Design and Implement a Web-Based Training Management Platform for Army Simulator Systems

Kai Chain*
Department of Intelligent Network Technology, I-Shou University, Kaohsiung City, Taiwan.
*Corresponding Author: kaichain@isu.edu.tw
DOI: https://doi.org/10.30211/JIC.202402.003

ABSTRACT

The present study redesigned the training management platform for the Taiwanese Army Simulator System by adding new functions, revising extant interfaces, and digitizing the basic information, teaching plan information, and usage analysis information of various simulation training systems (STSs); the training efficiency of the Taiwanese Army was subsequently improved. In addition, the data was uploaded onto the Internet to enhance management efficiency and save labor and costs. The present study considered the costs saved through STSs and their influences on training safety to fully elucidate the usage conditions of the STSs in the Taiwanese Army. The results were then used to design and implement a web-based platform. The findings obtained in the present study can be provided to relevant personnel as a reference for subsequent analysis and application.

Keywords: Simulator, Web-Based platform, Training and usage management.

1. Introduction

In recent years, the training capabilities of the Taiwanese Army have progressively deteriorated following continual army organization downsizing. Budget cuts, inadequate training grounds, and other factors hinder the execution of combat training missions. Currently, the Taiwanese Army is experiencing a transition period from conscription to full voluntary enlisting. This raises the problem of carrying out combat missions with limited human and financial resources. By implementing simulation training systems (STSs), fuel and ammunition consumption can be effectively controlled, equipment use can be fully understood, equipment operation safety can be successfully improved, and budget restrictions can be significantly reduced [1, 2, 11-13].

The Taiwanese Army currently possesses seven major STSs (i.e., infantry, artillery, armored reconnaissance, aviation, communication, engineering, and battalion) that provide 34 training items. Users of all ranks (e.g., recruits in recruit training centers and regular and reserved commissioned/ noncommissioned officers) have previously used the STSs. Thus, the importance of the simulation training system is evident. However, assessing the performance of STSs is extremely difficult because of several variables, such as different implementation times (e.g., implementation of the Artillery/mortar observation STS in 1993 and the UH-60M utility helicopter STS and AH-64E helicopter attack training STS now), functions (e.g., laser rifle STS for individual soldiers, OH-58D cockpit procedure trainer for pilots, and combined tank STS for combined training), and user traits.

Conventional performance assessment methods are based on statistical analysis, necessitating various assessment attributes and accurate simulator information. A review of the performance assessment results of extant army STSs indicated that infantry, artillery, armored reconnaissance, aviation, communication, engineering, and battalion STSs could not reflect the overall state of army STSs. Therefore, performance assessment methods based on statistical analysis may fail to register a portion of valuable information, resulting in biased conclusions [3, 6].

The Army calculates the saved fuel, ammunition, and human resources by applying yearly STSs. However, these statistics are based on cost conservations and do not consider training safety. Therefore, the present study developed a web-based platform by implementing comprehensive scientific and statistical methods (i.e., integrated analytic hierarchy process while simultaneously considering the influences of cost saving and training safety) [8]. The web-based platform was then used to fully elucidate the current usage status of extant army STSs and prevent the wastage of training resources caused by low system usage or idle systems [7]. The results of the present study can serve as a reference for subsequent analyses and applications to improve the functions and training efficiency of extant STSs, thereby effectively maximizing investment benefits [5, 9, 10].

In Section 2, we discuss the design and construction of the web-based platform. In Section 3, we introduce various functional interfaces of the web-based platform. Section 4 presents the security analysis of the web-based platform, and Section 5 presents research suggestions, improvements, and conclusions.

2. Design and Construction of the Web-Based Platform

The web-based platform was based on WAMP Server 2.5 and installed on Windows 2008 SP1. Apache 2.4.9 was adopted as the server software, MySQL 5.6.17 as the database, and PHP 5.5.12 as the coding language. Code Ignite was used as the framework for web-based development to enhance maintainability. Moreover, readability and navigation of the web-based platform were enhanced by applying Bootstrap, a framework based on JavaScript and CSS. Finally, the web-based platform was optimized for IE 9.0 because IE 9.0 and higher were the mainstream browser versions used by the internal staff.

