A Framework for Prioritizing Required Knowledge, Skills and Competencies of Cooperative Students

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***Abstract*—This research proposed a framework to identify the weight and also the priority of required knowledge, skills and competencies of cooperative students. The academic institute needs to supply the required knowledge, skills and competencies to students before they get in to the host organizations. However, the university has no sufficient resources to supply all requirements to the students. Therefore, a proper method to identify the weight and to identify priorities of considered elements was required. According to a distinctive of analytic hierarchy process, this study applied it to be a part of the framework to deliver the expected outcome.**

***Index Terms*—Analytic hierarchy process, cooperative education, competency, work integrated learning.**

I. Introduction

Knowledge, skill and competency are highly respected as the crucial attributes for working achievements. In currently intensive competitive situation, most of the organizations expect to recruit the graduate students with additional skills as well as working experience more than the typically theoretical and academic knowledge acquired from an undergraduate degree. Therefore, in a few past decades, several famous universities applied cooperative education (co-op), one type of work integrated learning (WIL), in their curriculums, since many empirical researches indicated that the co-op is an action that can deliver the potential advantages to students as well as firms participating in the project [1], [2] Many researches summarized benefits for undergraduate students such as career enhancement, cost savings, collaboration between employers and the academic institution, etc. Co-op is an educational process that is mainly operated by the cooperation between university and enterprise. Generally, university mostly educates an academic and theoretical knowledge to students, whereas host organization mainly provides skill and competency. In any case, knowledge, skill and competency must conform to the curriculum philosophy. Therefore, academic institutions must also involve with working knowledge, skill and competency development of student. One of important issues in the co-op is the working knowledge, skill and competency development of student. Most of knowledge, skill and competency of working are mainly derived from enterprise. Nevertheless, universities must also supply some initial knowledge, skill and competency responding to enterprises' requirements. Several studies identified the required knowledge, skills and competencies of students in the co-op curriculum such as communication, leadership, information technology skill, etc. A number of requirements of working knowledge, skills and competencies were declare, but the universities are not able to provide them within the typical academic courses as well as additional training courses. Therefore, in order to correctly focus on the important aspects, the prioritization of working knowledge, skills and competency of is critically required.

This study has an objective to propose a framework for prioritizing the requirements of working knowledge, skills and competencies of the organizations cooperating in co-op program. The remainder of this study is divided into four main sections. In the first section, related studies are reviewed. The second step briefly describes all the relative methods. Next, a framework of this study is described. Finally, the conclusions of this study are outlined.

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II. Literature Reviews

A. Cooperative Education

WIL is a learning paradigm concentrating on an integration of working and studying [3]. WIL can be performed in several formats including internships, cooperative education (co-op), professional work placements, community service, etc. Nevertheless, the advantages of co-op have been well documented over other WIL approaches. Most of benefits are identified for students, the host company, and the university. For students, the co-op program could help students by clarifying their career goals, enhancing self-confidence, and gaining high salaries [4]. Moreover, co-op students have better opportunity for getting a career, since they have good skills in resume writing and job interview [5]. For host organizations, the firms have opportunities to select and hire the potential employees, interactions with the academic institution, and cost-saving advantages [2]. For university, the academic institution can obtain several advantages from co-op program including curriculum improvement [6], and reputation and marketing enhancement [7].

One of critical matters in co-op activities is the identification of working knowledge, skills and competencies of students. These identifications directly affect to the study plan and training sessions of both academic institution and host organization. Nevertheless, the knowledge, skills and competencies of students may be dissimilar to the employees of companies. However, these knowledge, skills and competencies must relate to the requirements of the organization in order to strengthen a

relationship with the host organization. Several studies suggested the expected knowledge, skills and competencies of cooperative students from associated firms such as Table I.

TABLE I: EXAMPLE OF EXPECTED KNOWLEDGE, SKILLS AND COMPETENCIES OF CO-OP STUDENTS

Author / Year	Expected knowledge, skills and competencies
Gault *et al.* [8]	Communication, academic knowledge, leadership, working
Cullen [9]	Computer, writing, communication, data collection, data input, technical knowledge, information technology, problem solving
Asgarkhani and Wan [10]	Communication, relationship, teamwork, leadership, positive thinking, self-development, mentor, attention, problem solving, rapid learning, systematic management, innovative idea, ethics, multi-skills working, strategic thinking

From the literature reviews, all studies specifically intended to clarify and to establish the knowledge, skills and competencies of co-op student. Nevertheless, to develop the students to meet those identified requirements, the academic institutes as well as host organizations need to spend a lot of resource. Therefore, if the university and firms have limited resources, then they need to focus on the crucial matters first. Hence, the prioritization of the expected knowledge, skills and competencies are highly required. However, there is no research that appropriately prioritizes the required knowledge, skills and competencies by identifying the weights of each consider element. The closest study [10] identified the order of these aspects using the cumulative frequency, so it could provide the ranking of all aspects, but still could not clearly state the important weight of each required knowledge, skills and competencies. Since, the identification of weight with the required knowledge, skills and competencies would assist the university and host organization to firstly focus on the high weight, therefore, the method which can provide the weight and priority is highly required. Typically the multi-criteria decision making (MCDM) is identified as a proper method to solve this problem.

