International Journal of Innovative Research and Scientific Studies, 9(6) 2026, pages: 21-31

IJIRSS
International Journal of Innovative Research & Scientific Studies

**ISSN:** 2617-6548

URL: www.ijirss.com

# Engineering's curriculums between market demands pull & technology push

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## Abstract

Engineering is considered as a prominent subject of education in universities around the globe, the graduates of engineering are usually professionals, technologists, engineers, marketing agents and project managers. Industry and Economy in general are profoundly depending on technology, more over technology itself is developing so rapid to accommodate the needs of industry – this process called "demand pull" for technology , on the other hand . Engineering services and tools are pushed into new edges of technology to survive and to compete among other technological competitors, which is called "technology push". Teaching and learning technology have the same context and influence as for industry, this reflexive relation will affects directly the engineering educational techniques . Engineering curriculums and teaching / training methodologies must be modified to accommodate the highly pace developing in technology.. The academic institutions must recognize these two technology forces on society ( Demand Pull, Technology Push), and take them in consideration, to produce graduates that can work in modern tools and devices, This paper concludes by proposing a framework for curriculum development that ensures graduates are not only market-ready but also capable of leading future technological transformations.

**Keywords:** Demand pull, Engineering Curriculum, Teaching Approaches, Technology Push.

**DOI:** 10.53894/ijirss.v9i6.11709
**Funding:** This study received no specific financial support.
**History: Received:** 13 March 2026 / **Revised:** 14 May 2026 / **Accepted:** 18 May 2026 / **Published:** 1 June 2026

**Competing Interests:** The authors declare that they have no competing interests.
**Authors' Contributions:** All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
**Transparency:** The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
**Acknowledgment:** My gratitude and thanks to Palestine Technical University -kadoorie (PTUK) for financial support to conduct this research
My special thanks too goes to the engineering graduated students (Al-Quds University, Palestine Technical University -Kadoorie , and Palestine Polytechnic University ) who filled this research survey, and who are currently working in their fields of engineering.
**Publisher:** Innovative Research Publishing

## 1. Introduction

The future of the industry depends and defines the interests and trends of today's engineering students. Whether these students become followers or leaders in technology, they and only they will shape the future of industry and services. This starting from engineering colleges then the experience that the would build up is depends heavily on how modern their academic institutions offer their courses for graduation . Now adays it's urgently to present the collective objectives of academic programs are suitable for their future career, which represent a real life need of professional in a certain field of job in their economy, this is one coefficient of the equation of jobs development, the other coefficient is to follow up and to cope with new technology that pushes the economy into new comparative edges [1]. As we see in Figure 1 the industry and economy are demanding products and services, on the same time by research and innovation, technology will push industry into more comparative products and services.

As a matter of fact to design an engineering curriculum in which meets the desires of industries requires a careful deliberation and collaboration with the industry experts. The following are some aspects needed to be considered.

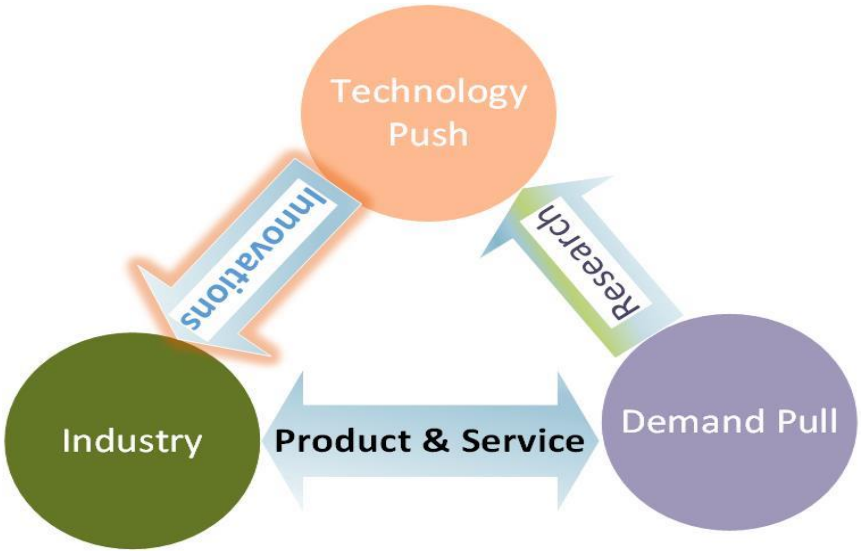



**Figure 1.**
Two forces for industry: Market Pull and Technology Push.

1. Engagement of industry : The need to connect with professionals and organizations from relevant sectors to understand their current and future needs. And also the need to conduct surveys, hold meetings, and gather their perspectives through partnerships.

2. Partnerships with Industry Sectors: Establishes strong relationships with industry sectors through partnerships, joint research projects, and lectures delivered by expert guests. This allows students to interact with professionals in the field, and to stay up to date [1].

