An Institutional Research of the Relationship between Student 's Academic Performance and Practice Performance in University of Technology

Chien-Chih Wang*, Wei-Ting Yu
Industrial Engineering and Management, Ming Chi University of Technology, Taiwan.

* Corresponding author. Tel.: +886-2-29089899; email: ieccwang@mail.mcut.edu.tw
Manuscript submitted January 21, 2018; accepted February 5, 2018.
doi: 10.17706/ijeeee.2018.8.3.240-247

Abstract: In Taiwan, internships are critical for technical and vocational education. Through the appropriate internship, arrangements allow students to lay the foundation for learning to enhance the employment capacity of graduates. In the study, from the historical data to analyze the academic performance of the internship and internship job satisfaction rules. The Ming Chi University of Technology (MCUT) overseas practical training program that began in 2006 has become the pioneer among all universities and colleges in the world. Therefore, using Industrial Engineering and Management (IEM) students of MCUT as an example and adopted data analysis techniques for model building. Results showed that the most relevant subjects for internship satisfaction are production system and information systems. The subject of scores influence internship scores to some extent, among which production control, basic concepts, and information programming are of more importance. The study provided to schools in arranging courses and first-year students in the selection of classes for reference.

Key words: Institutional research, off-campus internships, statistical decision model, learning outcome.

1. Introduction

The cultivation of talent in Taiwan transformed from elitism to universal education. In 2016, the amount of people with a bachelor's degree or above reached five million. This is about 25% of the overall population in Taiwan. The unemployed with a bachelor's degree or above account for 54.03% of the overall unemployment population. Having a bachelor's degree is no longer a competitive advantage, as recent graduates are inevitably faced with the unprecedented crisis of unemployment. The internship system originates from the U.S. in early 1990s. The system aims at referring students to relevant workplace settings based on their career interest and area of study. In doing so, students can experience the practical situation of workplace settings while they are still pursuing a degree. Internship is a special and innovative method of instruction. Through internships, students can enter the workforce and experience the workplace environment in advance, and it eventually is directly relevant to students' decision-making in regard to their career. Internships are a type of instructional resources and an educational program that keeps students away from the traditional school setting and allocates students in various organizations and settings. In doing so, students can be aware of the obstacles and challenges of the workplace, while workplace settings become an educational partner to schools [1]. Internships are a warm-up before entering the workforce, through which students can find out about their personal interests in advance and integrate practice and

theory [2]. Internships thus function as a career exploration [3].

Knowledge that is used in real life is different from theory. Students can explore careers and interests through an internship to find a direction through which they can achieve their personal goals. Research indicates that off-campus internships are significantly more helpful for students in terms of students' adaptability when they enter the workforce in the future [4]. Off-campus internships are a graduation requirement at many universities in Taiwan. As of 2013, the Ministry of Education has subsidized 83 universities to implement off-campus internship programs for their students in Taiwan. It is hoped that students can apply what they have learned to practical issues, and that their problem-solving ability can be enhanced through the curricular plan of learning-in-doing during their internship. Students with distinguished performance during their internship can receive employment offers in advance to increase the employment rate of recent graduates, creating a win-win situation for both industries and universities. Some schools, however, go awry from the principles of education-based internships upon establishing cooperation with the companies, as schools only provide their students with the options of an internship setting while companies take interns as cheap labor and ask them to perform miscellaneous tasks and unskilled work for their internship, causing disputes between the interns and their employers.

In principle, students can lift from internships if they work hard regardless of the company or the department they are in. However, this does not imply that choosing an internship is not important. According to the Enterprise Academy of Information, from its establishment in 2012 until now, organizations have provided a total of 9,273 internships, and the number of students demanding for internships from colleges and universities has reached 17,266 over the years. Thus, in terms of improving the quality of students' internships, maintaining the status quo, while merely providing students with internship options and being unaware of analyzing information such as student internships over the years, individual academic records, and personal attributes will not provide any constructive reference for decisions as student internships will remain at their current level of effectiveness and make the situation hard to break through. Future graduates with internship experiences will therefore gradually lose their advantage in the labor market.

