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An Evaluation Model for Private Information Security Education Programs in South Korea

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Abstract

Background/Objectives: In order to strengthen security from intelligent attacks and new security issues, for this is reason, it is necessary to systemize educational courses to raise professional information security workforce. **Methods/Statistical Analysis:** To develop evaluation criteria for educational courses on information security, this study formed an advising council with 7 experts. After constructing evaluation criteria, in order to calculate weights for each evaluation criterion, we conducted a questionnaire survey on professionals of information security education using Analytic Hierarchy Process (AHP). **Findings:** This study constructed AHP model based on (items of) evaluation criteria drawn out through literature review and experts' verification. The 1st level of the AHP hierarchy is composed of goal of the model, the 2nd level is composed of 4 higher standards and the 3rd level is composed of 14 lower standards. Finally, we draw out 4 evaluation criteria and 14 sub criteria and score for evaluate information security educational courses in private sector. **Application/Improvements:** This study intends to verify, modify and complement evaluation criteria through simulation tests by applying evaluation criteria to actual educational institutions.

Keywords: Education, Evaluation, Information, Private, Program, Security

1. Introduction

Recently, intelligent hacking attacks such as 7.7 DDoS attack and 6.25 cyber terror are on the increase. In response to ever more intelligent hacking attacks, development of security technology is at standstill compared with advanced countries and technologies to tackle new security issues are still deficient. Hence, in order to strengthen security from intelligent attacks and new security issues, workforce-centered security capable of immediate response is becoming more important. According to a survey material of Korea Internet & Security Agency, as of 2014, security workforce is in short supply by 2,144 personnel and by 2017, there will be new demand for 16,197 personnel. In contrast, supply of workforce is expected to be only 3,006 personnel, rendering the shortage by 13,191 personnel[1]. The shortage of workforce includes not only new recruits joining the job market but also currently working personnel, reemployed personnel and those who prepare to change jobs. While new recruits can be educated by regular educational institutions such as universities and graduate schools, other workforce must be educated in private education institutions on information security. Like this, although the discrepancy between supply and demand of security workforce is continuing, presently, there is still lack of education and training system to cultivate security workforce[2]. Although there are estimated 25 private educational institutions for information security as of September 2015, there has been no verification on the quality of these institutions. As the result of survey on the status of educational courses offered by domestic educational institutions on information security, it was found that domestic private educational institutions on information security are operating their curricula to fit the market demand and their curricular are different from one another[3]. As it is

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predicted that educational institutions on information security will increase in the future, there are possibilities that unverified educational courses will be established and operated in ever increasing number. Therefore, it is necessary to systemize educational courses to raise professional information security workforce[4]. In order to satisfy the demand for cyber security workforce on a national level, U.K. publicized technological competencies required by type of jobs in the form of framework and is currently operating various educational certification systems that authorizes excellences of security workforce, educational curricula and educational institutions related to information security education[5]. Educational institutions on information security in Korea also should double their efforts to develop and operate educational courses which reflect the needs of consumers, design professional technological education courses to secure professionalism and make stable operation possible for the long term by securing qualified instructors. From this perspective, this study developed and suggested evaluation criteria focusing on the contents and operation of educational courses on information security.

