Industry Academia Linkage and the Identification of Skills Gaps of the Graduating Engineering Students at Tertiary Level Education

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Abstract

The difficult and current concerns are unemployment and skill shortages among recent engineering graduates. All stakeholders, including businesses, engineering schools, parents of students, and the nation at large, are badly impacted by these difficulties. The labour market will experience its worst condition if things stay as they are, and the policymakers and the government will also suffer greatly. Privatization of engineering degree, skill shortages among recent engineering graduates, rising corporate demands, and a transition in the corporate sector are just a few of the issues that need to be thoroughly analyzed and concentrated on in order to bring about the necessary transformation. In this context, the study makes an effort to analyze prior research on skill gaps among engineering graduates and strategies to reduce those gaps. Additionally, this study will aid in clarifying the precise issues with underemployment and skill gaps amongst recent engineering graduates.

Keywords: Engineering; Skill Gaps; Graduates

1 Introduction

The world is changing far more quickly now than it ever has. The technology is what the world today depends on most. Every country on the earth looks for methods and procedures to support its economic development. One of the top priorities for the government of practically any nation is to effectively use its workforce to maintain a steady pace of national development. Everybody now has access to career opportunities made possible by technological advancements, which also provide optimum returns with the least amount of resources. Due to the abundance of prospects for commercial expansion caused by globalization, deregulation, and removal of trade barriers, every company must compete on a worldwide scale. Additionally, industries and the goods they produce came to represent the degree of progress attained by a nation. These additions have also increased the necessity for qualified employees in order to manage this business effectively. Industries require skilled and qualified labor. Subordinates are a resource for a company if they are skilled and productive. Organizations both require and demand competent individuals. Employees that possess the specialized abilities, know-how, and attitude required to complete a work flawlessly are considered valuable. A strong workforce is competent in all areas of development, and educational institutions are typically held responsible for producing strong workforces. Collaboration between academia and industry has improved knowledge and innovation over time and has been crucial to the growth of developed nations' economies. The collaborative approach between academia and industry performs a critical strategic role in the generation, procurement, and implementation of knowledge as well as the promotion of entrepreneurship and the development of key skills needed by industry (both in the service and manufacturing sectors). The expansion of market-driven development and technology at the tertiary level can also be used at the industrial scale to encourage commercialization. Among many disciplines, industries are significantly reliant on the engineering students. Engineers are crucial for a company's profit to attain the targeted margin when the world experiences a technological revolution. By utilizing innovation, creativity, and a plethora of information, engineering graduates are having an impact on the world unlike anybody else. Engineers are primarily responsible for the way the world is changing. The majority of today's services and goods were developed with at least some engineering involvement, paving the way for individuals who were influenced by them to live long, fulfilling lives. However, the problem of not being able to find enough skilled laborers, which is more frequently heard concerning engineering students, is one that companies constantly lament. Engineering graduates are usually ill-prepared for employment in the actual world of industry. It has become widely accepted that engineering students are underqualified because they lack practical experience, which hurts the industry. This lack of preparation goes beyond just the essentials and can also include communication abilities, tool proficiency and familiarity, and understanding of the pertinent engineering principles. One of the companies that had worked with NDSU on a

capstone project had raised concerns with the capstone instructor about some of the students from the university who had applied for positions at their company. The company mentioned that these students lacked the ability to use various tools and did not possess conceptual knowledge that was necessary for employment at their company (Radermacher, Walia, & Knudson, 2014). Many researchers tried to find the lacking, the problem caused by the lacking, the underlying reasons behind those lacking. The gap created by those failings is being analyzed more and more to come up with the solutions and also to find other gaps that might occur. Nowadays, graduates are finding it difficult to get on a job. On a survey, it was seen that the unemployment rate in Bangladesh in 2019 was 4.3 but in 2020 it increased to 5.3. Moreover, in a study, Nina Garthe & Hans Martin Hasselhorn (Garthe & Hasselhorn, 2021) showed that the profession-leavers were younger, had more unskilled or semi-skilled duties or highly challenging work, had fewer part-time hours, had relatively short seniorities, and more frequently had lower levels of income. It has been discovered that businesses are not pleased with the graduating engineering students' caliber and skill set (Blom & Saeki, 2011). The situation is getting worse by the day, and the educational systems that produce engineers need to undergo immediate adjustment. Researchers have looked into and reviewed a number of articles in an effort to identify a solution.

