
Questions and choices information	
Questions	Question storage
Choices	Storage choices
Question_list	Stores relationship of questions and choices (one question can have multiple choices)
Manual information	
Manual_topic	Store manual titles and descriptions
Manual_criteria_list	Store details of topics in manuals and descriptions
Manual_criteria_link	Stores relationship of topic in manual with link to web page/image/ video related to the topic (one topic can have multiple choices)

Table 1 Description of the class diagram of the recommendation system for occupational safety, health and environmental management for higher education institutions (Continued)

Class name	*Details*
Assessment structure (template)	
Templates	Stores name and version of assessment structure
Template_pages	Store details of assessment page
Template_question	Store questions that are displayed on each page of assessment
Template_choices	Store choices that will be displayed on each page of assessment
Template_choices_link	Stores choice association that is displayed only when certain choices are selected (one option on the previous page is related to one option on the following page)
Template_criteria	Store relationship of choices to topics in manual (one on last page is related to content of manual)
Assessment to collect detailed responses	
Assessment	Store each assessment from the user
Assessment_list	Store the details of the assessment
Assessment_question_list	Store assessment questions and choices

Administrators and users of the system ("users") can access it at http://w w w. p h b u u.com/occhealth/index .php/auth/login. There is a screen with a guide to the system (Figure 2). It was prepared for higher education institutions to operate according to the Occupational Safety, Health and Environment Act B.E. 2554 to use as a guideline for practice so that all workers are safe and in good health. It also results in working more efficiently, and reduces work-related risks by assessing physical characteristics and the working characteristics of the operator, leading to the manuals: 1. Handbook of Implementation of Occupational Safety, Health and Work Environment Management Standards for Higher Education Institutions: Management; 2. Handbook of Implementation of Occupational Safety, Health and Work Environment Management Standards for Higher Education Institutions: Safety; 3. Handbook of Implementation of Occupational Safety, Health and Work Environment Management Standards for Higher Education Institutions: Working Environment; and 4. Handbook of Occupational Safety, Health and Environment for Higher Education Institutions in addition to the Occupational Safety, Health and Environment Act B.E. 2554).

Upon first use of the system, a user must register so that they can store data; later the system user can return to check their information that was evaluated in the past. System users evaluate the risk factors that exist at their own institution and evaluate what has been done according to the law. After that, the system will display four manuals.

The results of the cases that have already been processed are shown in green, while matters that have not yet been processed are shown in red. After this, users of the system can download the manual in an e-book format as a guideline for legal proceedings.

We assessed the user's satisfaction with the system during the trials with scored questions. The assessment form was reviewed for content accuracy and its suitability for evaluating the recommendation system by professionals in occupational health and information technology.

In this satisfaction assessment, we hypothesized that the recommendation system would be applicable to all target groups working at the university, and not limited to those that have knowledge of occupational health. For testing this hypothesis, the sample group was divided into two groups: full - time professors in occupational health courses and lecturers from another branch. Our target was to have 30 people in each group, giving a total of 60 respondents. However, although the response rate was 100% among the instructors of occupational health programs, it was only 83.3% (25 people) from the other group. Most respondents (n=41; 74.5%) were female, and were from 3 types of higher education institutions: public higher education institutions (n=27; 49.1%), private higher education institutions (n=8; 14.5%), and Rajabhat universities (n=20; 36.4%).

After the sample group tried the recommendation system, it was found that most of the sample group had the highest satisfaction level on the following topics: 1. the system is easy to use/uncomplicated (49.1%), 2. ease of access to information (52.7%), and 3. beneficial to the operation (70.9%). Satisfaction was at a high level for four topics: 1. format and method of presenting the information (52.7%), 2. the completeness of the information (47.3%), 3. the information was easy to understand, (59.9%), and 4. overall satisfied with system utilization (58.2%).

The overall satisfaction with the recommendation system for occupational safety, health and environmental management for higher education institutions was high, with a (average 4.35). The most satisfying aspect was beneficial to the operation of higher education institutions, which scored an average of 4.67. Satisfaction was at a high level in other aspects also (Table 2).