B. Multi-Criteria Decision Making (MCDM) and Analytical Hierarchy Process (AHP)

MCDM is a suitable methodology to manage with the problem that consists of multi considered elements. There are several MCDM methods, and the most applied methods can be concluded as Table II.

Table II identifies that the AHP is a method that can consider either quantitative on qualitative data. Moreover, it also can check the consistency of decisions to verify the consistence of a decision maker. From these advantages, it has been highly applied with several studies. Saaty [12] initiated the AHP as a technique to analyze complicated problems. It constructs a decision problem into hierarchy format. The AHP has been widely applied in several domains. For example, Meixner *et al*. [13] applied this hierarchy decision method to find the weights of criteria of EFQM excellent award in order to provide an approach to food industry in Australia. Wudhikarn [14] applied AHP to identify the weight of six big losses following overall equipment effectiveness (OEE) in order to find the most problematic equipment. There was also a study using AHP to identify weighted value of various managerial competency facets, whereas this study focused on the competencies of healthcare middle manager. Several studies were applied AHP, since it closely relate to the human decision-making. Nowadays, there are several software packages such as Expert Choice, Super Decision, etc. These applications could reduce the errors of calculation, and also simplify the AHP.

TABLE II: COMPARISONS OF MCDM [11]

Characteristic	AHP	TOPSIS	ELECTRE I	ELECTRE II	ELECTRE III
1. Core process	Creating hierarchical model and pairwise comparison matrices	Calculating distance to positive and negative ideal point	Determining concordance and discordance indexes	Determining concordance and discordance indexes	Determining concordance and discordance indexes with indifference and preference thresholds
2. Necessity to quantify the relative importance of criteria	Yes	Yes	Yes	Yes	Yes
3. Determining of weights	Pairwise comparison with 1 to 9 scales.	Linear or vector normalization	Based on decision maker	Based on decision maker	Based on decision maker
4. Consistency check	Yes	No	No	No	Yes
5. Problem structure	Quantitative or qualitative data	Objective and quantitative data	Objective and quantitative data	Objective and quantitative data	Objective and quantitative data

III. RESEARCH FRAMEWORK

In this section, a framework for prioritizing required knowledge, skills and competencies of cooperative student is constructed. The identified methods with a proposed framework were selected from its potential advantages indicated in the former section. The framework of this research can be represented as Fig. 1.

This framework proposes an approach to collect the weight and priority of required knowledge, skills and competencies of cooperative students. First, the required knowledge, skills and competencies will be tentatively set

from the literature review. Then all host companies can add, edit or delete the identified knowledge, skills and competencies from the proposed list. After, edited list is obtained from the involved organizations, then all identified aspects that have similar characteristic will be grouped into the same cluster. In this study, only three clusters are classified including with working knowledge, skill and competency. All determined aspects will be categorized into these groups, and then the hierarchy model of this problem can be constructed as shown in Fig. 2.

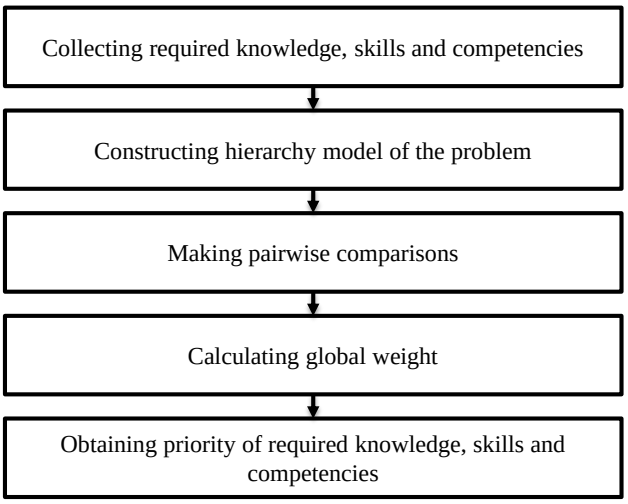

Fig. 1. A research framework.

Therefore, in this AHP problem, the hierarchy model will consist of three major clusters and each group will include with several elements inside. The priorities of the various elements are derived from pair-wise comparisons. The pair-wise comparison must be executed by considering on two relative elements within the same cluster, and the comparisons can be conducted by interview or questionnaire execution. However, if there are several participants similar to this study, the questionnaire approach is more preferable. An example of questionnaire of pair-wise comparison can be shown as in Table III. The questionnaires will be constructed by considering on all relative elements in all clusters, and then they will be sent and decided by responsible staff in all host organizations including with mentor of cooperative student, human resources manager, etc.