Since its establishment in 1964, Ming Chi University of Technology (MCUT) has been using the work study internship program. Students who attend MCUT are required to fulfill the one-year off-campus internship prior to their graduation. With long-term efforts, organizations providing internships to students at MCUT have expanded from the companies under the Formosa Plastics Group in the beginning to various domestic and international large-scale companies. Currently, there are more than 100 cooperative companies, providing 2 to 3 internship options to every student, and students receive a monthly income between 21,000 and 36,000 NTD during the internship period. The MCUT which is the best school of implementing the internship systems in Taiwan, will be the object of study for this research. This is representative in conducting the research.

2. Methodology

The research proposed a three-step procedure for establishing the recommendation rules [5]. The first being the classification of curricula taken prior to internship and internship settings. The second involves data organization and transformation of grades. The third is the computation of association rules. Using the students in the Department of Industrial Engineering and Management as an example, academic records, the types of internship duties, and internship performance were used for data clustering. The internship recommendation rules were established using association rules. In practice, analysis is conducted after the internship opportunities were published by the university in April and May every year, and it recommends a ranking of internship duties that are suitable for students as a reference. The model will be modified in

order to continually improve of the recommendation rules based on the new data retrieved after the competition of internship performance held in every December.

- Step 1: Students have numerous courses prior to their internship. Courses are categorized according to core professional licenses, specialized compulsory courses and core departmental competences. Take the Department of Industrial Engineering and Management as an example, courses are categorized base on the subjects tested for Certification in Industrial Engineering (Quality Control, Production Control, Engineering Economics, Facility Planning, Human Factors and Ergonomics, Operational Research), foundations, management knowledge, statistical analysis, programming, commercial knowledge, management knowledge, general compulsory courses, and specialized compulsory courses. Internship settings are categorized based on the students' future development after graduation. Specialists in the industry are consulted to discuss the core competencies that students are expected to possess in industrial engineering in order to suggest that internship settings be categorized into production management, quality management, and factory administrative management.

Internship duties include: (1.) production management: standard operating procedure planning and control, production scheduling management, inventory control, procurement management, procedural analysis and planning, work environmental testing, time measurement, motion analysis, operational efficiency analysis, analysis of production and control performance, production management and planning, and production management data storage management and analysis. (2.) Quality management: incoming quality control for raw material, sampling planning, quality abnormality analysis, production quality control, outgoing quality control, line quality control, confidence testing and analysis, statistical analysis and processing, quality management performance analysis, quality business communication and coordination, and management and analysis of quality management data storage. (3.) Factory administrative management: programming for information systems, information systems analysis, information systems design, computer software support, data processing, data validation, data analysis, data categorizing and archiving, customer complaints handling, and other administrative duties.

- Step 2: Data organization in this study was conducted according to the procedure of uniqueness, correctness, integrity, and rationality. Data uniqueness is used to check data. For instance, students' identification numbers cannot be repeated. Correctness is used to check if data abide by the regulations. For instance, the range of raw data scores must fall between 0 to 100. Integrity refers to the integrity of the records in the database. For instance, if a student does not complete the internship effectiveness evaluation, the data will not be used for analysis. Rationality refers to the existence of illogical data.

In their learning process, students may sit for exams of various difficulties in different years. In addition, the marking criteria differs from one teacher to another, while differentiation will be lost if the marks in percentage are directly converted to letter grades. Therefore, the study will make its classification of students' scores and performance based on their ranking in class. Scores ranking 1~25%, 26~50%, 51~75%, 77~100% are converted to A, B, C, D respectively.

- Step 3: This study adopts the Apriori algorithm to establish the association rules for the recommendation rules [6]. The association rule mainly uses the criteria of the smallest degree of support, the smallest degree confidence and lift to select the best method. The smallest degree of support is used to determine the prevalence of the rule, while the degree of confidence is used to select the rules with the highest accuracy. Even if a rule has high degrees of both confidence and support, it does not necessarily mean that the rule has practical value; therefore, the degree of lift must be used to determine the degree of correlation between the two aspects. It is only when the

degree of lift exceeds 1 that a positive relation exists, and a rule then becomes practical [7].