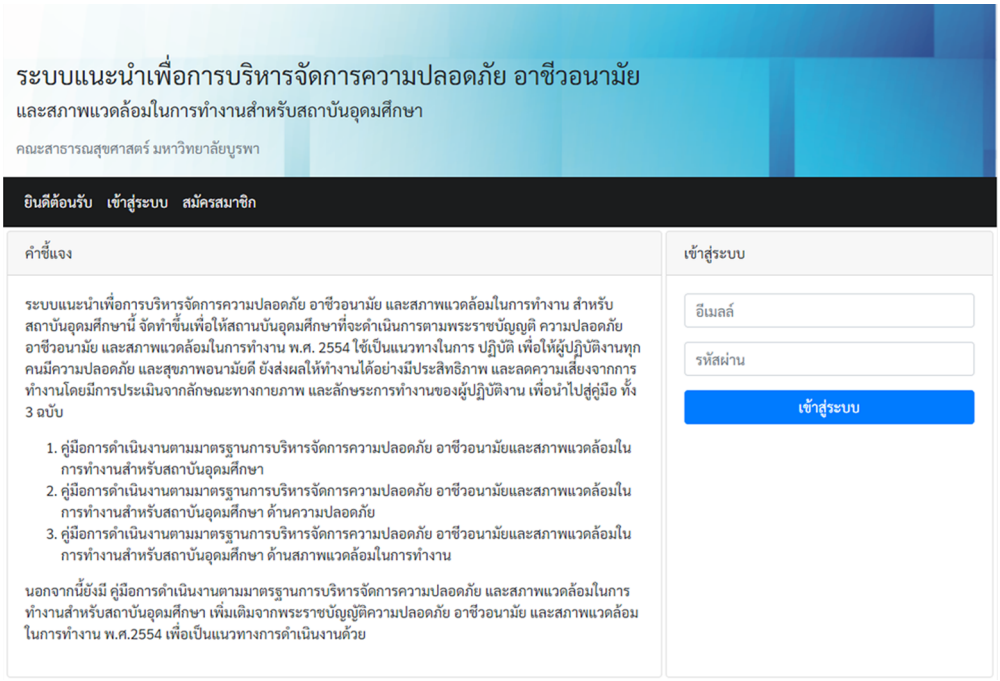


Figure 2 Recommendation system for occupational safety, health and environmental management for higher education institutions

Table 2 Level of satisfaction and comparison of various aspects of satisfaction with the recommendation system of occupational safety, health and environmental management for higher education institutions, by instructor affiliation week (n=170)

Satisfaction with the recommendation system	All (n=55)	OHS lecturers	Non-OHS lecturers	z	*p*
	Mean ± SD	Mean ± SD	Mean ± SD		
Easy to use, uncomplicated	4.45 ± 0.57	4.60 ± 0.50	4.28 ± 0.61	2.13	0.05
Ease of access to information	4.45 ± 0.63	4.53 ± 0.51	4.36 ± 0.76	0.98	0.53
Forms and methods of presenting information	4.18 ± 0.67	4.17 ± 0.70	4.20 ± 0.65	-0.18	0.89
Completeness of information	4.16 ± 0.71	4.10 ± 0.66	4.24 ± 0.78	-0.72	0.41
Information is easy to understand	4.13 ± 0.70	4.10 ± 0.66	4.16 ± 0.78	-0.32	0.71
Operational benefits	4.67 ± 0.55	4.73 ± 0.45	4.60 ± 0.65	0.87	0.55
Overall satisfaction	4.34 ± 0.55	4.33 ± 0.48	4.36 ± 0.64	-0.18	0.90

OHS = Occupational health and safety; SD, standard deviation

The overall satisfaction of the instructors in the occupational health program was not different from the instructors in other instructional groups. In terms of satisfaction, the majority also received similar scores between the two groups (Table 2).

Discussion

The design of the recommendation system for occupational safety, health and environmental management for higher education institutions opens by defining access to the system for two types of people that are system administrators and end - users. The construction of a definite and uncomplicated symbolic system also diminishes misapprehension and displays the formulated system requirements[15]. All processes of the system that interact can be shown in a class diagram. This diagram shows the system's classes and the relationships in different aspects between those classes.

The PHP computer language (PHP Hypertext Preprocessor or Personal Home Page) was used to code the recommendation system. It is a popular programming language because it was developed and designed for creating HTML (HyperText Markup Language) code elements. It is also a significant tool that supports the creation of dynamic and interactive web pages with the user.

We assessed the user's satisfaction with the system during the trials with scored questions. The assessment form was reviewed for content accuracy and its suitability for the evaluation of the recommendation system by professionals in occupational health and information technology. The form achieved a consistency index greater than 0.5 for all questions, which satisfies the measurement and evaluation criteria[16]. We then contacted the sample group via electronic mail and provided the URL of the referral system. The assessment form was sent to the participants through the online system.

The advantage of collecting data in this way is that the respondents are the real testers of the system because they are contacted via the same way as the trial participants. Those who could reply to our survey must have had a password to access it, and therefore they had already used the system. It is also convenient, and results are quickly available. The evaluation of research by using the internet for data collection is widely and increasingly used[17]. For example, Sarawudecha[18] provided a training program for conducting systematic literature reviews at the Faculty of Medicine, Chiang Mai University; a Google form was used to assess knowledge and satisfaction, which can be a reliable model of research[19]. However, the satisfactory assessment for this study and the response rate is still considered to be high enough to be acceptable[12]. Therefore, we used the response data for analysis comparison.

The overall satisfaction with the system of instructors in an occupational health program did not differ from those teaching other subjects. Most of the aspects of satisfaction also received similar scores between the two groups, indicating that the recommendation system is suitable for users in all fields of higher education institutions, despite them not having experience in occupational health and safety. This shows that the recommendation system we designed for entering information is comfortable and not complicated.

Conclusion

The recommendation system we developed is suitable for all instructors working in higher education institutions. There was no difference in the overall satisfaction with the system between instructors in occupational health courses and those from other fields. The scores for satisfaction with various aspects of the recommendation system for all study participants (both groups) were high. Accordingly, instructors working in higher education institutions have access to the recommendation system from the manual after assessing the preliminary information of the institution or faculty.

Recommendations for further research should be explored on the factors affecting the implementation of safety, occupational health and environment in higher education institutions. We also suggest a follow up study on the realization of the recommendation system. In addition, the system's drawbacks should be analyzed for future research so that future improvements can be made. However, the law should be applied to government entities in the same way as it is to establishments, because compliance is impossible without penalties. Executives should also be able to access the system, to enable them to spot non-qualifying needs and make the most of the operation.

Author Contributions

PP and PM designed the research. KA inspected the program. PP conducted the study, and PP, PM and YM wrote the manuscript. All authors discussed the results and commented on the manuscript prior to submission for publication.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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