1.1 Skill Gap Definition

The deficiency of proficiency is referred to as a skill gap. It is the discrepancy between what is necessary or anticipated and what actually occurs. Or, to put it another way, a skill gap is the difference between the desired performance and the actual efficiency (Adetokunbo, 2009). As a result, it is also known as the performance gap. It could occur in any relevant field of employment.

1.2 Comprehensiveness of the Gap

SN	*Malaysia*	*Japan*	*Singapore*	*Hong Kong*
I	Communication-Efficiently	Communications skill	Numeracy & literacy at work place	Attitude at work
II	Capable in practice and application	Problem-Solving	Communication technology and Information	Interpersonal Skill
III	Team building or interpersonal skills	Setting Goal	Decision making & problem solving	Problem Solving & Analytical
IV	Engg Problem Solving Skills And Decision Making	Individual presentation-Skills	Enterprise and initiative	Proficiency in English language
V	Application of Science , Knowledge and engg principles	Visioning	Relationship-Management and Communication	Competent in numeracy
VI	Capable in Engineering disciple specific	Computer and IT Skills	Learning Life Long	IT and Literacy
VII	Knowing social , professional ethical responsibilities	Leadership	Global-Mindset	Management – Skills
VIII	Learning lifelong	Self assessment	Managing Self	Proficiency in Chinese language
IX	Engg, System Approach	___	Life Skills with Work Related	____
X	Contemporary issues knowledge	___	Work-place Safety and the Health	____

Figure 1: Skills required for engineering students in Asia (Zaharim et al., 2009)

When it comes down to significant areas where the occurring gap may cause most problems, the areas are not limited to one or two perspective. However, some areas are quite large than the other. According to the UK Graduate Prospects Survey, which was cited by Dacre Pool and Sewell in 2007 (Pool & Sewell, 2007), one-third of graduate job openings required subject-specific knowledge and abilities, underscoring the fundamental and ongoing significance of practical competency. Numerous research (Learning, for Education, & Britain)(SSDA), 2004; of British Industry, 2008) has backed up this fact, proving that companies still value degree specialization. Employers in Australia (Business & Council, 2007) and the UK (of Directors (IOD), 2007) appear to be pleased with graduates' development of discipline-specific abilities. Although employability skills are receiving more attention, functional or subject-specific abilities are still seen as crucial. Employers state that in addition to subject-specific knowledge, candidates must also possess social skills and disciplinary expertise. The Boston Area

Advanced Technological Education Connections group (Borges-Méndez, 2014) discovered that hiring managers prioritized professional skills over technical ones in a US survey of IT firms. According to a UK employment statistics report (of British Industry, 2008), 27% of employers have been discontented with graduates' general employability skills. In a study, Zaharim et al. showed 10 abilities as crucial for employees in Table 1, which was developed by Singapore Workforce Development Agency (WDA), which employers and industries alike recognized for its employability skills framework (Zaharim et al., 2009).

In the same study, they also had discussed the situation of engineering students and the lack of employability skills among engineering students. In Malaysia, the joblessness issue has been exacerbated by the skills gap. This research has made an effort to highlight the expertise needed by Asian nations like Singapore, Japan, Malaysia, and Hong Kong for the modern engineering. According to this study, engineering students should acquire and display a variety of generic skills, including communication, problem-solving, and interpersonal abilities. It also emphasizes the convincing proof that employability skills influence job outcomes for potential entry job seekers. Due to the harsh job market brought on by globalization and the rising number of engineering graduates, there is now intense rivalry. Employers from four different nations also prioritized similar abilities including interpersonal skills, verbal and written communication, and problem-solving abilities. For recent engineering graduates seeking employment, other crucial skills including self-management, lifelong learning, and information technology are critical. Therefore, this study aims at:

- Examining the numerous employability qualities for engineers that various scholars have identified is one of the goals of this study.
- To learn about the difficulty engineering graduates have in finding suitable positions in the business world.
- to comprehend the main cause of the skill disparities among engineering graduates.

2 Method

In order to achieve the goal of the current study, the researchers have gathered secondary data from books, journals, and the internet as well as through personal anecdote and consultation with professional and academic experts. Research papers that have been published in the past have been studied, and the authors have offered their opinions.

2.1 Research Questions

While conducting this research, several research questions were targeted to be answered. Those are:

- What are the employability qualities for engineers that various scholars have identified as important?
- What are the difficulties engineering graduates have in finding suitable positions in the business world?
- What is the main cause of the skill disparities among engineering graduates?