2. Literaturere View

2.1 Research on Education Evaluation Criteria and Education Satisfaction

To develop educational evaluation criteria, this study conducted literature review on the studies on development of educational evaluation criteria and satisfaction with education. Hyo Jung Jeon et.al.[6] developed evaluation criteria on educational institutions through experts' panel discussions and verifications centering on educational contents and operations of educational institutions for information security in terms of operational efficiency of the institutions and calculated and suggested weights of the evaluation criteria by using AHP. evaluation criteria is largely classified into educational evaluation and operational evaluation and detailed evaluation criteria are business operation, human resources, financial management, educational operation, instructor workforce, educational plans and executions. Hartman et al.[7] suggested teaching competency of the faculty, exchange between instructors and students, interchange between administrators and students and support for career planning as items to assess students' satisfaction with education. Schweitzer et.al. [8] analyzed operational system, standards of certification and evaluation items of U.S. Certification System, Center of Academic Excellence (CAE) in Information Assurance Education (IAE). As factors influencing students' academic satisfaction, Sirgy et.al.[9] suggested instructors, teaching methods, learning environment and facilities, educational programs, quantity of learning and the reputation of educational institutions. Kaiwan's study[10] applied AHP method to assess education of universities and suggested educational methods, effect of education and relationship with students as evaluation criteria. To find out factors significantly influencing satisfaction with educational service, Aldridge et.al.[11] surveyed on university students' level of satisfaction. The surveyed items were computer equipments, instructor workforce and method of conducting instructions, instructors' competency, educational environment, educational contents, exchange with administrative personnel who manage students, counseling and financial support. Elliott et.al.[12] studied the aspects of educational experience influencing students' satisfaction.

2.2 Domestic and Foreign Education Certification

To draw out evaluation criteria, this study surveyed the cases of existing certification system related to education practiced in and out of Korea. For domestic cases, study surveyed Accreditation Board for Engineering Education of Korea (ABEEK)[13] and Korean Association of Business Education Accreditation (KABEA)[14] and for overseas cases, U.S. educational certification for information security Centers of Academic Excellence (CAE) in Information Assurance/Cyber Defense (IA/CD) certification[15] and Academic Centres of Excellence in Cyber Security Research (ACE-CSR) of CESG Certified Training (CCT)[16] and The Engineering and Physical Science Research Council (EPSRC) implemented by Communications-Electronics Security Group (CESG) in U.K. In addition[17], study also analyzed domains and items of evaluation criteria of respective certification by researching on Accreditation Board for Engineering and Technology (ABET) of U.S.[18] and international business administration education certification, Association to Advance Collegiate Schools of Business (AACSB)[19] evaluation criteria of domestic and overseas certification systems drawn out by analysis are presented in Table 1 and 2.

Table 1. Information security education certification criteria

Certification	CAE IA/CD	CCT	ACE-CSR
	United State of America	**United Kingdom**	**United Kingdom**
criteria	Outreach/Collaboration	Education management	Institution's letter of support for application
	Center for IA/CD education	Course materials	Description of the applicant
	A robust and active IA/CD academic program	Trainer availability	Track record and esteem indicators of members of staff
	IA/CD is multidisciplinary within the institution		Peer-reviewed publications
	Practice of IA encouraged throughout the institution		Doctoral level students programme
	Student-based IA/CD/cybersecurity research		External research funding and impact of projects
	Number of IA/CD/cybersecurity faculty and course load		
	Faculty active in current IA/CD/cybersecurity practice and research		

Table 2. Education certification criteria of management and engineering

Certification	Management Education Certification		Engineering Education Certification	
Type	**South Korea**	**United State of America**	**South Korea**	**International**
name	ABEEK	ABET	KABAE	AACSB
criteria	Students	Students	Mission, vision and goal	Strategic management and innovation
	Program educational objectives	Program educational objectives	Evaluation and evaluation of outcomes	Students
	Program outcomes and evaluation	Student outcomes	Program curriculum	Faculty
	Professional component	Continuous improvement	Student support service	Professional staff
	Faculty	Curriculum	Faculty qualifications	Learning and teaching
	Facilities and institutional support	Faculty	Physical, laboratory and training facilities	Academic and professional engagement
	Education improvement	Facilities	Continuous improvement	
	Program criteria	Institutional support		

3. Research Method

3.1 Evaluation Verification: Expert Panel Discussion

To develop evaluation criteria for educational courses on information security, this study formed an advising council with 7 members from field staff and instructors of public and private educational institutions on information security, professors of departments of information security and researchers of National Competency Standards, and conducted 2 times of expert panel discussions on September 10 and October 8, 2015. In the first discussion, study constructed evaluation criteria (draft) (on evaluation standards) drawn out through literature review and in the second discussion, developed detailed evaluation criteria reflecting the opinions raised in the 1st discussion.