3. Professional Development: Offers courses and workshops on professional ethics, project management, entrepreneurship, and lifelong learning. These skills are essential for engineers to adapt to changes in the industry, assume leadership roles, and continue developing throughout their careers [2].

4. Technological evolving: The is need to identify emerging technologies and trends likely to shape the future of sectors, like for instance integrating coursework and practical experiences focused on these areas to prepare students for the evolving demands of the job market [3].

5. Practice is essential: The emphasis more on hands-on learning through internships, cooperative training programs, and sector-supported projects. In which that will make students to gain practical experience and helps them develop skills aligned with industry prospects.

6. Approaches normally interdisciplinary: Naturally, it has interdisciplinary collaboration by integrating coursework or projects that require students to work with peers from various engineering disciplines, due to this fact it's ensured that a comprehensive understanding of real-world challenges and fosters teamwork skills.

7. Social skills and Communication: In engineering it is essential to have the social skills such as communication, teamwork, and problem-solving. That will give opportunities for students to develop these skills through group projects, presentations, and workshops.

Either confirmed or rejected by today's engineering students. There are a lot at stake ask today's industry managers what tomorrow's leaders must learn. If we want to ask what and who is responsible on our engineering curriculum, we must ask the question "What should tomorrow's industry leaders learn today?" we must ask this question to ourselves as educators. This paper is conducting a survey to highlight the natural reflexive relation between engineering's curriculum and the needed skill in real and daily life needs, then, reexplores how engineering curricula must continuously and consistently adapted for balancing these two driving forces. On one hand, industries need graduates with practical and employable skills that align with current market needs, while on the other hand, technological innovations are leading academic institutions to integrate emerging fields such as artificial intelligence, renewable energy, and smart systems into

their programs, even before they fully enter the market.. Through analysis of current curriculum models, industry expectations, and academic reforms, this study highlights the challenges and opportunities in aligning engineering education with both immediate employment requirements and long-term technological foresight

## 2. Market Pull Versus Tech. Push

As defined in Figure 1 , curriculum is developed periodically in steps , while technology is running in fact and contentious vector. One of the biggest challenges for the industry (and academia) is developing curriculum for students that go hand in hand with developments in industry and market's continuously developing technology [4]. There is a delicate balance between providing this kind of engineering curriculum, as shown in Figure 2 there are two forces are affecting engineering curriculums, namely *society demand pull and Technology advances push*, we need to manage this balance by the two forces to produce balanced and appropriate curriculum :

### *2.1. Curriculum Based on Job Market Demands Pull*

Designing curricula that align with the characteristics of market demand requires an understanding of the current and future needs of the labour market. Here are some considerations for creating an approach that responds to market demands [5]:

- Flexible and Adaptable: Process of developing a curriculum is flexible and adaptable to meet changing market demands. Industries are evolving rapidly, so curricula must be designed to incorporate emerging technologies, new methodologies, and interdisciplinary approaches
- Research and Analysis: Normally it's conducted thorough research to identify the specific skills, knowledge, and competencies that are in high demand in the job market. Stay up-to-date with industry trends, technological advances, and emerging areas to inform curriculum design.
- Industry Collaboration: Promote strong partnerships with industries and employers. Engage in ongoing dialogue with industry professionals to understand their current needs, employment trends, and skill requirements. Industry advisory boards can provide valuable input to curriculum development.
- Skills-Based Approach: Designing the curriculum to focus on developing practical skills that can be directly applied in the workplace. Incorporate practical projects, case studies, and internships to provide students with real-world experiences and enhance their employability.
- Entrepreneurial mindset: Encouraging an entrepreneurial mindset by incorporating courses or modules that promote innovation, creativity, and problem-solving. This equips graduates with the ability to identify market opportunities, adapt to changing business environments, and contribute to economic growth.
- Developing soft skills: As is recognizing the importance of soft skills such as communication, teamwork, leadership and critical thinking. Incorporate opportunities for students to develop these skills through group projects, presentations, and experiential learning activities [6].
- Continuous Improvement: Regularly review and update the curriculum based on feedback from alumni, employers, and industry experts. Stay in touch with alumni to understand how well the curriculum is preparing them for the job market and make necessary adjustments to address any gaps.

