



## **A Preliminary Case Study on Improving Engineering Students' Competency through Industrial Training in a Private University**

**Chong Foon Yee\* and Yeap Kim Ho**

*Faculty of Engineering and Green Technology, Universiti Tunku Abdul Rahman, Bandar Barat, 31900 Kampar, Perak, Malaysia*

### **ABSTRACT**

Engineers form an important part of our technical workforce to successfully transform Malaysia into a fully developed nation as envisaged in the Vision 2020 document. Thus, it is essential for higher learning institutions in Malaysia to produce effective and competent graduates who are able to contribute to the current needs and rapid changes in the engineering industry. However, a key challenge faced by engineering programmes is to address the misalignment in the graduates produced and the industry needs. To address this, industrial training in universities plays an important role in bridging academia and industry where students are able to experience real-life problems as opposed to only classroom challenges. In addition, it is also important that engineering students in universities are well equipped with critical thinking skills and strong technical knowledge to face current and future challenges in industries. In this study, feedback and evaluation forms from industries were analysed to explore the working competency of engineering students in a new engineering programme. It identifies aspects that call for improvement to successfully help engineering students' competency at workplace. This paper also offers a few suggestions on Continuous Quality Improvement (CQI) based on the Plan-Do-Check-Act (PDCA) model to improve strategies prior to, during and post industrial training for the betterment of this new engineering programme.

*Keywords:* Continuous Quality Improvement, Engineering Education, Higher Learning Institutions, Industrial Training, Malaysia, Plan-Do-Check-Act (PDCA) model, Working Competency

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*E-mail addresses:*

[chongfy@utar.edu.my](mailto:chongfy@utar.edu.my) (Chong Foon Yee),

[yeapkh@utar.edu.my](mailto:yeapkh@utar.edu.my) (Yeap Kim Ho)

\* Corresponding author

### **INTRODUCTION**

The need for competent fresh engineering graduates to achieve Malaysia's vision to be a fully developed nation by the year 2020 is vital. In fact, it is stated that there

will be a huge gap between demand and supply for engineers in Malaysia at the present and the near future (MOHE, 2012). Although Malaysia has taken several initiatives to produce more engineers to meet its targeted workforce to achieve Malaysia's Vision 2020, an emphasis on quantity alone is not adequate. As highlighted by Kennedy in NAE Annual Meeting (Kennedy, 2006), not only hard knowledge is important to secure jobs, broader skills including leadership, soft skills and attitudes are also required to be successful. The data from the Department of Statistics, Malaysia (DOS, 2012) and the Ministry of Higher Education (MOHE, 2012) showed that even though Malaysia had low unemployment rate, it has more than 60,000 young graduates who were unemployed in 2010. The major reasons cited for being unemployed were the lack of core knowledge and competency in the job they applied for, poor communication skills and language proficiency, and inadequate general knowledge. Similar findings were summarised by Mourshed, Farrell and Barton (2012), in a study of twenty-five countries, where it was found that 75 million youth were unemployed, with half of them were not sure that their study had improved their employability and almost 40% of the employers said lack of skills as the main reason for entry-level vacancies for jobs. In addition, a study conducted in Malaysia indicated that employers are in favour of fresh engineering graduates with a well-balanced profile (MOHE, 2011). Similar competencies are also prescribed

in the EAC Manual (2012), which will be discussed in our findings section later in this paper.

In order to address the gap between expectations and satisfaction levels of engineering graduates, Malaysian Engineering Accreditation Council (EAC, 2012) has made industrial training a compulsory element. The main objective of industrial training is to allow engineering students exposing professional practices during their four year engineering study.

It is suggested that learning experiences in engineering programmes should be strengthened in technical knowledge, soft skills and personal characteristics. The importance of holistic engineering education to foster competent engineers has been well documented in many studies (Hillmer, Wiedenbrueg & Bunz, 2012; Passow, 2012).