3.2 Evaluation Criteria : Analytic Hierarchy Process

After constructing evaluation criteria, in order to calculate weights for each evaluation criterion, study conducted a questionnaire survey on professionals of information security education using Analytic Hierarchy Process

(AHP), which is one of decision-making methodologies suggested by Professor Thomas L. Saaty. AHP is a method to obtain evaluation ranking and holistic preference for the alternatives compared by rendering decision-making a hierarchical structure and drawing out relative preference of evaluation alternatives with the weights (relative significance) of evaluation criteria applied based on pairwise comparison and by integrating them in hierarchical structure. The result of pairwise comparison requires consistency and AHP technique checks if the weights by pairwise comparison are logically consistent by using 2 criteria, Consistency Index (CI) and Consistency Ratio (CR). The process of AHP methodology is first, to establish hierarchy of the problem to be decided. This is the stage to classify overall goals, criteria and alternatives and to hierarchize them. Second, relative weights are given to criteria and alternatives. In the last stage, holistic preference rankings are assessed for alternatives and majority opinions are collected [20].

4. Evaluation Criteria Development

4.1 Composition of Evaluation Criteria

This study constructed AHP model based on (items of) evaluation criteria drawn out through literature review and experts' verification. 1st hierarchy of the study model is composed of goal of the model, 2nd (hierarchy of the study model is composed) of 4 higher standards and 3rd (hierarchy of the study model is composed) of 14 lower standards (Figure 1).

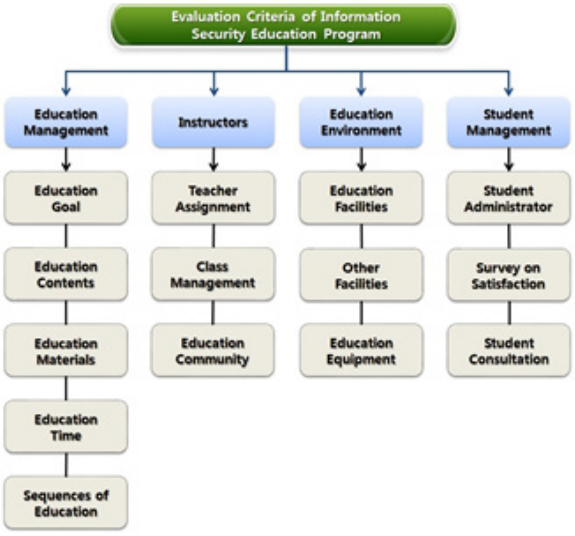

Figure 1. AHP model of evaluation criteria.

4.2 Drawing out Weight for Evaluation

To calculate weights for each evaluation criterion, study conducted a questionnaire survey on administrators, field staff, instructors and assistant instructors and professors of the departments of educational institutions of information security on and offline through email and direct visit for 3 weeks from November 1 through 21, 2015. Out of collected 25 questionnaires, a total of 15 questionnaires were judged to be valid and used as data for analysis except for 10 ones with consistency ratio of 0.2 and more or with defects. This study computed significance of group opinion by using geometric mean of 15 professional opinions and conducted analysis on order of preference between higher standards and lower standards by using AHP analysis program 'Expert Choice 2000.' (Table 3) shows professional opinions on the order of preference on higher standard (2nd class). As the result of analysis on higher standard, significance of educational management was the highest with 33% followed by instructors with 33%, educational environment with 17% and students with 17%. With drawn out weights, scores were distributed with the full mark of 400 points.

Table 3. Analysis result of criteria

Criteria	Weights (%)	Scores	Priorities
Education management	0.333(33%)	130	1
Instructors	0.333(33%)	130	1
Education environment	0.167(17%)	70	3
Student management	0.167(17%)	70	3
Total	1.000(100%)	400	-

Points on 14 items of lower standards were distributed according to the significance of their higher standard. Results of analysis on the evaluation items of lower standard are demonstrated in (Table 4).