To emphasise, Maier, et al. [7] the curriculum must strike a balance between essential knowledge and industry-specific skills to ensure graduates are well prepared for the job market while also having a strong educational foundation

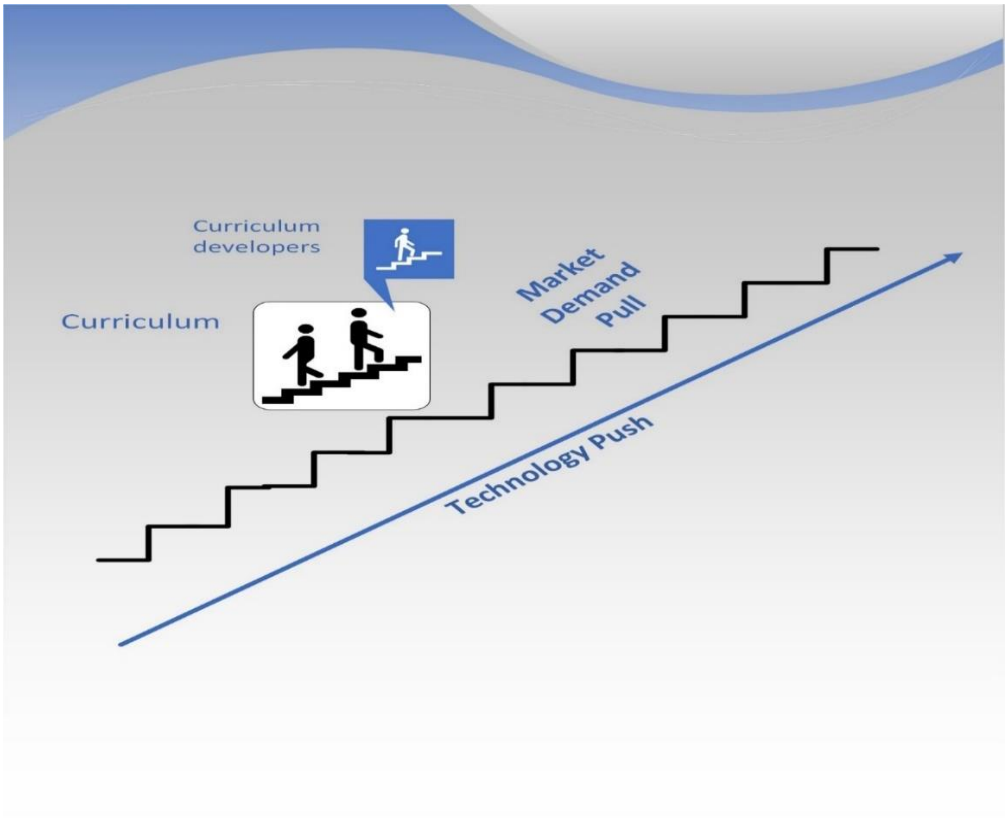



**Figure 2.**
The continuum "market demand pull" vs. "technology push". and Curriculum development**.**

*2.2. Curriculum based on Technology innovations push*

Designing a curriculum that considers technological advancements requires anticipating emerging technologies and integrating them into the educational environment. Here are some key points to consider [8, 9]:

1. Analyzing Technology Trends: Tracking technological developments and trends across various sectors. Monitoring progress in fields such as artificial intelligence, data science, robotics, renewable energy, and cybersecurity. Identifying technologies that could fundamentally transform industries or create new opportunities.

2. Future-Oriented Courses: Incorporating courses focused on emerging technologies into the curriculum. Offering specialized modules or programs covering topics such as machine learning, the Internet of Things, blockchain technology, and virtual reality. These courses enable students to acquire a solid foundation and practical skills in cutting-edge technologies.

3. State-of-the-art Laboratory Facilities: Equipping the educational institution with modern laboratory facilities and software tools suitable for emerging technologies. This allows students to gain hands-on experience and firsthand exposure to the latest tools and equipment used in industry. 4. Interdisciplinary Collaboration: Encouraging collaboration across different engineering disciplines and supporting interdisciplinary projects. New technologies often require collaboration across different fields; therefore, interdisciplinary courses and projects help students understand the broader impacts and applications of these technologies.

5. Industry Partnerships and Guest Speakers: Building strong relationships with technology companies, research institutions, and industry experts. Collaborating with them to host guest speakers, organize workshops, or present industry-supported projects. This enables students to gain firsthand knowledge from practitioners at the forefront of technology.

6. Continuous Learning Opportunities: Emphasizing the importance of lifelong learning and keeping pace with technological advancements. Encouraging students to engage in self-directed learning, attend conferences, participate in training courses, or pursue online certifications to stay abreast of rapid technological developments.

7. Ethical Considerations: Addressing the ethical and social implications of new technologies. Including courses or modules that address ethical frameworks, privacy concerns, and the responsible use of technology. This equips students with a solid understanding of the societal and ethical dimensions of adopting new technologies. Remember that the curriculum should strike a balance between basic knowledge and emerging technologies, ensuring that students have a strong understanding of the fundamental principles while also being prepared to work with the cutting-edge technologies that shape the future of industries [10].

## 3. Distinctives Between Market Demand Pull and Technology Push

The difference between demand-pull curricula and technology-push-based curricula lies in their core principles and focus.