2.2 Population and Sampling

The population being targeted in a study is that specific group that the researcher aims to examine or analyze. However, the reality is that it is frequently impossible or impracticable to attract the entire target demographic from the general population, the researcher would prefer to choose a sample of interest and work on it. 29 articles have been collected from internet, have been used as sample and analyzed in this study.

2.3 Study Procedure

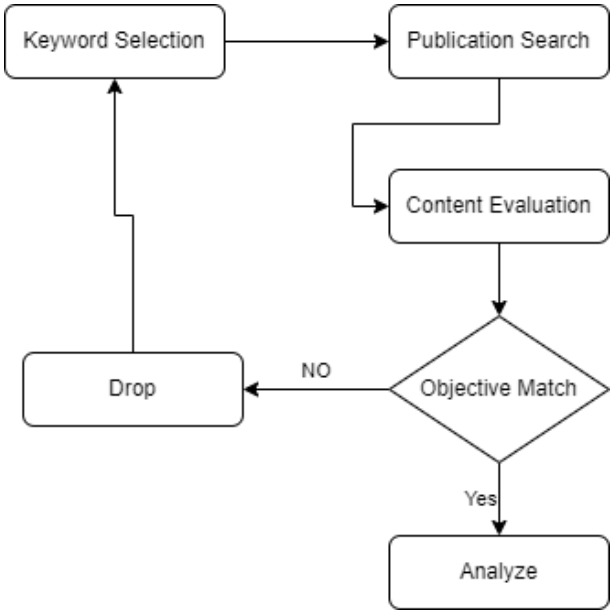

Figure 2: Study Procedure

3 Results and discussion

3.1 Causes of the Gaps

The American Society for Training & Development (2012) (for Training & Development, 2012) evaluated the consequences of the economic rebound, the employment pipeline, and the role of education and training to significantly lower the skills gap in their study titled "Bridging the skill gap." The ASTD defines a skill gap as a sizable difference between an organization's current capabilities and the skillsets required to fulfill its objectives. At this stage, the company is unable to expand and sustain its competitiveness because it is unable to fill key positions with workers who possess the necessary experience or understanding, skills, and talents. It is stated that the nation must pay a high price for the skill gap because it affects more than just individuals or enterprises. Despite the enormous number of unemployed employees in the United Nations, firms are having difficulty satisfying the nation's expanding demand for skilled labor. According to the report, there is a lack of skilled workers for positions requiring both high and middle levels of education, including those requiring science, engineering, and technology. Management skills, executive skills, leadership abilities, supervisory roles, and specialized qualifications were identified as having the greatest skills gaps in an ASTD member poll. The most critical skill gaps that businesses are looking for are in the areas of management and supervision. According to ASTD, the workforce's capabilities did not align with the company objectives, strategic plan, markets, or business functionalities. This was followed by a lack of depth in the senior ranks of the company. Another important result was that the inadequate investment in training and the absence of encouragement for employees' development and growth were the main causes of skills gaps. After a postsecondary education, it was suggested that policymakers and the general public change their perspectives and include early learning in any educational reform. It is proposed that specialized training and instruction are required to address shortcomings.

According to Simmons et al., courses should place more focus on requirements elicitation and elaboration and should teach students about software development methods (Simmons & Simmons, 2010). The usage of new technologies, according to (Pool & Sewell, 2007), is a critical component of a graduate's employability. In order to ascertain whether there was a discrepancy between industry demands and degree programs for game development, McGill conducted a study on the kinds of talents required in the game development sector. Participants in the survey included fifteen academicians from colleges with a game development department and twenty-six hiring employees or other experts in the game development industry. The study's findings revealed that industry, as opposed to academics, gave more attention to multi-threaded programming, toolset development, and programming languages like C++ and Lua. They also mentioned problems with motivation, the capacity to take criticism, and the capacity for listening and paying attention. The finding of this research were identical; the most frequent responses suggested that new recruits had trouble asking for assistance when they were stuck, as well as trouble connecting with other team members. There was also an overlapping problem with fresh graduates sometimes not acting in the way that is anticipated of them in terms of their personal and professional qualities (McGill,

