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Research paper

Towards Industrial Revolution 4.0: Employers' Expectations on Fresh Engineering Graduates

Aini Najwa Azmi*[1], Yusri Kamin [2], Muhammad Khair Noordin [3], and Ahmad Nabil Md. Nasir [4]

[1,2,3,4]*Department of Technical and Engineering Education, Faculty of Education, Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor Bahru, Johor, Malaysia*
**Corresponding author E-mail: ainainajwa.azmi@gmail.com*

Abstract

From the pass until now, the industry was affected by technological change and innovation. These paradigms are called industrial revolutions. These revolutions were caused by mechanization (1st industrial revolution), use of electrical energy (2nd industrial revolution) and electronics and automation (3rd industrial revolution). All these industrial revolutions did influence only the production itself, but also the labour market and the educational system as well. Currently, due to the development of digitalization and robotics, we are facing the next industrial revolution, known as the Industry Revolution 4.0. The emerging technologies have huge effect on the education of people. Only qualified and highly educated employees will be able to control these technologies. The skills needed by employers' in the Industry 4.0 have change due to the changes of the technologies. In this paper, we present the non-technical skills those are demanded by employers' in Industry 4.0 based on recent studies by doing meta-analysis technique. In addition, interviews with five employers have been done to clarify the meta-analysis results. Based on the results, the non-technical skills which are demanded by employers are communication skills especially in English, teamwork skills, critical thinking and problem-solving skills, entrepreneur skills and computer skills. Universities should be exposed their students with much more of interdisciplinary teaching, research, innovation and valuable industrial training to meet current demands of industries.

Keywords: *Industrial Revolution 4.0; Industrial training; Non-technical skills; Employers' demands; Engineering graduates*

1. Introduction

The development of higher education and careers in the 21st century is discussed based on knowledge, skills and ability of graduates to meet industries expectations. Higher education is based on preparing a standard curriculum for students in certain period of time in order for students to be equipped by emphasizing the knowledge and specific skills [1]. Meanwhile, the industries expectations and job market are influenced by economy, social and competition and revolutions of industry. Non-technical skill is known as the main attributes for fresh graduates to be employed by industries [2]. The skills have changed according to the changes of era from Industrial Revolution 1.0 (IR 1.0) to Industry Revolution 4.0 (IR 4.0), recently. However, certain skills remain unchanged but with a bit of enhancement to complement the needs of the today's industry.

Basically, the changes in revolution of industry may have massive effect on the education of people especially in higher learning institutions [3]. The linkage between university and industry should be strengthened to achieve the vision of Industry Revolution (IR 4.0) which is the emergence of "smart factories". The skills and qualifications of the workforce will become the key to success of a highly innovative industry.

The curriculum that is designed by a university should has the elements that can produce holistic graduates with technical, non-technical skills and good ethics and morality. The non-technical skills which are hard to learn in the universities can be learned effectively during industrial training [4]–[6]. Industrial training is a part of university curriculum that provide an opportunity for students to apply what they have learn in the lecture class to the real workplace in the industry [7]–[10]. Industrial training program is in the academic curriculum in higher education institutions. This training is an opportunity for undergraduate students to incorporate work-related experience and knowledge into their formal education in a university by taking part in supervised and planned work in real-world professional environments [11]. Industrial training program can develop students' technical skills, non-technical skills and good-work ethics. Industrial training is a platform for students to gain confidence and face challenges at work such as teamwork, working under pressure and dealing with people from all levels of the organization [12].

2. Methodology/Materials

There are two types of methodology in this paper. The first one is by doing extensive secondary data analysis. The related papers from years of 2009 until year of 2017 are collected and then summarized in a table to see the trend of the non-technical skills demands by today's employers. In order to see the trend, a meta-analysis technique was done.

The second methodology was conducting interview protocols on five employers from manufacturing industries who used to supervise trainees. For the number of interview participants, [13] sug-

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gested that the number of sample for qualitative part is four to ten samples while [14] suggested six samples. However, there is no minimum sample requirement in qualitative studies as the number of participants depends on the achievement of data saturation points [15]. The interview was done regarding to non-technical skill development for engineering students during their industrial training.