3. Main Results

The web-based platform contains five sub-platforms, precisely "Demographic Information" and "Back-End Maintenance and Management" (of various simulators), "Training Management," "Personnel Management," and "Document Management" (of various training command centers). The functions and content of each sub-platform are described below:

(1) *Basic information*: This sub-platform contains information concerning building times, building costs, and building statuses of current simulators. This information is accessible to

relevant units and operators.

(2) *Training management*: This sub-platform contains the annual training schedules of various training units and feedback about simulator usage provided by various building units. This information is accessible to relevant units and operators. In addition, training performance and value analysis can be accessed in this sub-platform.

(3) *Back-end maintenance and management*: This sub-platform contains information concerning simulator availability statistics, maintenance providers, budget statistics, and other relevant maintenance logs and statistics. This information is accessible to relevant units and operators.

(4) *Personnel management*: This sub-platform contains information on the simulator administrators in various building units. It also manages the information of educators and trainers and the account details of relevant units using the platform.

(5) *Document management*: This sub-platform contains implementation plans and regulations, technical manuals of individual simulators, and other relevant documents.

3.1 Basic Information

A login system was incorporated into the web-based platform to effectively build the basic information of various simulators based on military branches and make the information accessible to users and training/management units. The data stored in the platform can be updated in real-time. In addition, permissions can be set so that only administrators with the highest permissions canaccess and modify the basic information of various simulator building units. Basic information can be characterized into two sections, namely, "Basic Simulator Information" and "Current Simulator Building Status," as illustrated in Figures. 3 and 4. The two sections are separately discussed below.

Figure 1. System architecture

Figure 2. List of all army simulators

Figure 3. Simulators categorized by military branch

Figure 4. List of Artillery Simulators

3.1.1 Basic simulator information

This section contains information on currently active army simulators (Figure 1). The data is organized into "Military Branch," "Tactics," and "Combat" (Figure 2).

When selecting "Military Branch," the STSs are ordered based on infantry, armored reconnaissance, artillery, aviation, communication, engineering, transport, political warfare, and combined arms, as illustrated in Figure 3. By clicking on a branch, the system displays the names of all simulators in the specific branch. Figure 4 illustrates a screenshot of the simulators in the "Artillery Simulators" category.

The system displays information about the selected simulator by clicking on a specific simulator. Figure 5 illustrates the essential information for the "Avenger Anti-Air Missile STS." The "Modify" button can be chosen to modify simulator information, as illustrated in Figures. 6 and 7.

Figure 5. Basic Simulator Information (using the Avenger anti-air missile STS as an example)

裝備料號	6920YETV06977、8
獲得方式	委中研院
訓練對象	"1.專業軍官班（步兵隊、機步隊）、義務役預官班（步兵隊、機步隊、120砲隊、反裝甲隊）、體幹班、政戰學校職前訓練班、國防大學畢訓班、體幹班、考選、自選預備士官班（步兵隊、機步隊）、考選、自選預備士官班（偵搜、60砲、81砲、120砲、車裝42砲、車裝120砲、40榴彈機槍、托飛、標飛、觀測）、儲備士官班 2.本軍所屬戰鬥部隊與勤務支援部隊之編制步槍人員"
運用構想	"1.培養官校步兵伍、班及步訓部步兵班、排實兵對抗訓練暨測驗並滿足專精管道班戰鬥教練實兵對抗訓練，使部隊能夠汲取實戰經驗，並銜接基地排、連教練、鑑測與實兵對抗需求。 2.藉以培養單兵射擊基礎訓練，以成為一合格射手，可銜接實彈射擊需求"
修改	修改

Figure 6. Modifying basic information

陸軍模擬系統 - T91射擊訓練模擬器 基本資料	
核撥文令	Test001 ×
類別	步兵
單價	24478190
建案單位	教準部
作需單位	步訓部
建案案號	TT97003Y、TT98009Y

Figure 7. Modifying basic information (using T91 as an example)

3.1.2 Current simulator building status

This section contains building information categorized into "Overall Army Simulator Building Status," "Training Command Centers," and "Battalion," as shown in the Figures. 8 and 9. Ascreenshot of the options for the "Training Command Centers" category is illustrated in Figure 8.

By clicking "Overall Army Simulator Building Status," the system displays the current building status of the Army. As illustrated in Figure 9, this page shows the building units and locations.