2009). In a study by Miller et al., ten IT hiring managers were questioned about the qualifications that candidates should possess. The personnel who were interviewed were questioned about the significance of the four preselected abilities and also gave extra uninvited comments about areas where candidates needed to be skilled, like problem solving and collaborative experience (Miller & Dettori, 2008). Eight fresh software engineers at Microsoft were the subject of a case study by Begel et al. over the two-month period of time (Begel & Simon, 2008a, 2008b). The authors of that study discovered that collaboration and communication issues were most frequently experienced by new software engineers. One such illustration was the fact that many of the newcomers were reluctant to seek clarification, even if they were having difficulties. A common source of difficulty was also noted to be a number of technological problems. In their research report, "Role of career and technical education and 21st century skills in college and career readiness", the Partnership for 21st Century Skills, the Association for Career and Technical Education, and National Associations of State Directors of Career Technical Education Consortium (2010) advised academic leaders to create the infrastructure, initiatives, and connections necessary to support twenty first century responsiveness (for Career & (ACTE), 2010). Education that provides the knowledge and required skills for someone to become intensely competitive in the work market can close the skills gap. The development and implementation of a rigorous course of study that combines academic content, technological knowledge, and 21st century skills must be done in collaboration with businesses and industry organizations. Additionally, there is a requirement to promote professional growth and learning communities that encourage communication between administrators, instructors, and centers for technical training. Students should develop an individualized learning plan that clearly relates a coherent plan to their academic and professional objectives. The recommendations made for CTE are particularly significant since they integrate a wide range of 21st-century abilities into the CTE curriculum and encourage teacher cooperation. The policy makers were advised to support research and development initiatives for building institutes and career preparedness, offer rewards to companies for giving faculties work-based experience, and encourage staff and educators to construct collaborative learning that enhance 21st-century readiness.

Relevant investigations have also been carried out by researchers in fields connected to software engineering and computer science. McGuire et al. calculated the discrepancy between how IS employees assessed their existing skill in a number of process improvement opportunities and how important they thought those areas were. The study involved 141 IT specialists who worked on software development initiatives. The findings showed that these professionals believed their familiarity with metrics and measurement, change management, process control tools, risk analysis, and other categories was significantly less than the value placed on those categories (McGuire & Randall, 1998). The discrepancy between the abilities of graduating IS students and the demands of African businesses was measured by Scott et al. Their investigation revealed that the biggest discrepancy between graduates' skills and what the market needs was in databases (Scott, Alger, Pequeno, & Sessions, 2002). A research by Lethbridge looked at 75 different areas, including those that showed a big discrepancy between what responders said they studied in academy and what they required for their current employment, such as data structures, database systems, and object-oriented conceptions and technologies (Lethbridge, 2000). Trauth, et al. undertook a study to ascertain how differently industry and academia regarded the significance of several categories. The findings showed that academia and industry weren't really frequently on the same page, with academia placing an excessive amount of emphasis on teaching a particular programming language and program execution while giving less attention to topics like networking and systems integration (Trauth, Farwell, & Lee, 1993).

Millions of engineering school graduates in India face the possibility of unemployment, according to researchers (Chaturvedi & Sachitanand, 2013). The oversupply of educational institutions and the mismatch between graduate skill sets and industry demands has made life difficult for Indian engineers. India trains more engineers than China and the US combined, at over 1.5 million. Manufacturing and information technology, two major sectors that employ the large percentage of engineers, are reportedly employing very few engineers. According to AICTE (Handbook, 2017), there have been 1511 engineering schools in India, and 550.000 people received engineering degrees in 2007. The number of educational institutions and graduate students has doubled due to the economy's rapid growth. Tier-I institutions like IIT Bombay are having trouble placing students, and even the students' enrolling is taking longer. Engineers are heading toward the different direction, and engineering students are inevitably driven to enter positions that are not fit for them.

Researchers found that engineers with a complete and vast range of in-demand abilities are extremely important for the growth of both the nation and investor individuals (Blom & Saeki, 2011). According to the study of employers, companies are not pleased with the caliber and set of skills of engineering graduates. It was determined that engineers' qualifications are insufficient. Indian businesses are less happy with recent engineering graduates than are American businesses. The writers made the argument that the caliber of engineering degree has to be improved. They suggested that the intended learning outcomes for each engineering program be stated clearly and assessed. According to authors, if the weight of graduates' learning outcomes were increased, NBA accreditation would have a much more substantial impact than other certifying agencies. Key employability skills, organizational skills, and professional skills are in great demand, according to the report's Three Skills set. Therefore, engineering education programs need to implement a thorough quality upgrading of their curriculum.