The demand-driven curriculum takes into account the needs and requirements of the learners and the community. It is logically that by the understanding that education should be related and answer to the current and future needs of individuals and societies. In this method, the curriculum is designed based on the specific skills, knowledge, and capabilities needed for or desired by employers, businesses, and society. The aim is to prepare learners for the current and developing demands of the personnel and society [11].

On the other hand, technology based curricula are driven by the advancement and availability of technology. It stresses on the integration of innovations and technological developments into the curriculum. The emphasis is on providing learners with skills and knowledge related to emerging technologies and their applications. This method recognizes the influence of technology in various fields and pursues to prepare learners to adapt to technological new trends and contribute to technological development.

Whereas demand-driven paradigms are more responsive to the direct requirements of learners and society, technology-driven paradigms are progressive and emphasize the potential of technology to drive progress and change. Both paradigms have benefits and can be complementary in guaranteeing a value and appropriate education. Figure 1 represents in the stairs . The going up vector represents an extreme technological push approach. The curriculum development is going with low pace on the stairs of market demand pull , technology push is taking up the direction of market pull and also curriculum development, assume a location on it depends on the market approach methodology used to create the product. shows a bandwidth policy. This bandwidth may move up or down, and be narrower or narrower either specific product. Product offerings may generally be placed along the bandwidth, and some Represents more focus on attracting the market, pushing other technology. Curriculum development represents the average product offering and reflects its year Philosophy towards new product development. Bandwidth represents The product's ability, willingness, or culture most likely to handle a new product development from different perspectives along the chain. Show the band too It represents a certain inherent tension between the attractiveness of the two approaches. In this Illustration, the most common approach in favour of the end pull market The product development spectrum is illustrated [12].

### *3.1. Engineering Curriculum Characteristics*

When it comes to the characteristics of engineering curricula, there are several key aspects that are commonly noted. The following are some characteristics of the engineering curriculum criteria:

- Predefined
- Straightforward
- Consistent
- Deliberated
- Modernised
- Adapted
- Integrated
- Uncertain
- Unpredictable
- dynamic

It should be declared that *engineering curricula* normally and naturally can differ and vary between various universities, countries, and specific engineering majors. The characteristics listed above offer a general overview of what is commonly observed in “engineering curricula”.

**Table 1.**
Distinctive differences between technology push product and market pull Characteristics on curriculums.

| **Engineering Education Curriculum characteristics** | **Demand pull Criteria** | **Technology push Criteria** |
|---|---|---|
| Solid foundation of technical knowledge in their chosen discipline, | Predefined | Dynamic |
| Practical application of knowledge and skills. | Straightforward<br>Consistent<br>Integrated | Alternated<br>Adapted |
| develop creative and innovative solutions to engineering problems | Objectified<br>predictable | Uncertainty<br>Unpredictable |
| focus on mathematics and applied sciences, such as physics and chemistry | Predefined<br>Straight forward | Scattered<br>Adjusted |
| interdisciplinary field, and approaches may integrate knowledge from different disciplines | Consistent<br>Integrated | Inconsistent<br>Scattered<br>Modernized |
| training in engineering tools, software, and computer-aided design (CAD) software | Deliberate modernised | Alternated<br>Adaptation |
| Engineering projects often require collaboration and effective communication. | Consistent<br>Integrated<br>Predictable | Dynamic<br>Alternated<br>Unpredictable |

| | | |
|---|---|---|
| Ethical and professional aspects to help students understand their responsibilities | Straightforward, Consistent | Deliberated Adaptation |
| Emphasizes the importance of lifelong learning and adaptability. | Predefined Straightforward, Consistent Integrated | Dynamic Alternated Inconsistent Scattered |
| Reviewed and updated periodically based on feedback and new research | Integrated Deliberate modernised Objectified Predictable | Adaptation Uncertainty Unpredictable |