Industrial training in many engineering schools in higher learning institutions is regarded as an essential component in engineering curricula to ensure that engineering graduates produced have a well-balanced profile (Hasbullah & Sulaiman, 2002). The importance and necessity of industrial training has been highlighted by EAC (2012) and MOHE (2012), where it was strongly recommended that industrial training in higher learning institutions be extended to at least 6 months. However, in view of the heavy course structure scheduled for engineering programmes in general, the suggestion to extend the training duration may overstress or overload engineering students. A better suggestion

would be to have an improved 'well-structured' industrial training. It is thus important to find out what is the best way to the cultivate necessary skills such as technical knowledge, soft skills and good engineering characteristics into the current industrial training in higher learning institutions within a reasonable time period. In addition, any elements incorporated into the industrial training must also be examined carefully.

*...the practical application of mathematics and science to create, design, test, improve and develop knowledge, research, money, business, economics, and technology. This is why engineering is such a challenging and demanding field of study. It involves areas of expertise that continue to evolve independently yet are required to perform together as part of the engineering process. Thus, an engineer must be expert in many areas, must know how to communicate knowledge among those areas, and must apply that knowledge to create, design, study, research, and invent all kinds of things. (Schiavone, 2007, p. 16)*

In this study, step by step of Continuous Quality Improvement (CQI) is carried out for our new engineering programme based on the data obtained from the first two batches of students participated in industrial training. The objectives of industrial training for this engineering programme are:

- To provide opportunities for students to apply knowledge and skills learnt in an actual working environment.

- To instil in students the right kind of work attitudes and professionalism.
- To familiarise with on-the-job requirements.
- To enable companies to assess working attitudes and technical capabilities of students.

Industrial training may help students make connections among all different areas of knowledge and skills, integrating these at various stages of their training period as their knowledge and skills develop (Renganathan, Abdul Karim, & Chong, 2012). The intellectual requirements involve students in the kind of thinking that engineers use in professional practice. Thus, we believe industrial training provides the most commodious and stable bridge between learning the basics of engineering knowledge, skill, as well as judgment and entry into actual practice.

The benefits of industrial training for engineering students are obvious; these are summarised by Schiavone (2007) in *Engineering Success*:

1. Trainee is learning on-the-job skills that cannot be learnt in the classroom to bridge the gap between academia and the workplace.
2. Trainee may gain valuable real work experience to prepare for the future job market.
3. Trainee may make valuable contacts for networking inside the engineering and business professions and have improved employment opportunities upon graduation.

4. Trainee may learn to work in groups and interdisciplinary teams.

In short, industrial training plays an important role for engineering students to 'taste' the real work life and understand what the expectation from industry is. Therefore, it is crucial for engineering students and academics to understand the expectation of industry and how they evaluate trainees' competency during industrial training (Omar, Kofli, Mat, Darus, Osman, Rahman, & Abdullah, 2008).

## RESEARCH CONTEXT

This study was conducted on a new engineering programme at a private university in Malaysia. It is compulsory for all students in this engineering programme to attend industrial training for at least 3 months before their graduation. Industrial training is offered in Year 3 with 4 credit hours. It is a pass/fail subject with a cut-off point of 50 marks. After the Industrial training, students will remain at least one more semester in the university to digest what they have learned during their industrial training and apply them in their final year of study. Prior to Industrial training, students must earn a minimum of 60 credit hours, maintain a CGPA of 2.00 or above, and must not be under academic probation.

During the industrial training, students are encouraged to conduct complex engineering activities and solve complex engineering problems (EAC manual,

2012). The evaluations of industrial training are divided into two parts. The first part is assessed by academic lecturers based on log book, final report and oral presentation prepared by the students pertaining to his/her experiences. The second part is assessed by the Supervisor (of the Company) concerning students' competency during industrial training (Industrial Training Handbook, 2012).