3. Non-technical Skill Needs for a Future Engineer: A Meta-analysis Study

Every year, countless students pass out from engineering universities in Malaysia or other countries in the world. For example, in India, only about 30% of the engineering graduates get jobs while the rest either remain unemployed or take up jobs that are not related to their field. The unemployment issue among graduates is a serious phenomenon that occurs nowadays. Furthermore, in Malaysia, statistics show that the output of the fresh graduates from higher education institution especially universities are still not able to cope with available job vacancies. Current trends, according to Tracer Study Report 2006 to 2014 (Ministry of Higher Education, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015) show that graduates do not work after graduation is on average 31% (Mahmud *et al*, 2016). The readings for every year for the period 2006 to 2014 were 2006 (36.4%), 2007 (30%), 2008 (25%), 2009 (29.16), 2010 (25.62%), 2011 (24.62%), 2012 (28.57%), 2013 (31.42%) and 2014 (31%) [1]. According to the PEMANDU, (2010), the target is 75% of graduates are working after graduating taken as a benchmark to the marketability of a student according by university and course taken. Based on current trend, it indicates that the percentage of graduates who are jobless is 31% in average, and this illustrates that 75% of graduates employed after graduation has not been fully achieved. While in the developed countries, the benchmark is based on a target number of undergraduate students and their marketability. These policies and benchmarks are to support countries to achieve Vision 2020. The factors of the unemployment occur because the graduates are lack of non-technical skills such as leadership skills, communication skills, teamwork skills, problem solving skills, entrepreneurial skills, critical thinking and creative skills (Roslidawati, 2015). While a study by Arshad Ayub, (2014) describes the graduates do not get jobs after graduation are caused by problems with communication skills, attitude and low self-esteem [16].

Based on literature, technical and engineering graduates are said to be mastered in technical skills, but unfortunately they are lack in non-technical skills such as communication skills [17]. Even worse, in Malaysia, English becomes a language barrier to some locals that stops them to be employed. As we are known that English is the language that widely used in engineering industries, this problem should be diminished from engineering graduates in Malaysia. Large number of engineering graduates are focusing on their academic qualification rather than preparing themselves with non-technical or employability skills [17]–[19].

In Malaysia, Ministry of Higher Education of Malaysia (MOHE) has established a Soft Skill Module which has listed seven non-technical skills that should be possessed by graduates which are communication skills, critical thinking and problem-solving skills, teamwork skills, lifelong learning and information management, entrepreneur skills, leadership skills and professional ethics and morality. To support this statement, a study done by Zaharim et al., (2010) said that fresh engineers must possess good skills in communication, teamwork, lifelong learning, professionalism and problem-solving and decision making. Nilsson (2010) also agreed with her study which fresh engineers should have a good set of interpersonal skills.
Even worse, paper qualification seems be the most important part when applying a job [21]. Therefore, based on Zaini Ujang statement that can be found in [22], he found that 80.000 technical graduates who are still unemployed, are too depending on academic qualifications and less of the non-technical ability which employers required most. Furthermore, nowadays employers are looking for employees who has at least couple of years of work experiences. This will be a crucial problem for fresh graduates. Universities are now accommodating students with the opportunity to convert the theory learned in the lecture into practice through industrial training. Throughout this research, the term of "industrial training" will be used. Furthermore, more students from higher learning institutions have the advantage of achieving an interesting practice and experience through industrial training. It is aiming to develop the skills that required by the industry that can be necessary to the students in building their future career [23].

Globalization era needs human capital resources with competency, competitive and multi-skilled to lead a country to be a developed country. Malaysia is one of developing country in the world that is facing the unemployment issue among graduates. The unemployment issue among engineering graduates is an issue that cannot be neglected because they are very important to drive the nation to be more innovative and productive high-income economy [19]. Creative, innovative and productive are the skills that are demanded by IR 4.0 that is already started in Malaysia (www.miti.gov.my). This unemployment issue arises when there is insufficient or inappropriate education and training which does not focus on non-technical skills such as innovation and creativity skills to increase the competency and competitiveness of the workers. A low quality of human capital resource may lead to a slow movement of economy in a country. This is a huge problem in the most of developing country in the world.