When viewing the information in "Training Command Centers" or "Battalion," the user must select the desired training command center or battalion to view the corresponding simulator building status. Figure 10 illustrates the building statuses for simulators owned by the 10th Army.

Figure 8. Building Status

Figure 9. Overall Army Simulator Building Status

Figure 10. Simulator Building Status (using the 10th Army as an example)

3.2 Basic Information

Training units can be requested to submit their schedules via the "Training Management Platform" for review to help the Army Education, Training, and Doctrine Development Command ensure that the training units implement the STSs allocated to them by the items, content focus, training intensity, and methods stipulated in the annual training plans. When training units fail to comply with training plans, their immediate authorities are notified to facilitate the control and

arrangement of remedial training. This platform also provides information concerning training performance, which can be used to assist administrators in organizing training outcomes (Figures. 11 to 14).

Figure 15 illustrates the yearly, monthly, and daily training conditions of the training units for each simulator. Figure 16 illustrates annual training performance. In addition, monthly training performance is similar to Figure 16.

Figure 11. Training Standard Settings

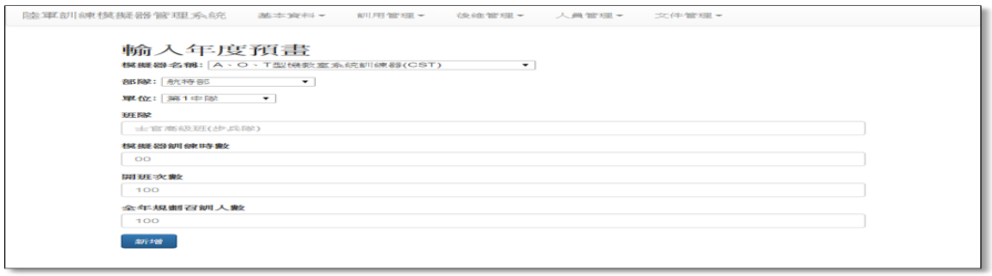

Figure 12. Annual Training Plan

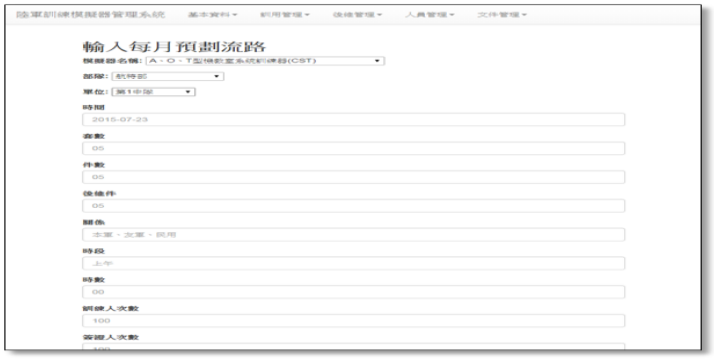

Figure 13. Monthly Implementation of the Training Plan

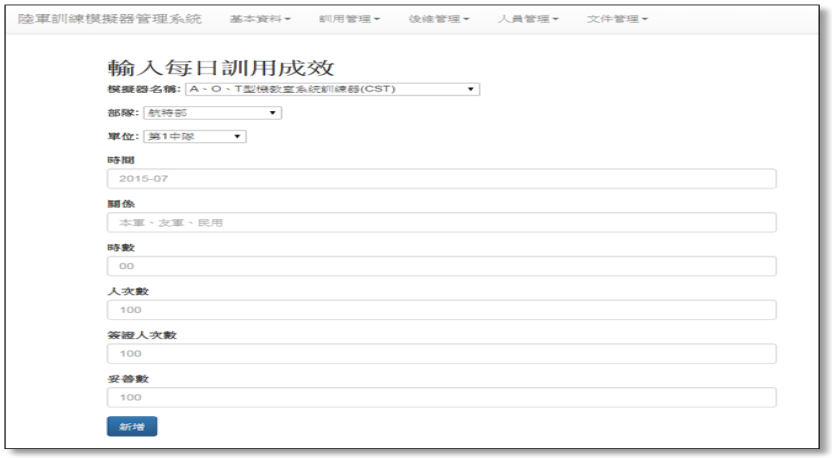

Figure 14. Daily Training Performance Entry

Figure 15. Simulator List

使用班隊/單位	模擬器訓練時數(A)	開班次數(B)	全年應訓練時數(A*B)	全年規劃召訓人數(C)	全年實際訓練人數
564旅機步2營	24	1	24	240	0
564旅戰車1營	24	1	24	240	0
564旅反甲連	7	1	7	70	0

Figure 16. Training Performance Preview

3.3 Back-End Maintenance and Management

This section provides summaries for training expenses and simulator usage conditions. The information can be provided to relevant units or personnel to manage back-end maintenance estimations, as shown in the Figures. 17 and 18.