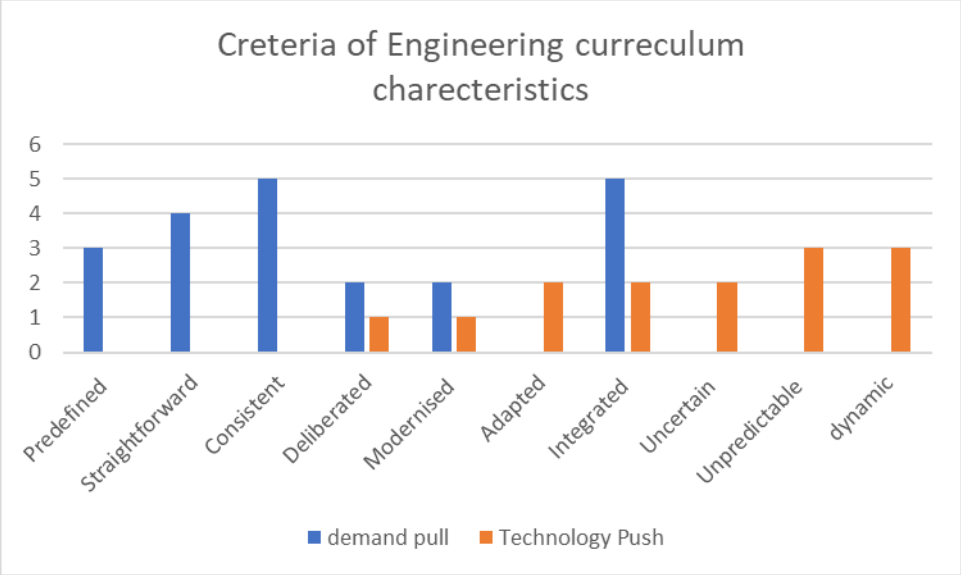



**Figure 3.**
Technology and demand criteria of engineering curriculum characteristics.

Table 1 defines the main characterises that must took in consideration we engineering curriculum is designed , the other columns of Table 1 is to explain the criteria of demand for new technology , and the push vy technology that affect each characteristic, we notice from Figure 3 that demand to embed new technology teaching in curriculum must be predefined ,straightforward, and consistent . On the other hand the technology pushes to extreme edges of uncertainty , unpredictability , and dynamic curriculum design, which is more critical and needed to be revised and reconsider to be taken into curriculum. Figure 2 shows the safest path to design efficient and rational curriculum that balances between market demand pull and new technology push is to consider the criteria of deliberation , modernisation, adaptation and integration when build and update engineering curriculum

## 4. Survey Methodology and Results

*4.1. Engineering Graduate Satisfaction survey methodology*

This paper has conducted an Engineering Graduate Satisfaction survey on the most prominent universities in Palestine that has graduates computer engineering colleges, each graduate will fill the survey in unanimously to have honest answer with no impressments. The result of the survey will cover 60 graduates , 20 for each university, the graduates have graduated within the past 2 years the most, all of them are working in software/ hardware jobs or freelancer. Figure 4 is showing the main points of the survey that concentrated on four main categories:

- Technical Skills
- Communications (Soft Skills)
- Real work and Practical Applications
- Curriculum Relevance to Job Market

The main purpose of this survey is to evaluate how well the engineering curriculum will prepares graduates for there professional roles. This survey collects graduates' insights across four domains using a 5-point as in Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). According to survey results, this paper identifies strengths and weaknesses, and provides actionable recommendations to enhance curricular effectiveness and industry relevance. The Methodology of this survey is based on the following:

- Responses results are rated statements from 1 to 5.
- The weighted averages are calculated for each statement: $Average = \Sigma\ (Response \times Number\ of\ Responses) \div The\ total\ Responses$
- The analysed data is identifying the following ranks:
- High-performing areas (≥ 3.30)

- Moderate areas (2.90–3.29)
- Weak areas (< 2.90)

Generally, graduates are expressed moderate satisfaction, with a notable strengths in communication skills, theoretical applications, and creativity. However, the significant weaknesses are identified in hands-on experiences, modern technology integration, and the effectiveness of laboratory and workshop sessions.

The key conclusions indicate that while the curriculum is successfully builds theoretical knowledge and soft skills, it requires substantial improvement in aligning with modern industry practices and practical readiness.

Engineering Graduate Satisfaction Survey (Likert Scale)

**Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree**

Technical Skills Preparedness

| Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| The curriculum provided strong technical fundamentals. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Courses covered up-to-date technologies and industry trends. | ☐ | ☐ | ☐ | ☐ | ☐ |
| I gained sufficient hands-on experience with tools/equipment/software. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The program developed my problem-solving and analytical skills. | ☐ | ☐ | ☐ | ☐ | ☐ |

Soft Skills Preparedness

| Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| The curriculum improved my communication skills. | ☐ | ☐ | ☐ | ☐ | ☐ |
| I developed effective teamwork and collaboration abilities. | ☐ | ☐ | ☐ | ☐ | ☐ |
| I gained project-management and organizational skills. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The program enhanced my creativity and innovation skills. | ☐ | ☐ | ☐ | ☐ | ☐ |

Practical Application & Industry Readiness

| Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Labs and workshops strengthened my practical understanding. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The program provided meaningful internships or industry training. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The curriculum encouraged real-world problem solving. | ☐ | ☐ | ☐ | ☐ | ☐ |
| I can confidently apply theoretical knowledge in work situations. | ☐ | ☐ | ☐ | ☐ | ☐ |

Curriculum Relevance to Job Market

| | | | | | |
|---|---|---|---|---|---|
| The curriculum matched the skills needed in my job/industry. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Courses reflected actual industry standards and expectations. | ☐ | ☐ | ☐ | ☐ | ☐ |
| The program supported my career development goals. | ☐ | ☐ | ☐ | ☐ | ☐ |
| Overall, I am satisfied with the job-market relevance of the curriculum. | ☐ | ☐ | ☐ | ☐ | ☐ |