Entering the professional workplace in the industries, "employers seek graduate employees who are able to transfer their critical thinking abilities to the workplace" [24]. This is the proof that critical thinking that lead to problem solving skill is very important. However, not all fresh engineering graduates in Malaysia can possessed this skill outstandingly. Based on a research done [25], critical thinking and problem solving skills are at the below of the ranking compared to teamwork skill which is in the first ranking. Critical thinking and problem-solving skills should be emphasized by higher institution because these skills are demanded by today's industry. Furthermore, students feel that their critical thinking and problem solving skills are good, but the employers in the industries feel that their non-technical skills are at the intermediate level [25], [26]. The gap between students' and employers' perception will give an impending problem for fresh engineering graduates to be hired once they are graduated [27]. Based on [22], an employee who is high in critical thinking and problem solving skills according to the employers could demonstrate creative and innovative thinking, able to generate new ideas and able to decide the best alternative.

Skills, unlike innate abilities, can be learnt and trained. This way, alertness understood as a skill can be learnt through education and further developed in industrial training program [28]. Industrial training is a platform for students to get exposed in the real workplace and professional practice. At the same time, students will learn and develop technical and non-technical skills. Industrial training is the only way for all students to relate the theory learned in the university with practices in the industries. In addition, based on [10], who were study about industrial training for Electrical and Electronics students, not all engineering practice can be learned in classroom, but they must undergo to real industry to learn the actual engineering practices. Based on [8], there is an existence of gaps between perceptions and expectation between all stakeholders especially students, universities and industries during industrial training. According to Muhammad and Shariff study that can be found in [8], there are some weaknesses in the current practice of industrial training.

Teamwork skill is one of the seven skills that established by Ministry of Higher Education (MOHE) of Malaysia. Even though almost universities in Malaysia emphasizing teamwork or collaborative learning, the problem lack of teamwork skill in the industry is still questionable [2]. The teamwork skill cannot be developed effectively in the learning if the team members are among their close friends. In addition, students tend to choose friends who have similar demographic, characteristic, interest and academic performance which will create a homogenous group. The disadvantage of homogenous group is it will create a restricted learning opportunity especially for team member who has lower academic performance. They will be abandoned and will be together in a leftover group. Although the task is a group work, students like to delegate work individually. As a result, there are less collaboration between team members. Thus, students are not fully experienced and developed teamwork skills [2]. All above context regarding to collaboration between human and human.

For industries to grow in the new market is the reason to identify this area of skill. New services and products need to be produced to compete in current markets. In developing the business or innovative approaches from the employers interviewed suggested that industries relied not only on managers and specialists. The initiative should be taken by collective effort from everyone in the industry. Student should be exposed to the entrepreneur skill and should be included in program to encourage students involved in business. Comment on entrepreneurial skills employers is that they require an employee can contribute more than a potential business idea and can work with minimal supervision but perform. Managers and employees need to manage time effectively and reduce the process time and how to save money. Employees also must have initiative to be able to work independently and without constant supervision. They need employees that can work independently and can complete projects given on time as well as save budget but quality standards and priorities to achieve project outcomes must be well kept. Contrary with the study has done by [29], they found out that employers rated low on entrepreneur skill with mean 3.9. Even though the number is not very low, but entrepreneur skill seems not important compared to other skills such as communication and teamwork skills. On the other hand, internal entrepreneur is the individual who has a high quality of entrepreneurship in a "dreamer" organization and who is ready to take a greater responsibility to create an invention. They are the inventors and form the group of employees that will passionately find ways to convert ideas into reality and bring more profit to the organization. Based on other findings in the same study, it was found that many employers cannot see the importance of the entrepreneur skills for future graduates or current employees because they will be more practical and more creative individual person [29]. These kinds of employees are careful in planning, which indirectly suggests that they are willing to take risks by preparing themselves for uncertainties such as workers retaining their jobs. Comments made by the employer to give the impression that technology skills are crucial. Employer's need workers at least understand the procedures for operating machines, including computers and their programming. Employees also need know how to choose the procedures, equipment and machinery to be used. Employees in a plant environment may need to be familiar and specialized in preventative maintenance requirements because company emphasis on maintaining technology to solve problems in machines and other equipment. It is an advantage if employees have good or basic computer skills. Basic technology skills are fundamental to employment. Reliance on technology is increasing. It is important to understand to maintain the system. This caused each manufacturing process using current technology and it is constantly changing and workers need to find those skills very quickly. Thus, employers insist on new and existing employee to use technology to benefit the business.