The Apriori algorithm was proposed by Agrawal and can be used to efficiently find out the association rules with the smallest degree of support and confidence in a massive database. The rules of support, confidence and lift of are defined as follows. The support supp(X) of an itemset X is defined as the proportion of transactions in the data set which contain the itemset.

supp(X)= no. of transactions which contain the itemset X / total no. of transactions

The confidence of a rule is defined

$$conf\left(X \to Y\right) = \frac{supp\left(X \cup Y\right)}{supp\left(X\right)}$$

The lift of a rule is defined

$$lift\left(X \to Y\right) = \frac{supp\left(X \cup Y\right)}{supp\left(X\right) * supp\left(Y\right)}$$

The actual process involves selecting transactions (large 1-itemsets) with a degree of support larger than the least amount of support. Large 1-itemsets is then used to produce large 2-itemsets and used to determine the association rules whose degree of confidence is larger or equal to the least amount of confidence. This continues until large k-item sets ($k \geqq 2$) become an empty set. The procedures are explained as follows:

Step 1: Calculate the degree of support of all 1-itemsets and find the 1-itemset whose degree of supportiveness is larger or equal to the least amount of supportiveness and call these large 1-itemsets. The process should stop when large 1-itemsets become an empty set.

Step 2: Combine the items in large 1-itemsets into various options of 2-itemset. Similarly, find the 2-itemset whose degree of supportiveness is large or equal to the least amount of supportiveness and call these large 2-itemsets. The process should stop when large 2-itemsets become an empty set.

Step 3: List all the possible association rules for each 2-itemset in large 2-itemsets and find the association rules whose degree of confidence is larger or equal to the least degree of confidence.

Step 4: Repeat Step 2 and 3 in order to produce large *k*-item sets ($k \geqq 2$) and association rules whose degree of confidence is large or equal to the least amount of confidence until large k-item sets become an empty set.

Step 5: Finally, use the degree of lift to select the relevant important association rules.

3. Analysis and Discussion

MCUT has accumulated a lot of information relevant to the internships, so MCUT used as the research object. The university can find out students' attributes, specialties, and their subsequent relation with internship providers using scientific methods. Afterwards, students only need to provide the competences they currently possess and rank the orders of the types of internship options that are suitable to them. Through the mechanisms of referring work study internships, students can be referred to the internship settings that provide positive learning experience to them according to the students' current abilities. This will definitely enhance students' learning effectiveness and lower the risks of negative outcomes of

internship and those of changing internship settings. Simultaneously, students can become aware of the professions that are suitable to them in terms of their current competences through the internship process, as well as the professional skills that need to be improved for the future. University freshmen, based on their aspired career in the future, can also find out the professional skills that the senior students, who had distinguished performance during their internship in relevant internship settings, possess in order to accordingly adjust their learning plan in advance to lower the chances of not being able to apply what they have learned in their workplace and maximize the lifts of their internship.

This research is based on the evidence-based exploration of the students in the Department of Industrial Engineering who did their internship in 2015. The established association rules include two parts, which are the association rule of a single course and distinguished performance in internship. They are aimed at understanding whether there is any association existing between internship scores and the courses, while the association discussion on internship duties and distinguished performance in internship is to establish rules of internship recommendation.

The first step is to conduct a parameter estimation, i.e. to select the smallest degree of support from outstanding internship performance and internship experience, and then use the figure as the largest value of support in the study. Data statistics found that 70.7% of people attained outstanding internship performances (A+ in the work study program), 48.0% of people chose production management as their internship positions, 53.3% selected facility administration, and 18.7% selected quality management. Therefore, the smallest degree of support must be lower than 18.7% in order to obtain all the internship position selections and performances, as well as their corresponding association rules. It was observed in the heat map (Figure 1) where the lowest degree of support is 0.03 and the lowest degree of confidence is 0.5, most rules fall between 0% to 10% of support and 50% to 80% of confidence. Therefore, the lowest degree of support, 5%, 8% and 10%, are used to adjust the degree of confidence. When the lowest degree of support is set at 0.05 and the degree of confidence is less than 0.8, the number of association rules will drastically decrease. However, a high degree of confidence will make the selection process overly stringent and inflexible; the degree of support of 0.05 is therefore excluded from the setting. When the degree of support is set at 0.08, the total number of rules will decrease as the degree of confidence increases, and the consequent association rules, i.e. the degree of outstanding internship performances, will begin to decrease when the degree of confidence exceeds 0.7. On the other hand, when the supportiveness value is 0.01 and the confidence value is 0.5, the total number of rules is only 128 and the consequent association rules, i.e. outstanding internship performance, only result in 17 rules.