Open-Ended Questions

**1. What aspects of the curriculum were most useful?**

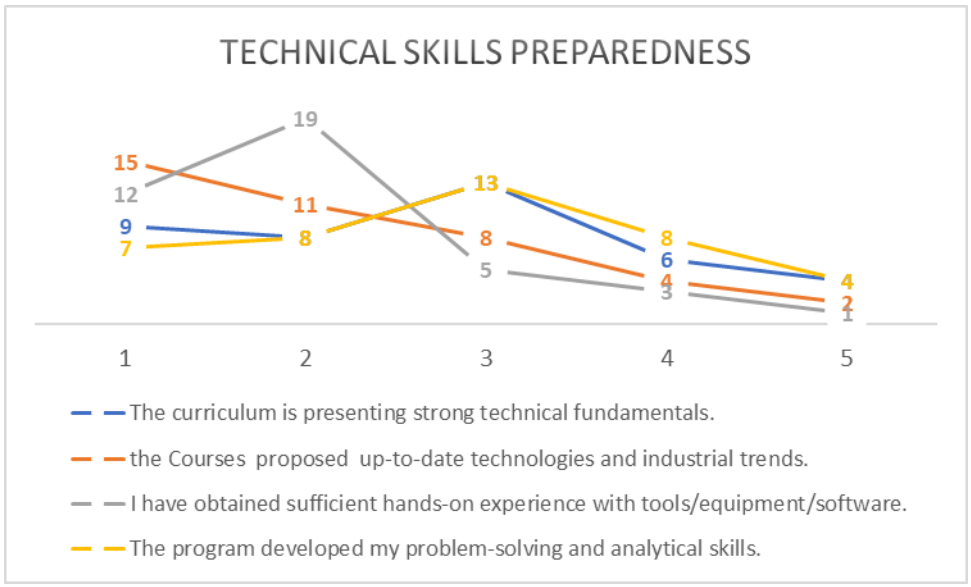
_____

**2. What improvements would better align the curriculum with job-market needs?**

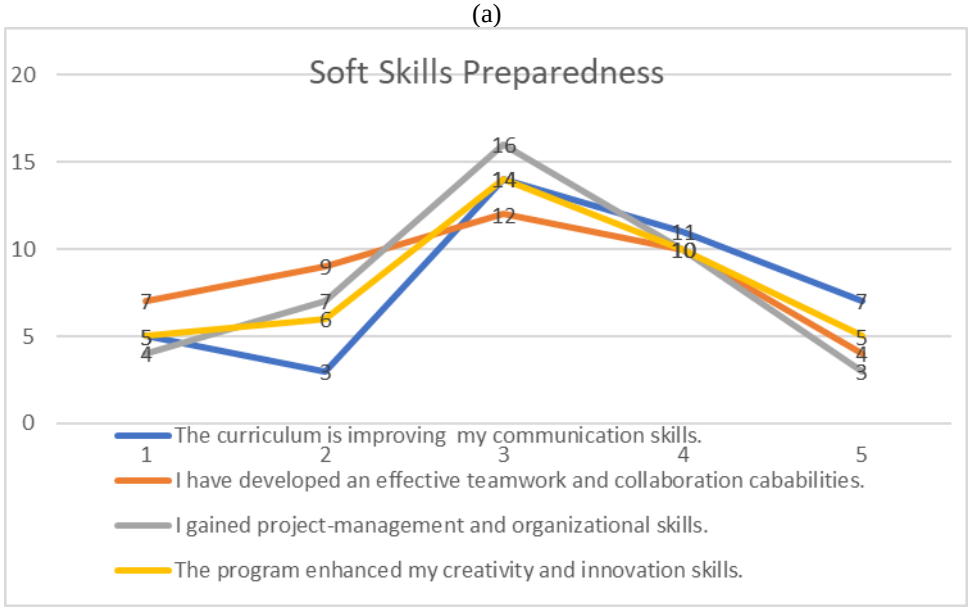
_____

**Figure 4.**
Survey on engineering graduates satisfaction from universities curriculums.

*4.2. Survey Results*




(a)