Based on Table 1, there are several studies which are summarized in a table to see the trend of non-technical skills demands among engineering graduates from year 2009 until year 2017. The objectives of some studies were basically to identify the aspects of non-technical skills that are required by employers in the era of Industrial Revolution 4.0. Based on [30], employers from small, medium and large-sized manufacturing companies agreed that non-technical skills are the most important attributes for fresh engineering graduates to get hired especially interpersonal skills (which include communication skills, leadership and teamwork skills), thinking skills which include problem-solving and decision making skills, critical thinking and creative thinking) and personal qualities (which include achievement orientation, high self-esteem, time management, lifelong learning and strong work ethics). In the consequences year, [18], [27], [31] again did some studies regarding the employability skills required by employers of small and medium sized manufacturing industries. It revealed that the employers agreed that interpersonal skills, thinking skills and personal qualities are the most important aspects for new employees to get employed which is the results are the same with their previous study. In the study by same authors in year 2013, the indicator which is studied which are work safety, integrity, customer service, creative/innovative thinking and problem solving, and exercise leadership showed the highest mean score. Next year, [22] did an interview protocols to 30 employers from industries to verify that communication skill, problem solving skills, team work and entrepreneur skills are the skills that are really demanded by employers. It can be concluded that leadership skills, teamwork skills, critical thinking and problem skills, communication skills and resource skills are the most important non-technical skills that demanded by employers.

In term of communication skills in the context of Malaysian graduates, [32] stated that English language becomes the barrier and need to improve by the graduates to be more employable. Furthermore, [33] also agreed when communicating in English is the most important for engineering graduates to be chosen as new employee.

The issue of fresh graduate is unemployed because of the expectations of employer are not able to fulfill. In the study of [34] revealed that the skills which are basic entrepreneurial, communication, and problem-solving skills among fresh engineering graduates were not at the satisfactory level but satisfied with graduates' individual and in the group work. Besides, [25] proved in their study that employers rated lowest on entrepreneur skills, critical thinking and problem-solving skills and spiritual skills. Nevertheless, based in the same study, employers rated the non-technical skills among fresh engineers are moderately high.

In abroad context, [35] stated that employers place the highest importance on soft-skills and the lowest importance on academic reputation when hiring new graduates. They also emphasized on communication, problem-solving and critical thinking skills and interpersonal skills. This statement is agreed by [36] in Nigeria, which the skills that sought by employers are communication research, computer, interpersonal, problem solving and adaptability skills. In the same country, [37] did a survey on 131 employers and revealed that the most important employability skills from the perspective of the employers include teamwork, written communication, oral presentation, willingness to learn and adaptability. Similar with studies in Malaysia, [38] stated that employers demand broader skills and attributes that include team-working, communication, leadership, critical thinking, problem solving and often managerial abilities or potential. In India, [39] performance of students in non-technical skills is very important in technical education. They focused on problem-solving, communication, and teamwork skills.

For countries which English is not the first language like Malaysia and Oman, mastering English language will become a challenge and obstacle for graduates. A study done by [40] said that English language proficiency is one of the main skills that are demanded

by employers in Oman. The remaining four skills are computing, teamwork, prior training and good personality.

Table 1: The recent studies of non-technical skills demand among engineering graduates (Years 2009-2017)