公司名稱	服務項目	聯絡人	聯絡電話
領航	戰車模擬器	于凱	0918453276
鴻宇		黃奕義經理	02-22621234
博宇		蔡金宏工程師	03-5785821
開拓		王振發顧問	0917924376
惠陽	雷射接戰系統	黃經理	02-27466863

Figure 17. List of Back-End Maintenance Service Providers

Figure 18. Cost Estimations for the Back-End Maintenance of the Simulators

3.4 Personnel Management

"Account Management" can be categorized into administrator accounts and user accounts. Administrators can create new users, perform modifications, and browse various simulator administrator information. Users are only authorized to change their password and modify personal details. Figure 19 illustrates the personnel management interface.

The "Account Management" section lists the information about all current simulators and their administrators. This function lets supervisory units view each simulator's current administrators, responsible units, and locations, as shown in Figure 20. New administrators can be appointed when previous administrators have been transferred, as shown in Figure 21.

The "Simulator Trainers" section lists all trainers using simulators in their training programs. Similarly, transferred or retired trainers can be modified in the system, as shown in Figures. 22 and 23.

The Figures show that the "Account Management" section enables administrators to modify personnel-related authorization. 24 and 25. This section lists all administrators and the names of the simulators managed by each administrator.

Figure 19. Personnel Management Information section

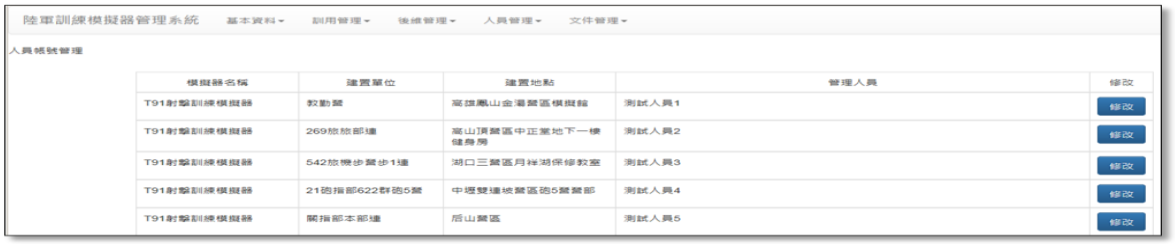

Figure 20. Personnel management

Figure 21. Administrator modification

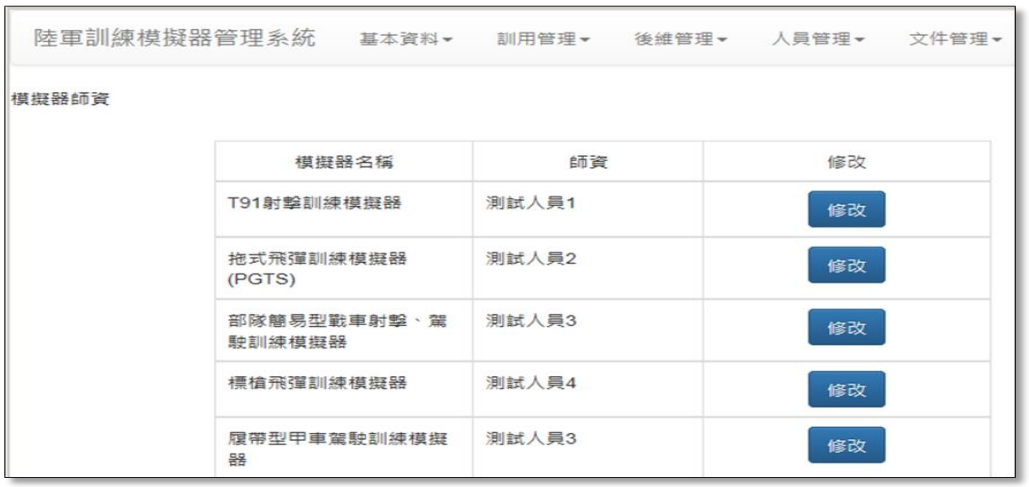

Figure 22. Trainer list

Figure 23. Trainer modification

Figure 24. Test Personnel Account Management

Figure 25. Test Personnel details

3.5 Document Management

This set of system functions enables users to browse and modify simulator execution plans, regulations, technical manuals, building documents, and relevant agreements. Figure 26 illustrates the options in "Document Management."