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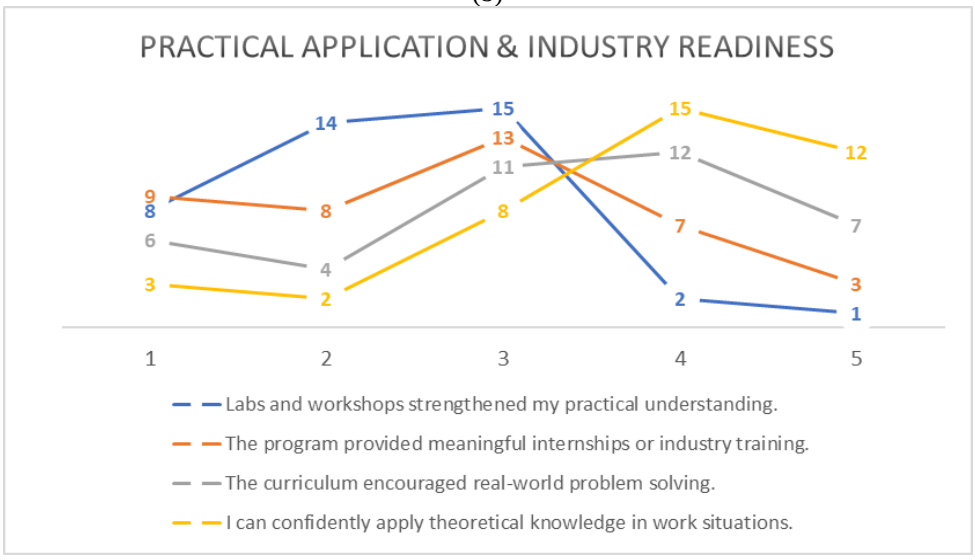


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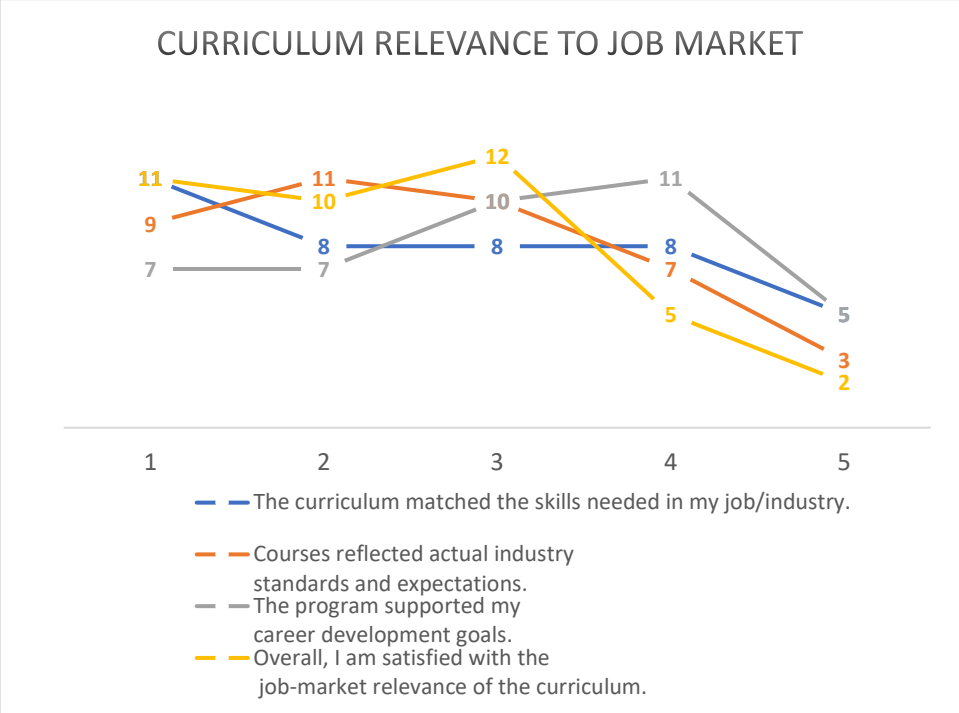


(d)

**Figure 5.**
The survey results in charts (a…d).

**Table 2.**
The Engineering Graduate Satisfaction Survey – Results.

| **Engineering Graduate Satisfaction Survey - Results** | | |
|---|---|---|
| **Technical Skills Preparedness** | **Average** | **Performance** |
| The curriculum is presenting strong technical fundamentals. | 3.2 | Moderate |
| the Courses proposed up-to-date technologies and industrial trends. | 2.49 | Weak |
| I have obtained sufficient hands-on experience with tools/equipment/software. | 2.36 | Weak |
| The program developed my problem-solving and analytical skills. | 3.17 | Moderate |
| Soft Skills Preparedness | Average | Performance |
| The curriculum is improving my communication skills. | 3.34 | Moderate |
| I have developed an effective teamwork and collaboration capabilities. | 3.19 | Moderate |
| I gained project-management and organizational skills. | 3.21 | Moderate |
| The program enhanced my creativity and innovation skills. | 3.26 | Moderate |
| Practical Application & Industry Readiness | Average | Performance |
| Labs and workshops strengthened my practical understanding. | 2.39 | Weak |
| The program provided meaningful internships or industry training. | 3.04 | Moderate |
| The curriculum encouraged real-world problem solving. | 3.14 | Moderate |
| I can confidently apply theoretical knowledge in work situations. | 3.81 | Strong |
| Curriculum Relevance to Job Market | Average | Performance |
| The curriculum matched the skills needed in my job/industry. | 3.16 | Moderate |
| Courses reflected actual industry standards and expectations. | 2.88 | Weak |
| The program supported my career development goals. | 3.1 | Moderate |
| Overall, I am satisfied with the job-market relevance of the curriculum. | 2.89 | Weak |

*4.3. Key Finding of the survey*

Figure 5 has four divisions from (***a..d),*** each of which depicts one survey's item as explained in Figure 4 in which is reflected and defined in Table 2 , the harvested results of this survey is showing an interesting key findings , it shows items with strength and items with weaknesses , the degree strength or weakness has been presumed earlier in this survey methodology.