Author (s)	Objectives	Method Used	Instrument/Sample	Findings
[34]	To investigate the gap the difference between expectation and perception among majority of Malaysian industries towards existing engineering graduates.	Survey	Questionnaires/ 422 employers	Basic entrepreneurial, communication, and problem-solving skills were not at the satisfactory level (more than 10%). Employers satisfied with graduates' individual and in the group work (more than 50%).
[30]	To identify aspects of the employability skills and its relationship with the requirement of the employer in the manufacturing industries.	Survey	Questionnaires/ 107 employers	All the manufacturing employers agreed that interpersonal, critical thinking skills and personal qualities were most important.
[41]	To propose a practical and simple framework of engineering employability skills that can be used as a framework for working with engineering graduates to develop their employability before entering workforce	Literature review	Secondary sources	Fresh engineers must possess good skills in communication, teamwork, lifelong learning, professionalism and problem-solving and decision making.
[21]	to explore how engineering graduates', perceive, invest in, manage, and develop their employability. Design/methodology/approach	a longitudinal qualitative study	Questionnaires Interview protocol/ 20 recent graduates	Engineers should have a set of employability skills such as interpersonal skills, socio-communicative abilities and leadership abilities.
[27]	To develop an Employability Skill Assessment Tool to help students and lecturers produce competent graduates in employability skills needed by the industry.	Survey	Questionnaires/ 107 employers	The important aspects demanded by employers are leadership skills, teamwork skills, critical thinking and problem skills, communication skills and resource skills.
[31]	To identify the important aspects of employability skills as perceived by the employers	Survey	Questionnaires/ 107 employers	The findings indicated that thinking skills, problem solving skill, creative thinking and innovative, and reasoning skill is of utmost priority by the employer in the manufacturing industry.
[25]	This study aims to evaluate the level of employability skills on engineering students at higher education institutions from the perspective of employers	Survey	Questionnaires/ 171 employers	The results showed that the level of employability skills among engineering students from the employer's perspective is moderately high. Employers rated lowest on entrepreneur skills, critical thinking and problem-solving skills and spiritual skills.
[25]	To study the employability skills required by employers of small and medium sized manufacturing industries.	Survey	Questionnaires/ 58 employers from small-sized 49 employers from medium-sized	The employers agreed that interpersonal skills, thinking skills and personal qualities are the most important aspects for new employees to get employed
[18]	To investigate the importance of employability skills as perceived by 107 employers from manufacturing industries	Survey	Questionnaires/ 107 employers	The findings of the study revealed employers place significant importance on interpersonal skills, thinking skills and personal qualities that students need to emphasize to be employed in manufacturing industries. Indicators such as work safety, integrity, customer service, creative/innovative thinking and problem solving, and exercise leadership showed the highest mean score.
[35]	To increase our understanding of factors that influence the employability of university graduates	Literature review Mixed method	Secondary sources Interview protocol/ 30 employers empirical examination/ 115 employers	Findings illustrate that, when hiring new graduates, employers place the highest importance on soft-skills and the lowest importance on academic reputation. The emphasized soft-skills are communication, problem-solving and critical thinking, interpersonal skills
[22]	This study aim was to elicit views of 30 employers in the manufacturing industries on employability skills individuals in the workplace focusing on the future needs.	Interview	Interview protocol/ 30 employers	Employers need employees with strong interpersonal skills such as communication skill, problem solving skills, team work and entrepreneur skills which related to the context of working environment.
[36]	To investigate the possible relationship between vocational education and the acquisition of employability skills and discusses basic requirements of employers worldwide in this regard.	Literature review	Secondary sources	They found the skills that sought by employers are communication research, computer, interpersonal, problem solving and adaptability skills.
[38]	The purpose of this paper is to outline the findings from an exploratory research project investigating perspectives on the recruitment of work placement students	Interview	Interview protocol/ 30 employers	Require graduates to demonstrate a range of broader skills and attributes that include teamworking, communication, leadership, critical thinking, problem solving and often managerial

	among a diverse sample of employers to disentangle what constitutes student "employability" in the eyes of these employers			abilities or potential
[32]	To study on how social entrepreneurship could improve graduates' employability	Interview	Interview protocol/ 4 employers	Communication skills, English language proficiency, Information, communication and technology skills. Interpersonal skills, teamwork, leadership skills, Problem solving skills, adaptability skills, risk taking skills, creativity skills, time management skills.
[39]	To investigate the importance of technical and non-technical education, respectively, in the employability of undergraduate engineering students	Survey	Questionnaire/ two cohorts of 500 undergraduate engineers	The performance of students in non-technical education was a stronger predictor of employability than was grade obtained in technical education. They focused on problem-solving, communication, and teamwork skills.
[37]	The study examined the skills-gap in real estate education with the aim of identifying the important employability skills that are required for a graduate	Survey	Questionnaire/ 131 employers	The study revealed that the most important employability skills from the perspective of the employers include teamwork, written communication, oral presentation, willingness to learn and adaptability
[40]	This research explores the most common graduate attributes as they apply to graduates' employability in Oman.	Survey	Questionnaire/ 114 students	Students' perspectives on employers' selection criteria reveal that computing skills, the ability to work in teams, English language proficiency, prior training, and the graduate's personality are the five most significant employability skills in Oman
[33]	To study the effectiveness of English language courses offered in the engineering colleges in Hyderabad.	Literature review	Secondary sources	Based on this paper, the important skills are communication especially in English language, teamwork and problem-solving.