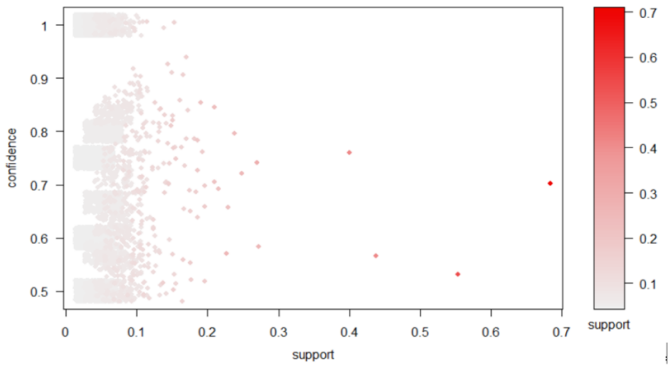


Fig. 1. The heat map between support and confidence.

The next step is to conduct an analysis of association rules regarding a single subject and the corresponding internship performance. Using 0.08 as the degree of support and 0.6 as the degree of

confidence, the result will only show two rules, the antecedent being A- and B+ in compulsory courses and the consequent being A+ in the work study program. However, as long as the compulsory course is better than B, there will be a 0.76 of confidence that the internship performance is A+. Therefore, the result of adjusting the parameter of support to 0.01 and confidence to 0.6 to identify the association rules is shown in Table 1. The result found that if a student achieved a better grade than B+ in compulsory courses, B- in human engineering, C in engineering economics, C+ in production management, B- in operation research, A in special compulsory courses, A- in business knowledge, C+ in basic concept, B+ in statistical analysis, C in facilities planning, C in information programming, B in management knowledge before an internship, there is a 70% chance of having a performance during the internship.

Next is to analyze the association between subject grades, internship positions and internship performance in Table 2. The support value is 0.08 and the confidence value is 0.6, while the antecedent includes internship positions and the consequent is an A+ in the study and internship program. The result found that students with a grade of C in information programming who choose quality management or facility administration as their internship positions have a high chance of performing well in their internship (confidence higher than 0.857).

Table 1. The Support and Confidence Value of Rules by Apriori Algorithm

IF (course grade)	THEN (internship performance)	support	confidence
C+ in basic concept	A+	0.640	0.722
C+ in production management	A+	0.627	0.714
C in information programming	A+	0.560	0.714
C in facilities planning	A+	0.493	0.706
B- in human engineering	A+	0.467	0.769
B in compulsory courses	A+	0.453	0.765
A in special compulsory courses	A+	0.453	0.756
A- in business knowledge	A+	0.413	0.756
B+ in statistical analysis	A+	0.387	0.722
B in management knowledge	A+	0.347	0.750
C in engineering economics	A+	0.320	0.750
B- in operation research	A+	0.320	0.714
B- in quality management	A+	0.307	0.714

Students with an A grade in compulsory courses who choose quality management or facility administration for as their internship position also have a high chance of performing well in their internship (confidence higher than 0.846). Students with a C or C+ grade in facilities planning who choose facility administration can further increase their chances of performing well in their internship (confidence higher than 0.750). Students with a B grade in production management who choose facility administration as their internship have a high chance of performing well (confidence higher than 0.857). Students with a B- grade in basic concepts who choose facility administration as their internship position have a better chance of performing well compared to other internship positions (confidence being 0.750). Students with a C- grade in quality management, although unable to achieve the average grade in both academic subjects and internships, still enjoy a very good chance of performing well in an internship if they choose facility administration as their internship position (confidence being 0.750). Students with a D grade in operation research, although unable to achieve the average grade in both academic subjects and internships, still

enjoy a very good chance of performing well in an internship if they choose facility administration as their internship position (confidence being 0.778). Students with a C- grade in engineering economics, although unable to achieve the average grade in both academic subjects and internships, still enjoy a very good chance of performing well in an internship if they choose facility administration for as their internship position (confidence being 0.818). Students with a B or A- grade in compulsory courses have a better chance of performing well compared to other internship positions (confidence being 0.750). Students with an A- grade in business knowledge who choose production management as their internship position have a better chance of performing well compared to other internship positions (confidence being 0.727).