This section also allows users to download relevant execution plans, browse regulations, or create and upload new information, as shown in Figures. 27 and 28, using the "T91 Shooting STS" example. Simulator documents can be downloaded, modified, or uploaded in "Building Document," as shown in Figure 29. Agreements can be viewed and uploaded in "Commission (Modification) Agreement (Contract)," as shown in Figure 30.

Figure 26. Options in document management.

Figure 27. Execution Plans and Regulations.

Figure 28. Download and Modify Execution Plans and Regulations (using the T91 Shooting STS as an example)

Figure 29. Building Documents

Figure 30. Agreement Upload.

The white box and black box scanning are required to set the simulation system online. After the scanning is completed and the weaknesses or vulnerabilities are fixed, the simulation system will be online [4, 5]. This sector will discuss the scanning results and process of fixing the vulnerabilities.

4. Security Analysis

4.1 Result of Black Box Scanning

The result of black box scanning is shown in Table 1. The scanning tool for black box scanning is Acunetix, and the first scanning shows the websites are at high risk, as shown in Figure 31.

Table 1. Result of Black Box Scanning

Vulnerability Type	Risk
Host Header Attack	High
Weak Password	High
Form without CSRF protect	Medium
User credentials are sent in clear text	Medium
Login page password-guessing attack	Low

Session Cookie without Secure flag set	Low

Source: By authors.

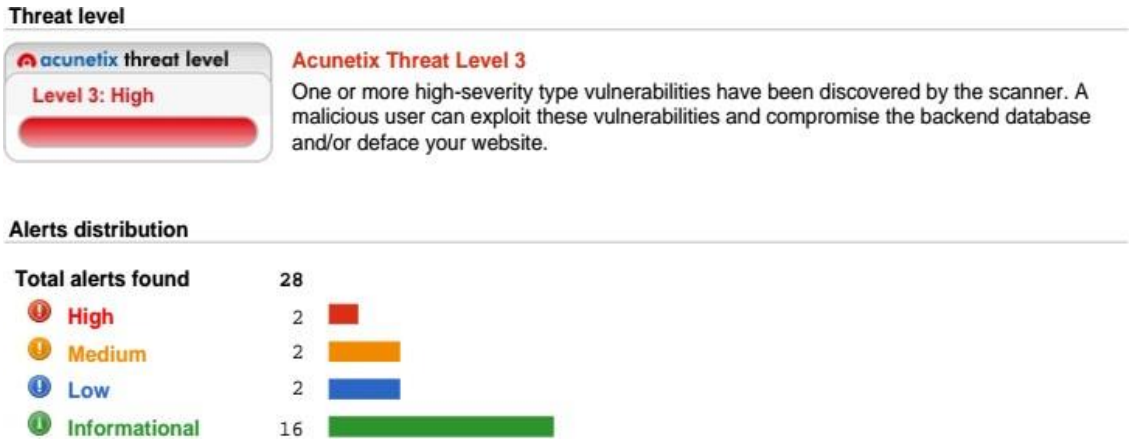

Figure 31. Black box scanning report

4.2 Fixing Process of Black Box Scanning

According to the scanning results, there are six vulnerabilities in the simulation system, with two high risks, two medium risks, and two low risks.

Host Header Attack: Host header attack means malicious users can modify the host field of the header. Simulation systems use the framework Code Ignite to build the primary web, and Code Ignite_SERVER ['HOST'] can be set to a fixed string rather than default "NULL." After setting a fixed string, this kind of attack is fixed.

Weak Password: At the beginning of establishing the system, the developer set an easy password to decrease the process of entering a password. The password was not modified while executing the scanning process.

