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DEM KNOWLEDGE PAPER

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DEPARTMENT OF ENGINEERING MANAGEMENT

Dem-1/Oct/2024

BEYOND TECHNICAL EXPERTISE: THE CRITICAL ROLE OF SOFT SKILLS FOR EMPLOYMENT OF ENGINEERS

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1. BACKGROUND

Universities and training institutions play a vital role in preparing future engineers to meet the ever-evolving demands of industry. In developed nations, engineering programs prioritize a balance of technical and soft skills to ensure well-rounded career performance. While technical skills like mathematics, programming, and engineering principles are key to problem-solving and innovation, soft skills such as communication, teamwork, and critical thinking are crucial for effective collaboration and leadership. This study evaluates the impact of these skills on employability through a web-based survey of recent graduates from a public university in Islamabad, Pakistan. By sampling graduates from various engineering departments, the study investigates the influence of both technical and soft skills across different fields. The findings reveal a strong positive correlation between soft skills and employability, with communication, teamwork, presentation, time management, leadership, confidence, and problem-solving highlighted as the most influential. The graduates have also expressed concern that the current curriculum falls short in preparing them for the professional world, as it is heavily focused on theory with limited opportunities for practical skill development. This study underscores the need to revise the undergraduate engineering curriculum to better integrate soft skills training.

2. INTRODUCTION

Engineers are an integral part of our society. Their innovative contributions have become essential for sustaining and improving the quality of life. In today's digital era of latest technological trends and increasing demands of industry, it has become a primary need of universities to produce competent engineers with sound knowledge and skills to survive in the competitive marketplace (Sorby et al., 2020). Developed countries incorporate a blend of technical and soft skills into their engineering curriculum. This focus on a diverse skill set aims to develop well-rounded engineers capable of excelling in both technical tasks and interpersonal interactions, leading to enhanced performance metrics in their professional roles.In a developing country like Pakistan, approximately 25,000 engineers graduate annually [*a] (Pakistan Engineering Foundation, 2020), with a total population of 241.49 million [*b] (United Nations, 2023). Despite this substantial number of engineering graduates, Pakistan ranks 87th on the Global Innovation Index (Dutta et al., 2022). Furthermore, the unemployment rate among engineers stands at 23.5% [*c] (Labor Force Survey, 2020-2021), indicating a significant disparity between the number of graduates and available employment opportunities. This high rate of unemployment among engineers highlights a critical issue in the country's employment sector, necessitating an in-depth exploration of the underlying factors contributing to this imbalance. Possible areas of investigation include the quality of engineering education, requirement of appropriate technical and soft skills, the alignment of curriculum with industry needs, economic conditions affecting job creation, and the effectiveness of career placement services. Addressing these factors is essential for improving the employment rate and ensuring that the skills of these graduates are effectively utilized in the workplace.

*a https://pef.com.pk/overview
*b https://pakistan.un.org/en/232900-media-update-united-nations-pakistan-23-may-2023
*c https://www.pbs.gov.pk/sites/default/files/labour_force/publications/lfs2020_21/LFS_2020-21_Report.pdf

3. STUDENT-PROFESSIONAL TRANSITION

The university-workplace transition is a critical phase in the life of young graduates (Trajkovski et al., 2021). Several factors affect the employment of engineers, with individual skills being the most important (Sahudin et al., 2022). Universities and training institutions play a crucial role in equipping future engineers with the necessary skills to meet these dynamic industry requirements, ensuring they remain competitive and capable of contributing to national development. These skills are broadly classified into two categories: soft skills and technical skills (Lyu & Liu, 2021). Technical skills are particularly important due to the nature of the work. In industries where technology and methodologies rapidly evolve, possessing up-to-date technical skills is crucial for engineers to stay relevant and effective. Employers seek individuals who can adapt to new tools and processes, ensuring that their organizations remain at the forefront of innovation and efficiency (Monteiro et al., 2021). However, employability is also significantly impacted by soft skills. These skills enable engineers to effectively collaborate, manage projects, and navigate workplace dynamics. Employers highly value candidates who can complement their technical abilities with strong interpersonal skills as they are more likely to advance in their careers, take on leadership roles, and drive organizational growth (Nickson et al., 2011).

4. TECHNICAL SKILLS & EMPLOYABILITY

Technical skills refer to the specific knowledge, proficiency, and abilities that are critical to a worker's field, be it technical or engineering (Nasir et al., 2011). Often termed "hard skills," these capabilities are closely associated with the effective use of tools and equipment necessary for performing tasks accurately and efficiently. The direct and observable nature of these skills makes them relatively straightforward to assess and understand. Their importance extends to employability, as technical skills are pivotal in demonstrating competency and enhancing job prospects (Laddha et al., 2021). Core engineering skills, such as technical problem-solving and design expertise, are especially emphasized due to their fundamental role in achieving success and driving innovation within the engineering sector (Litzinger et al., 2011).