Chithra ran a survey as part of his research to learn how hiring managers and engineering students felt about employability abilities (Chithra et al., 2013). Employers are shown to place more weight on a candidate's

behavioral and personal traits, whereas students place more emphasis on their technical abilities. Employers and students have different perspectives on what constitutes employable skills. The perspective of students either with or without work experience differed significantly in another area. Overall, this study's findings show that students with job experience are more aware of the employability abilities that businesses need. There is a critical need to raise awareness of employability and transnational skills among Indian graduates. To meet the demands of the industry, it is also vital to regularly update the curriculum. Researchers contend that a long-term strategy for educating recent graduates is required to raise their standards and skills in order to compete for employment in the global economy. Finally, this investigation also comes to the conclusion that improving abilities and applying specialized knowledge training will support and help employees do their jobs effectively. In their study, Hari Prasad and Parasuraman discovered three crucial training strategies: basic employability skill training (BEST), campus readiness training (CRT), and campus placement training (CPT) (N, 2014). These strategies help people find employment in the competitive industry. Researchers also recommend that internet capabilities, office attire, typing proficiency, consciousness of safety and privacy issues, hardware, security-related problems, and troubleshooting be integrated into campus placement training. For success in the written and professional interview rounds, campus preparedness counseling on job readiness is helpful. The Blooms Taxonomy Hierarchy is another tool the researcher advises using to assess the gained skill set. The study's final finding is that it is important to correctly stimulate skill enhancement awareness in order to aid students in finding employment quickly.

Engineering students from the University of Kebangsaan Malaysia (UKM)'s engineering departments, that are Mechanical and Materials Engineering, Electrical, Electronics and Systems Engineering, Chemical and Process Engineering, and Department of Civil and Structural Engineering-were the subjects of a study conducted by Kamarulzaman et al. They interviewed 285 students both before and after their industrial training. These pupils were assessed on abilities, knowledge, and attitudes. More than 90% of the students concurred that receiving industrial training boosted their employment options. Additionally, those who participate in industrial training have advantages for their own future employment, education, and prospects. Industrial training also improves knowledge, skills, and attitude, and this academic research also suggests that a five-month industrial training program is suitable for students. The study also came to the conclusion that a program of industrial training will benefit students' employment prospects (Mat et al., 2011).

According to Riemer, the most important component of an engineer's education today is the development of their communication abilities (Riemer, 2007). For meeting the needs of society and business, the institute integrated multilingualism and communications aspects. Engineering schools should include other competencies such as professional, global, multicultural, and most importantly communication in their dense engineering curricula. Inclusion of communication and language enhancement courses is a key component of lifelong and ongoing learning. At the secondary education, students' communication skills and emotional intelligence (EQ) should be introduced and instilled. If it isn't covered in the national curriculum for schools, postsecondary education should develop it. These abilities were also learned as grownups and will support a lifetime process.

Despite the fact that problem solving has been commonly mentioned, several research lacked more information. According to one study conducted by Haddad, new workers frequently lack the capacity to think of different approaches to a given situation. The findings of this study show that while interviewing new graduates who were searching for jobs, problem solving was seen as a critical skill, possibly the most significant (Haddad, 2002). Moreover, few specific problems were identified by the researchers. Lack of familiarity with the most recent applications and quick use of technology, a poor attitude toward problem-solving abilities, a lack of knowledge of decision-making processes, a lack of project management enthusiasm, a lack of clarity about ethics and responsibility, and a lack of creativity are the issues that plague engineering graduates the most and lower industry expectations. The consensus among experts is that these talents should have been cultivated at the postsecondary level with the aid of academics (Jackson, 2010).

3.2 Discussion

While degree classification is no longer the primary measure of graduate intelligence, degree-specific talent is still highly valued by companies for graduates. There are other additional abilities that employers respect and view as essential. The need for and actual performance levels for graduates' verbal and written communication abilities, which are both multidimensional in nature, routinely rank among the most crucial in many countries. A number of performance dimensions are included in interpersonal skills, which are likewise considered crucial but lacking globally, but there are very few definitions of these in the literature on employability. There is a significant amount of repetition in the collaborative skill composition, but it is distinguished as being used in a team atmosphere instead of in an individual way. Although the value of teamwork is universally acknowledged, there is a lot less debate and actual proof of level of satisfaction than there is for other competencies. The comprehensive skill set of professionalism and ethical values also includes enthusiasm and dependability. Because a strong work ethic is valued by employers all over the world, it is critical that employers examine each competency area's attributes to ascertain their genuine practical value and significance in the workplace. The weight of empirical evidence supporting the value of job experience is likewise substantial. Notably, there is a clear overlap between organizational skills competences and work ethics, with time management appearing in both sets of employer-provided descriptions. The use of critical thinking is another aspect. Problem solving and decision-making,