## METHODS

In this study, the whole population of eligible year three students in two successive years was involved. In 2012 and 2013, 14 students of the first batch and 33 students of the second batch in this new engineering programme went for industrial training. Their Industrial Training Evaluation Forms filled by the supervisor were collected and analysed.

In 2012, an evaluation form containing 17 competence criteria was used to collect the evaluation from the industry regarding students' competency (Industrial Training Handbook, 2012). In the year 2013, the evaluation form had been revised after taking into consideration the latest published EAC manual (2012). As shown in Table 1, apart from the previous 17 competence criteria, three more items were added, as follows:

18. Ability to follow rules and regulations at the work place
19. Technical ability and knowledge
20. Ability to link and apply theoretical knowledge to the work being done

TABLE 1  
Overall Student's Evaluation Data in 2012 and 2013

	Evaluation Criteria	2012	2013		Evaluation Criteria	2012	2013
1	Communicates in English with others at all levels	3.86	3.93	11	Working under pressure	3.50	3.73
2	Written communication skills	3.64	3.73	12	Questioning skills	3.43	3.63
3	Punctuality	4.14	4.40	13	Organisation skills	3.29	3.90
4	Teamwork / collaboration skills	4.14	4.13	14	Problem-solving skills	3.43	3.60
5	Self-motivation/initiative	3.57	3.93	15	Awareness of quality issues and continuous improvement	3.43	3.66
6	Work ethic / dependability	3.50	3.93	16	Appropriate codes of practice and industry standards	2.93	3.57
7	Critical thinking	3.50	3.60	17	Awareness of intellectual property and contractual issues	2.93	3.53
8	Flexibility / adaptability	3.93	4.03	18	Ability to follow rules and regulations at the work place	-	4.12
9	Leadership skills	3.29	3.40	19	Technical ability and knowledge	-	3.58
10	Interpersonal skills	3.57	3.93	20	Link and apply theoretical knowledge to the work	-	3.62

## RESULTS AND DISCUSSION

In this study, the evaluations from on-site supervisor in two consecutive years of 2012 and 2013 were examined. The results are used as indicators for the Continuous Quality Improvement (CQI) of the department.

### *Students Competency in 2012*

As shown in Table 1, students' industrial training data in 2012 had 17 criteria which were used to evaluate students' competency. A 5-point Likert scale was used in the evaluation form to identify satisfaction levels from the industry ranging from *strongly disagree* to *strongly agree*. A scale equal or higher than 3 indicates that the students' competency is considered acceptable from

the perspective of industries. According to the data, 15 out of 17 items have met the expectation from the industry. The lowest scores obtained are: *item 16* - understanding of appropriate codes of practice and industry standards; and *item 17* - awareness of intellectual property and contractual issues. The possible reason(s) for low scores for *item 16* & *item 17* will be discussed later. The results indicate that there is still a gap between classroom knowledge and knowledge applied in engineering, which is more practical and realistic in a working context.

### *Students Competency in 2013*

After the evaluation forms were revised, 20 criteria were used to assess student's

competency, as shown in Table 1. All the 20 criteria being assessed scored higher than 3. This finding shows that all the criteria pertaining to students' competency being evaluated had met the expectation of the industry and improved compared to the previous batch. The improvement might be attributed to the action taken by CQI in the programme. The item that obtained the highest score was "Punctuality". According

to the feedback from the industry, most of the trainees were not only punctual to work, they also showed high commitment on task completion and completed ahead of due dates. These were acknowledged by their supervisors. On the other hand, the item which obtained the lowest score was leadership. Most of the trainees were not able to lead or were not given the opportunities to lead during their industrial training.