4. Results and Findings

In this section, the results from interview protocols will be illustrated. In addition, discussion on both meta-analysis and qualitative results are discussed.

Based on interview coding that can be seen in Figure 1, all five employers agreed that industrial training do improve the non-technical skill of a graduate. Employer 1 said that graduates have less exposure in industries because of less opportunity is given. This is related to the duration of industrial training. Most employers agreed to extend industrial training for engineering students from ten weeks to three months which is the shortest and the best can be six months. This statement is supported by a study from [8] which six months is the best duration can be given to engineering students to do their industrial training.

Based on meta-analysis, some studies said that communicating in English is one of the skills demanded by employers. Employer 4 stated that language barriers can become a roadblock whereas trainees with more passive attributes may find it hard to work across teams that is required when working cross functional projects. In addition, based on Employer 4, a good communicator will have some good teamwork skills when the message can be transferred successfully among the team members.

On the other hand, in the era of IR 4.0, computer skills seem important where two of five employers demand those skills from fresh engineers. This is agreed by [40] which computer skills are the main attributes for fresh engineer to be employed. Programming skills is very important for semiconductor companies such as INTEL and Infineon. Based on interviews, the most important skills demanded by employers in the era of IR 4.0 are communication skills, computer skills, teamwork and entrepreneur skills. These results are reflected to the meta-analysis done to the past studies in the Malaysia and from abroad.

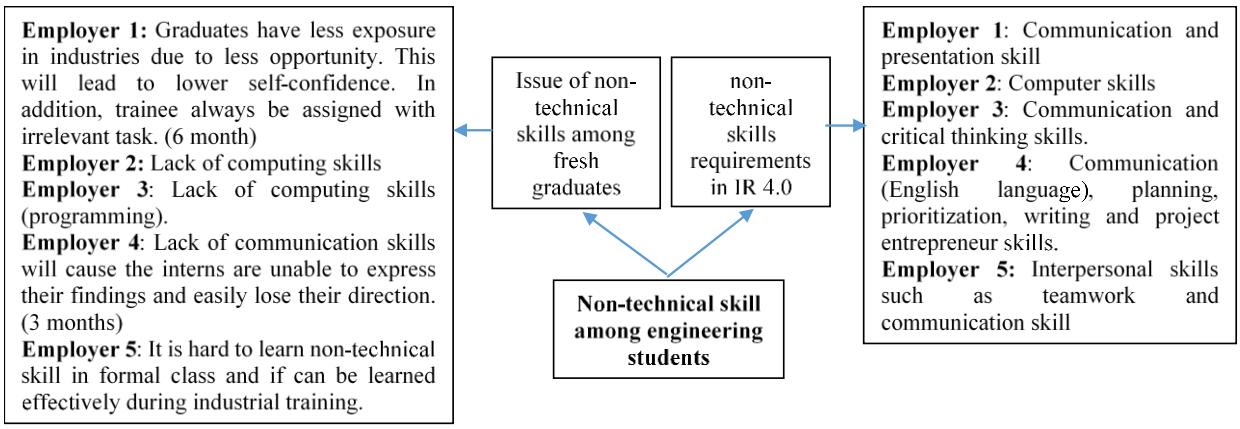


Figure 1: Interview coding from five employers in manufacturing companies.

5. Conclusion

Education system and industrial training programs must be shaped to meet the knowledge, skills, and abilities required by employers. A university should have a well-organized structure of curriculum especially in industrial training program. This is very important to make sure students can gain the maximum non-technical skills and experience which are essential in their future career. Industrial training is proven by many scholars that it can develop students' non-technical skills. It is important because employers really emphasize on non-technical skills to hire new engineers.

As students, the objectives of industrial training must be fully understood. This opportunity should be used by student to gain the most experience, skills and knowledge from industries. In addition, the theory learn in the lecture can be related to the practices in the industry. During industrial training, students should give full commitment, actively interact with colleagues and observation to gain the most knowledge and experience. Therefore, graduates with non-technical skills will have an advantage in getting jobs in the industry. The institutions of education must produce graduates with high non-technical skills.

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