Table 2. The Association Rule between Subject Grades, Internship Positions and Internship Performance

IF (course grade)	(internship position)	THEN (internship performance)	support	confidence
C in information programming	quality management or facility administration	A+	0.160	0.857
A in compulsory courses	quality management or facility administration	A+	0.107	0.846
C or C+ grade in facilities planning	facility administration	A+	0.713	0.750
B in production management	facility administration	A+	0.093	0.857
B- in basic concepts	facility administration	A+	0.080	0.750
C- in quality management	facility administration	A+	0.080	0.750
D in operation research	facility administration	A+	0.080	0.778
C- in engineering economics,	facility administration	A+	0.093	0.818
B or A- in compulsory courses	facility administration	A+	0.213	0.750
A- in business knowledge	production management	A+	0.187	0.727

4. Conclusion

There is a significant correlation between the students' internship prior to graduation and students' follow-up development. Thus, it is of exceptional importance to assist students in arranging a suitable internship setting. Ming Chi University of Technology is the first school that implements internship systems in Taiwan. They have an excellent procedure for their internship system and maintain long-term records relevant to internship. Therefore, research results obtained from the study using Ming Chi University as an example can serve as a reference for internship promotion at other schools.

This research is based the students in the Department of Industrial Engineering and Management, using data mining, organizing information from historical database, and transforming and modelling based on the obtained data. Information such as academic records, types of internship and internship performance were used for data clustering, while the association rules were used to develop the recommendation rules. Results suggest that subject scores influence internship scores to some extent, among which Production Control, Basic Concepts, and Information Programming are of more importance. Over 80% of students with distinguished performance during their internship are to some degree proficient in these three areas, no matter what duties they were responsible for. Therefore, it is advised that schools emphasize in enhancing these three professional abilities in order to enhance the effectiveness of internship. Students who would like to work as a quality control inspector for their internship should strengthen their programming skills and their performance in specialized compulsory courses. Those who choose to work as a factory administrative manager should put emphasis on their commercial knowledge and their performance in the general compulsory courses. In terms of the application of the established recommendation model, it is recommended that internship companies have students perform duties in quality control or factory administrative management for their internship if their programming skills are slightly below average or if

their performance in specialized compulsory courses is average. On the other hand, it is recommended that internship companies have students perform duties related to factory administrative management for their internship if their performance in management knowledge, general compulsory courses and Operational Research is slightly below average or if their performance in Facility Planning and Production Control is slightly higher than average.

Finally, it is recommended that companies have students perform duties in production management if their performance in general compulsory courses is below average or if their commercial knowledge is better than average.

References

[1] Getz, D. (1994). Students' work experiences, perceptions and attitudes towards careers in hospitality and tourism: A longitudinal case study in Spey Valley, Scotland. *International Journal of Hospitality Management, 13(1)*, 25-37.

[2] Merritt, R. D. (2008). Student internships. *EBSCO Research Starters: Academic Topic Overviews*, 1-8.

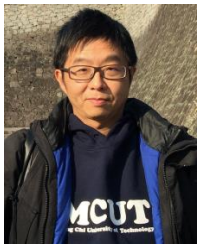
[3] Ramsden, P. (2008). The future of higher education teaching and the student experience. *The Higher Education Academy.* \

[4] Shathya, B. (2013). Applications of data mining techniques in higher education. *Software Engineering and Technology, 5(12)*, 409.

[5] Bhardwaj, A., Sharma, A., & Shrivastava, V. K. (2012). Data mining techniques and their implementation in blood bank sector — A review. *International Journal of Engineering Research and Applications*, *2*(4), 1303-1309.

[6] Osman, N. H., & Fattoh, S. E. (2017). Discovery some of the influencing patterns in the academic performance of the students of the Faculty of Education using the Association Rules technique. Case study: Faculty of Education, Afif. *International Journal of Scientific Research and Educa*tion, *5(6)*, 6571-6567.

[7] Ma, Y. L. (2016). The research on courses correlation based on the intelligent education frame. *The 2nd International Conference on Modern Education and Social Science*, 1236-1240.



Chien-Chih Wang is a professor in the industrial engineering and management at Ming Chi University of Technology in Taiwan. He received the B.S. degree in applied mathematics from National Chung Hsing University in 1992, and the M.S. degree in statistics from the University of National Cheng Kung University in 1994, and the Ph.D. degree in industrial engineering and management from Yuan Ze University in 2001. His current research activities include institutional research, quality engineering, data mining and six sigma methodology and applications.

Wei-Ting Yu is the master's student in the industrial engineering and management at Ming Chi University of Technology, Taiwan. Her research is focused on the topic of institutional research and data mining.