Form without CSRF protection: The simulation system is used by administrators to upload the training data. Input forms are required for entering the data and are also a good way for hackers to use SQL injection and cross-site scripting. In the development stage, such vulnerabilities are fixed. However, Cross-site request forgery (CSRF) attacks are not. After adding a CSRF token, the attack is fixed.

User credentials are sent in clear text: The original simulator system was not using security transfer. Every data was sent clearly since the simulator system uses HTTP. To solve this problem, the administrator applies a certification for security transfer.

Login page password-guessing attack: When users input the wrong password several times, the system should apply a detection mechanism for brute force attacks. Otherwise, malicious users can enter the system after huge tries and errors. This issue was solved by using Captcha and locking the IP after entering the wrong password.

Session Cookie without Secure flag set: This vulnerability was fixed after using security transfer.

As shown in Figure 32, the vulnerabilities were fixed.

4.3 White Box Scanning

The white box scanning result is shown in Figure 33 and Table 2. The white box scanning tool is Chekmarx.

Figure 32. Fixed black box scanning report

	高風險	中風險	低風險	資訊	總共
To Verify	0	5	34	98	137
Not Exploitable	0	0	0	0	0
Confirmed	0	0	0	0	0
Urgent	0	0	0	0	0
總共	0	5	34	98	137

Figure 33. White box scanning report.

Table 2. Results of White Box Scanning.

Vulnerability Type	Numbers of Vulnerabilities	Risk
Privacy Violation	3	Medium
Stored Code Injection	2	Medium
Use of Broken or Risky Cryptographic Algorithm	28	Low
Information Exposure Through an Error Message	4	Low
Information Leak Through Persistent Cookies	2	Low

Source: By authors.

4.4 Fixing Process of White Box Scanning

Opposite to online black box scanning, offline white box scanning, such as source code analysis tools, can examine the possible risks in source codes.

Privacy Violation: The developer set a variable $password in the PHP files, and the attribute for the variable was public. After reconstructing the codes, the vulnerability was wiped out.

Stored Code Injection: The simulator system uses echo () and eval () functions to calculate and combine the strings. The functions are viewed as dangerous and need artificial examination—the white box scanning. After modifying the code and artificial verification, the risk was fixed.

Use of Broken or Risky Cryptographic Algorithm: The simulator system used MD5 as the default hash function. MD5 was regarded as a more dangerous hash function. After changing the hash function, the vulnerability was fixed.

Information Exposure Through an Error Message: When the error occurs, the error message will show the reason why the error occurs. This is friendly information for both developers and malicious hackers. Although the system turned off the error message, the white box scanning still detects the risk and reminds the developers.

Information Leak Through Persistent Cookies: User information was stored in the cookies, and the persistent cookies are stored on the user side. This can cause security and privacy problems. The vulnerability was fixed after modifying the code and store type of cookies, as shown in Figure 34.

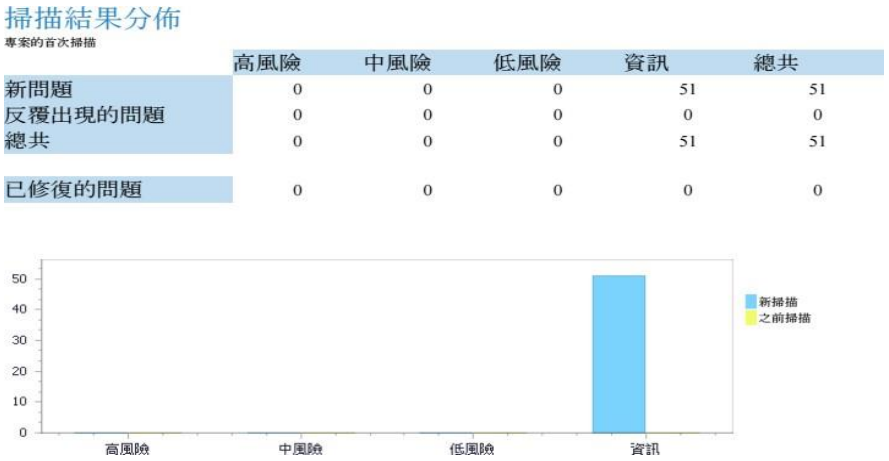

Figure 34. Fixed white box scanning report

5. Conclusions

With advanced and modern technological combats, digitization of combat environments, and developing high-technology weapons and equipment, the Taiwanese Army will require high-quality and long-serving professionals to effectively enhance the quality and specialization needed to create an elite army. By upholding the guidelines of "maintaining basic combat ability and permanently developing asymmetric combat ability," modern weapons that conform with the future combat requirements of the Army can be secured, essential techniques can be self-developed, and various weapons systems can be researched and manufactured. In addition, under the principles of "defense,