4.3 Evaluation Standards Drawn out by Weighted Evaluation Criteria

Scores were distributed on evaluation criteria according to the calculation result of weights for evaluation criteria and evaluation standards for each domain were drawn out. Evaluation criteria are as follows (Table 5).

Table 4. Final results of analysis

Criteria	Sub Criteria	Weight	Scores	Priorities
Education management (115)	Education goal	0.262	35	2
	Education contents	0.321	40	1
	Education materials	0.077	20	4
	Education time	0.129	10	5
	Sequences of education	0.210	25	3
Instructors (135)	Teacher assignment	0.400	50	1
	Class management	0.400	50	1
	Education community	0.200	30	3
Education environment (80)	Education facilities	0.379	25	2
	Other facilities	0.113	10	3
	Education equipment	0.508	35	1
Student management (70)	Student administrator	0.413	30	1
	Survey on satisfaction	0.260	20	2
	Student consultation	0.327	20	2
Total	14	4.000	400	-

Table 5. Evaluation criteria for information security education program

Criteria	Sub Criteria	Descriptions	Scores
Education management (115)	Education goal	Does education goal correspond with educational contents?	35
	Education contents	Do the actual educational contents include the ones prescribed in the curriculum?	40
	Education materials	Do educational texts include educational contents?	20
	Education time	Do educational courses satisfy the time required for the education?	10
	Sequences of education	Are the educational courses conducted considering the relationship with related courses?	25
Instructors (135)	Teacher assignment	Do the professional fields and careers of instructors fit the educational courses?	50
	Class management	Are the instructors' teaching competencies/communication skills fit for the educational contents?	50
	Education community	Can the leadership of the instructors draw out well-rounded exchange with students or exchange among students?	30
Education environment (80)	Education facilities	Are the educational facilities including laboratories/ learning environment sufficiently equipped to perform educational contents?	25
	Other facilities	Are the supplementary facilities including study room/student lounge sufficiently equipped to perform educational contents?	10
	Education equipment	Are the educational facilities including laboratory/laboratory equipments (devices) sufficiently equipped to perform educational contents?	35
Student management (70)	Student administrator	Are standing supplementary workforce secured to administer students other than instructors for each curriculum?	30
	Survey on satisfaction	Do the educational institutions conduct regular satisfaction survey on students when educational courses are completed?	20
	Student consultation	Do the educational institutions provide counseling services on study plan and job search (led by instructors)?	20
Total			400

5. Conclusions

The purpose of this study was to develop and suggest evaluation criteria to enhance the level of quality of information security courses provided by private educational institutions. This study drew out (items of) evaluation criteria through literature review and case studies, distributed scores by calculating weights (relative significance) for each evaluation criterion using AHP methodology and presented detailed criteria and evaluation standards for detailed criteria. The results of this study are significant in that this study provides evaluation criteria which enable students to make judgments on whether education programs for information security are excellent or not. Educational courses on information security in private sector have the problem of inconsistent levels of quality depending on the expertise and knowhow of the educational institutions and developers and the difficulty for the students to select proper and excellent educational courses which fit their needs out of numerous courses. evaluation criteria suggested by this study are expected to provide direction and meaning in developing excellent educational courses by specifying factors for the courses and guidelines for the developers of educational courses. By strengthening education on information security, this study is also expected to contribute to fortifying the competencies of security workforce. Although it is not certain that the evaluation criteria developed and suggested by this study for educational courses of private educations institutions on information security can be utilized in the field, they are still expected to provide practical help for private educational institutions in developing educational courses and improving their education by suggesting study results as guidelines. Yet, the limitations of this study are first, there were only 15 subjects of AHP analysis in calculating weights for evaluation criteria and second, verification on the evaluation criteria by simulating them on educational courses of actual educational institutions was not conducted. Author of this study intends to verify, modify and complement evaluation criteria through simulation tests in the future studies by applying evaluation criteria to actual educational institutions.

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