*4.3.1. The Major Strengths*

- Capability to apply theoretical knowledge to real work (3.81)
- Strong communication skills (3.34)
- Creativity and innovation (3.26)
- Career-support elements (3.26)
- Industry standards orientation (3.24)

*4.3.2. Major Weaknesses*

- Hands-on laboratory/workshop experience (2.36)
- Use of up-to-date technologies and tools (2.49)
- -Overall job-market relevance (2.89)
- Meaningful internships only moderate (3.04)
- Practical readiness inconsistent across the program

The survey results is reflecting a theory-strong but practice-weak curriculum. Graduates are appreciating the foundational theoretical knowledge and soft skills but emphasize the urgent need for:

- Better-equipped laboratories
- Updated technology and software
- More structured practical components
- Stronger bonds with industry partners

These results are aligning with the common skills gaps observed in evolving engineering programs, particularly where theoretical emphasis exceeds experiential learning

*4.4. Pitfalls in Engineering Curriculum*

Many deficiencies or pitfalls are identified in engineering courses in general, including: *out-of-date content* that unsuitable to the current industries; *insufficient practical application and hands-on experience* [13]; due to emphasis on theoretical soft skills and teamwork without real application projects; *inadequate preparation* for continuously evolving technologies; due to limited opportunities to engage with real-world challenges. The following are some potential problems in engineering courses:

1. Lack of practical application: Concentration on theoretical and hypothetical matters, with insufficient practical experience will prevent students from practicing real-world engineering challenges.
2. Out-of-date courses ‘contents: Engineering approaches are rapidly evolving, and if courses are not updated regularly, the knowledge students acquire upon graduation may be outdated or no longer effective.
3. Lacking of diversity and inclusion: A lack of diversity in courses can worsen biases and deter innovation. Engineering education better to reflect the variety of practitioners in the field and the societies they serve.
4. Ignoring of new technologies: With continuously evolving technologies such as artificial intelligence, robotics, and sustainable energy, the need is to adopt and integrate into the curriculum to meet industry needs.
5. Heavy course workload: In semester studding time , an excessive workload can lead to student burnout and hinder their in-depth understanding of course content.
6. Unbalancing between theory and practice: Actually achieving a proper balance between theory and practical application is not easy. Any theory given to student must meet with practical application
7. Insufficient Elective courses: some times , limited range of electives restricts students' specialization in areas of interest.
8. Inadequate ethics education: Normally ,engineering involves ethical issues, but the curriculum may not provide students with sufficient opportunities to explore the ethical aspects of their work.
9. Lack of importance on sustainability: As an increasing concern about environmental impact, engineering curricula should more prominently integrate sustainable design principles.

These pitfalls stem from survey findings of engineering curriculum in general , nevertheless; they are varied across different institutions and regions. Actually addressing these issues will contribute to creating a more effective and practical engineering education.

## 5. Conclusion

Various factors can influence the conclusion curriculum of engineering courses, including advancements in technology, industry demands, educational standards, and feedback from employers and graduates. Balancing forces affecting engineering curriculum include the need to cover fundamental concepts, incorporating emerging technologies, meeting industry demands, allowing for specialization, ensuring accreditation standards are met, and adapting to changing educational methodologies. Engineering is defined as an applied and highly dynamic field of study in universities , this means it needs a continuous development from time to time , Two main forces are affecting the engineering content of study . First one: market demand pull that pulls the engineering paradigms to be more usable according to the demands of society like for example the increasingly using of data in our daily life the demands is creating applications to serve the people to satisfy their needs to organize their work and to visualize their future projects. Secondly ,technology push ,

technology with its all shapes is developed so rapid specially in the current and the last century, like for example transportation , construction , telecommunication and most important power generation all these shapes of technologies have revolutionary developments in each day passes in which push economy into new levels of technology in various paradigms of engineering into new edge of knowledge and practice for engineering students., These two main forces call universities for revising engineering curriculum and change it to meet the new technological development , this change needs teachers and professors attention to adopt these changes to be able to teach these new developed curriculum. By that graduates can compete in the job market, otherwise the curriculum will be obsolete and engineering graduates needs a lot of training to apply and to start their engineering job

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