no self-production, and replacement" proposed by the Ministry of Defense, the Taiwanese Army shall continue to procure advanced weapons systems externally to foster modernized combat capabilities that conform with the defense requirements of Taiwan and establish "three-dimensional, digitized, and automated" ground combat capabilities.

The present study re-designed a web-based training management platform for the Taiwanese Army Simulation System by compiling the usage conditions of various users as well as revising the interface and adding new functions based on user demands, thereby information and networking the "basic information," training management," "back-end maintenance and management" "personnel management," and "document management" of various STSs. Administrators and users can interact online through the proposed web-based system, enhancing army training efficiency. Subsequently, compiling multiple pieces of information into a web-based platform enhances management efficiency and saves labor and cost.

In the future, researchers can add new user interfaces or modify extant interfaces to enhance operations and satisfy customization requirements. Moreover, because information is stored in a database, extensive data analysis methods can be adopted following a period to provide even more information, facilitating the subsequent usage conditions and development of simulators.

Acknowledgments

The MOE Teaching Practice Research Program supported this research.

References

[1] Chou, C.C. and Ding, J.F. Application of an integrated model with MCDM and IPA to evaluate the service quality of transshipment port. Mathematical Problems in Engineering, 2013, Article ID 656757. DOI: 10.1155/2013/656757.

[2] Danese, P. Supplier integration and company performance: A configurational view. OMEGA International Journal ofManagement Science, 2013, 41(6), 1029-1041. DOI: 10.1016/j.omega.2013.01.006.

[3] Koblitz, N. and Menezes, A.J. Another look at non-standard discrete log and Diffie-Hellman problems. Journal ofMathematical Cryptology, 2008, 2(4), 311-326. DOI: 10.1515/JMC.2008.014.

[4] Martilla, J.A. and James, J.C. Importance-performance analysis. Journal of Marketing, 1977, 41(1), 77-79. DOI:10.1177/002224297704100112.

[5] Zhang, S.L. A model for evaluating computer network security systems with 2-tuple linguistic information. Computers and Mathematics with Applications, 2011, 62(4), 1916-1922. DOI: 10.1016/j.camwa.2011.06.035.

[6] Molodtsov, D. Soft set theory-first results. Computers, and Mathematics with Applications, 1999, 37(4-5), 19-31.DOI: 10.1016/S0898-1221(99)00056-5.

[7] Zadeh, L.A. Fuzzy sets. Information and Control, 1965, 8(3), 338-353. DOI: 10.1016/S0019-9958(65)90241-X.

[8] ANSI et al. Justification study for a new work item proposal for an energy management standard and guidance document. 2007.

[9] ISO, Guidelines for the justification and development of management system standards, ISO, ISO Guide 72:2001(E), 2001.

[10] ISO, Information, and Documentation – Management systems for records – Fundamentals and vocabulary, *ISO*, ISO DIS 30300:2010-05-21, 2010.

[11] Danese, P., Molinaro, M. and Romano, P. Investigating fit in supply chain integration: A systematic literature review on context, practices, performance links—Journal of Purchasing and Supply Management, 2020, 26(5), 100634.DOI: 10.1016/j.pursup.2020.100634.

[12] Li, S., Huo, B. and Han, Z. A literature review towards theories and conceptual models of empirical studies on supply chain integration and performance. 2022, 250, 108625. DOI: 10.1016/j.ijpe.2022.108625.

[13] Jhang, S.S., Lin, W.T. and Fang, I.H. How do firms' integrated market power affect upstream trade credit and institutional ownership? Evidence from Taiwan. Asia Pacific Management Review, 2020, 25(2), 75-86. DOI: 10.1016/j.apmrv.2019.08.001.