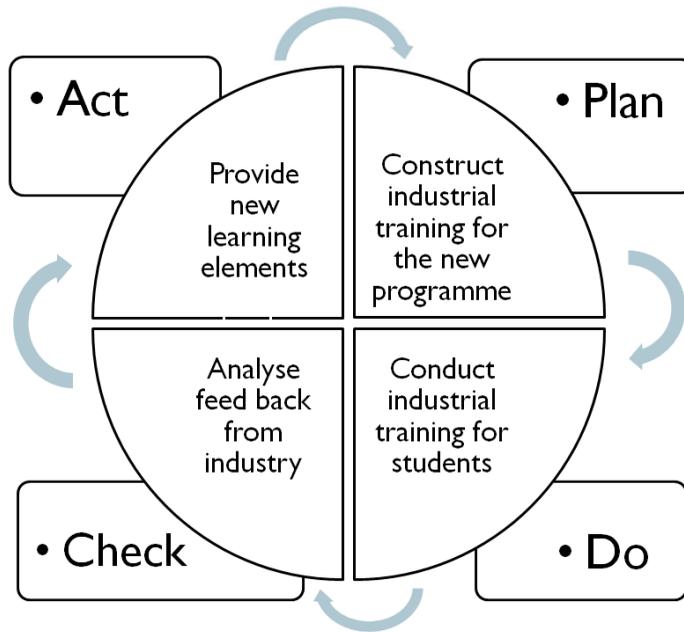


Fig.1: Continuous Quality Improvement (CQI) for Industrial Training using Plan–Do–Check–Act (PDCA) Cycle

*Evaluation as indicators for Continuous Quality Improvement (CQI)*

Continuous Quality Improvement (CQI) process was carried out following the Plan–Do–Check–Act (PDCA) cycle as action model (Sokovic, Pavletic, & Kern Pipan, 2010) as shown in Fig.1. Four steps of the PDCA cycle were implemented following the sequence of planning to send the first

batch of trainees, conducting the industrial training, evaluating their competency and suggesting an action plan for the next batch, and repeat the cycle again.

The results from 2012 were compared with the planned target to determine the satisfaction of the industry. The weakest competency was highlighted and actions were taken for rectification. The following

corrective measures were adopted before the second batch of trainees was sent for industrial training in 2013:

- Student Development Committee (SDC) discussed and suggested necessary action plans
- Curriculum Development Committee (CDC) (involving all academic staff) will take initiative to address gaps identified during lectures and practical work.
- Supports from other resources such as Centre of Extended Education (CEE) and Industrial Advisor Panel (IAP) to conduct talks and seminars were initiated.
- New criteria were added to further enhance students' competency in the future.
- Competencies from the next batch of students were analysed and compared with previous results to assess the effectiveness of rectified measures.

Realising the trainees' weakness in 2012, actions were taken for further improvement. The concept of using industrial codes and industrial standards was incorporated in courses taught in the engineering programme. For example, lecturers of the relevant courses have put in more effort to emphasise the concept of using industrial codes and industrial standards. In addition, speakers from the industry were invited to present talks to encourage students to gain knowledge and focus on these areas. The results were found to be positive. In 2013, these areas were improved.

Comparing the students' competency evaluation between 2012 and 2013 shown in Table 1, an overall improvement was observed. Although data in 2013 showed that satisfaction improved in general, the CQI process would continue and another PDCA cycle would be taken into consideration based on the latest data. New criteria were identified for further improvement, such as *Item 9* - leadership skill; *item 17* - awareness of intellectual property and contractual issues; *item 16* - understanding of appropriate codes of practice and industry standards; *item 19* - technical ability and knowledge; *item 7* - critical thinking and *item 14* - problem-solving skills. Therefore, another cycle of PDCA model was conducted to further enhance the competency of engineering students during future industrial training.

## CONCLUSION

This study shows that industrial training provides opportunities for engineering students to apply knowledge and skills learned in class to actual working environment. The feedback and evaluation from the industry pertaining to the engineering students' competency during industrial training are very valuable. In more specific, it highlights the students' strengths and weaknesses, and serves as an indicator for Continuous Quality Improvement (CQI) of engineering programmes in higher learning institutions.

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