The pair-wise comparisons are considered on the relative importance scores that is 1-to-9 scale as shown in Table IV.

TABLE IV: SCALE OF ANALYTIC HIERARCHY PROCESS PREFERENCE [10]

Intensity of importance	Definition	Explanation
1	Equal importance	two activities contribute equally to the objective
3	Moderate importance	experience and judgment slightly favor one over another
5	Strong importance	experience and judgment strongly favor one over another
7	Very strong importance	activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	used to represent compromise between the priorities listed above

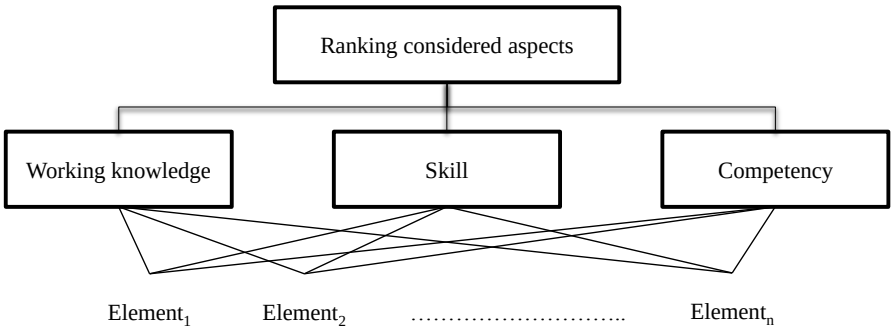

Fig. 2. A hierarchy model of this study.

TABLE III: EXAMPLE OF QUESTIONNAIRE OF PAIR-WISE COMPARISON

Element	Pairwise comparison																	Element
	Element on left side is more important								Equal important	Element on right side is more important								
Element 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Element 2
Element 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Element 3
….	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	….
Element n	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Element n+1

Nevertheless, one of critical issue that must be considered with the pair-wise comparisons is the consistency of the

consideration. It is an essential procedure after finishing each pair-wise comparison. If the inconsistency is large, it would disrupt an accuracy of the measurement. Saaty [10] also determined an index of consistency called the consistency index (CI), and it can be computed by Equation (1).

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (1)$$

from the equation,

λ_{max} is the maximum eigenvalue

n is number of criteria or elements

The equation implies a variance of the error incurred in the comparison matrix. Nevertheless, to measure the final consistency result, the CI value must be calculated concurrently with another index that is a random consistency index (RI). The RI is an index that assesses the consistency of an obtained pair-wise comparison matrix and the average random consistency index can be obtained from Table V.

TABLE V: RANDOM CONSISTENCY INDEX [10]

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

After CI and RI are obtained, a consistency ratio (CR) can be computed by using Equation (2).

$$CR = CI / RI \quad (2)$$

After the CR result is obtained, it should be aware that if the CR is greater than 0.1, then the comparisons must be revised. Three procedures are required to improve the CR outcome as follows:

1) Searching the most inconsistent comparison in the matrix.
2) Making new pair-wise comparison for the most inconsistent decision. This new consideration should improve the CR.
3) If the inconsistency cannot be changed from the former process, then the second most inconsistent value and others in consecutive order will be considered.

After the CR is checked, and the consistency outcome is obtained, the results will be used to calculate the global weights of all considered elements. From the final weight result, it will suggest the priorities of all required knowledge, skills and competencies of cooperative students. These priorities will be applied to identify courses, training sessions and resource usages for developing cooperative students.

IV. DISCUSSION AND CONCLUSION

Cooperative education has been respected as a successful way of new educational paradigm. It is a learning process that is mainly associated by academic institute and host organization. Several potential advantages for both university and company have been well documented such as career enhancement of co-op student, cost saving of host company, collaboration between academic institute and organization, etc. One of critical matters in co-op education is the requirements of host organization. The university must supply the knowledgeable students to firms in order to sustain the co-op education. Therefore, the students should have some critical knowledge, skills and competencies, before entering the host organization.

However, the academic institution cannot educate and supply all required knowledge, skills and competencies to the students according to the limitation of resources. Hence, the weight and prioritization of those aspects is highly required, since the university is able to correctively supply the important aspects to student first.

From the limitation of resources of academic institute, this research proposed a framework to find the weight and priority of required knowledge, skills and competencies in order to apply them to plan the resource consumptions and to develop course and training session for cooperative student. In this study, the proposed framework was constructed following the AHP approach, since it has several potential advantages to the problem of this study.

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