Table 1: Skill gap founded by the researchers summary

Serial	Skills	Mentioned in
1	Management skills, executive skills, leadership abilities, supervisory roles, specialized qualifications	for Training & Development (2012)
2	Motivation, the capacity to take criticism, the capacity for listening and pay	McGill (2009)
3	Collaborative experience	Miller and Dettori (2008), Begel and Simon (2008a)
4	Reluctant to seek clarification	Begel and Simon (2008b)
5	More focus on theoretical part rather than practical one	Trauth et al. (1993), McGill (2009)
6	Behavioral and personal traits rather than technical knowledge	Chithra et al. (2013)
7	Communication abilities	Riemer (2007), Begel and Simon (2008b)
8	Problem solving	Haddad (2002), Miller and Dettori (2008)

which both call for in-depth analysis, share a lot of ground with critical thinking. Since some people accept that both are necessary for good performance and since technical skills are increasingly organization specific, there is some crossover between discipline expertise and the capacity to operate in the organizational environment. Due to the fact that many definitions only consider disciplinary background, which is frequently determined by degree major, they should be provided to employers individually for discussion. Similar to how flexibility, adaptability, and change management were combined in the results due to significant overlap, they should be represented independently for empirical inquiry: the capability to effectively initiate and manage change as well as the capacity to be flexible and respond to change. These skills should have been acquired by the graduating engineering students in their academic life but instead, they are finding gaps between their understanding and the reality of workplace. This gap is a result of the inadequate educational curriculum, which lack obvious consideration for how they would be applied in the workplace. In addition to the above, there is some unevenness in how courses are implemented. The degree of skill supply is directly impacted by frequent program discontinuities in universities. Additionally, without adapting to change and expanding research program as well as encouraging students for real world problem solving, the gap will remain a major problem for the graduating engineering students and the industry.

Table 2: 10 skills identified by WDA as essential employability skills. (Zaharim et al., 2009)

NO.	**EMPLOYABILITY SKILL**
1	Workplace literacy & numeracy
2	Information & communications technology
3	Problem solving & decision making
4	Initiative & enterprise
5	Communication & relationship management
6	Lifelong learning
7	Global mindset
8	Self-management
9	Workplace-related life skills
10	Health & workplace safety

4 Future Works

Interviewing managers from various businesses will be a part of yet more research in this field to understand how knowledge decencies fluctuate between geographical locations. Additionally, it would be advantageous to pursue this research from several aspects, such as by polling or speaking with development teams who have recently started their careers because they would have more information on knowledge gaps to share. Working with businesses to carry out research on senior-level computer science students to ascertain whether their education has adequately prepared them for the workplace is another possible strategy.

5 Conclusion

The biggest concern of the 21st century is indeed a skills gap within engineering graduates. Individuals, corporations, and the nation as a whole are all negatively affected by the skills gap. Engineers are frustrated as a result of the inconsistency in the quality of recent engineering graduates, which forces them to accept unsuitable employment. There is an urgent need to offer engineers with training and education that helps them acquire knowledge and abilities. In addition to technical talents, corporations place a premium on engineers' behavioral skills, which are often deficient. To overcome these gaps, stakeholders must implement solutions such as the implementation of the case method during the teaching and training of students and the provision of quality communication and general skills. There is also a need for the stakeholders to be required to participate in the continuous improvement of all areas of the higher education system, for engineering curricula to be continually updated, and for students to receive more vocational and on-the-job training. To educate grads for the world of the future, higher education must create and implement relevant learning tools based on the most recent scientific and technological advances in education. Preparing the essential curriculum to instill these employable abilities in students' profiles needs careful thought and preparation. Nowadays, engineering graduates must engage themselves more than ever to be competitive. Students who are committed to improving their employability can acquire and enhance their work-readiness by participating in industrial training sessions or pragmatic training activities or by obtaining assistance from their institution of study to acquire the capacity to efficiently apply knowledge in their future work environment. Engineers must be able to accomplish more both now and in the future. In addition to executing technical tasks, the candidate must also have mission, vision, commitment, and tenacity, and comprehend corporate, social, and ethical responsibilities.

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