5. SOFT SKILLS & EMPLOYABILITY

Soft skills encompass crucial intrapersonal and interpersonal abilities that enable individuals to manage their own behavior, attitudes, and interactions effectively. These skills, including communication, teamwork, and emotional intelligence, are highly valued by employers because they significantly influence not only an individual's job performance but also the overall workplace environment (Maldonado & Marquez, 2023). While technical or hard skills pertain to the specific technical requirements of a job, soft skills are essential for career success and satisfaction as they facilitate better collaboration, problem-solving, and adaptability in various professional settings (Majid et al., 2012). These skills are essential for engineers to work efficiently in multidisciplinary teams and to contribute positively to their organizations. Soft skills facilitate better peer interactions, clearer communication of complex technical concepts, and efficient conflict resolution, all of which are vital for project success.

6. METHODOLOGY

To evaluate the impact of individual skills on employability, a web-based survey was administered to a sample of recent graduates from a public university in Islamabad, Pakistan. The survey was meticulously designed to provide a comprehensive analysis by targeting all four departments within the campus: Computer Engineering, Electrical Engineering, Mechanical Engineering, and Mechatronics Engineering.To ensure accurate representation and participation, the survey was distributed through the respective program coordinators. This approach allowed the collection of data from a broad spectrum of perspectives and experiences, reflecting the diverse academic backgrounds of the respondents. The following questions were asked specifically from employed graduates:

- Which technical skills helped you to achieve the current job?
- Which technical skills would you recommend being included in undergraduate studies?
- Which soft skills helped to achieve the current job?
- Which soft skills would you recommend being included in undergraduate studies?

7. RESULTS

The survey was shared with 270 graduates to gather insights into their experiences and perceptions related to employability. Responses were received from 115 graduates resulting in a response rate of 42% of the total sample.Among the respondents, 93 mentioned "male," while 22 mentioned "female." The following graphs represent the distribution of engineering major, employment status, scope of work and comparison of importance of technical and soft skills for graduate engineers' employment.

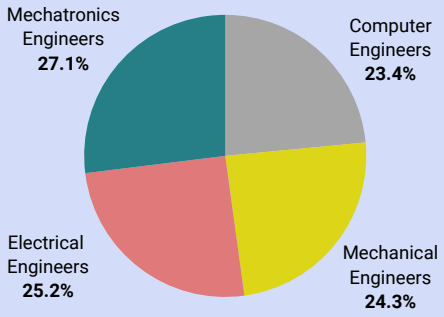

Figure 1: Engineering Major

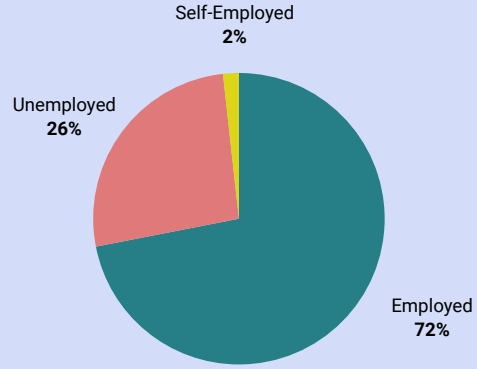

Figure 2: Employment Status

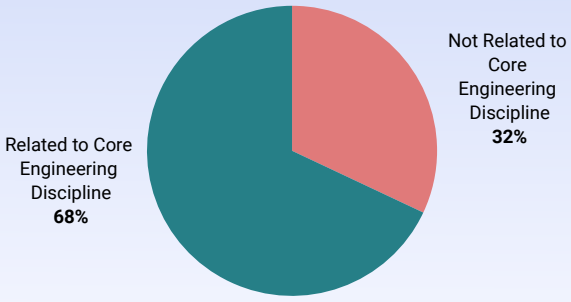

Figure 2: Employment Domain

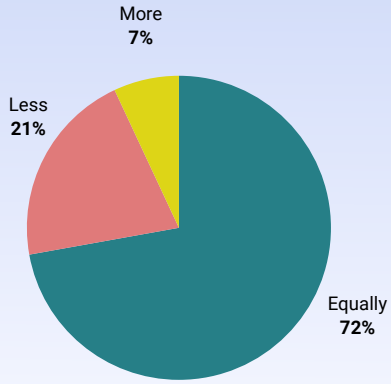

Figure 2: Soft skills are as important as technical skills for graduate engineers' employment

The results of the survey reveal that technical skills vary significantly across different job roles, underscoring the specialized nature of the technical expertise required in various positions. Respondents reported a range of technical skills depending on the scope of work, including programming languages (such as C++, Java, MATLAB), hardware-related skills (such as microcontrollers, PCB design, embedded systems), CAD (Computer-Aided Design), AI (Artificial Intelligence), MS Office, Project Management, Web Development, and more. These skills were closely aligned with the specific demands of their respective job roles. However, among soft skills, "communication skills" emerged as the most frequently cited and emphasized skill across all respondents, highlighting its critical importance in both securing employment and succeeding in engineering careers. Regardless of the specific technical requirements of their jobs, graduates consistently identified communication skills as essential for effective collaboration, problem-solving, and career advancement.

The graph in Figure 5 illustrates the responses to the question: "Which soft skills helped to achieve the current job?". They clearly indicate that "communication skills" are significantly dominant among all the reported soft skills followed by teamwork, presentation skills, time management and leadership skills, further emphasizing their crucial role in the professional success of engineering graduates. This finding suggests that while technical expertise is important, strong communication skills are universally recognized as a key factor in the employability and effectiveness of engineers.

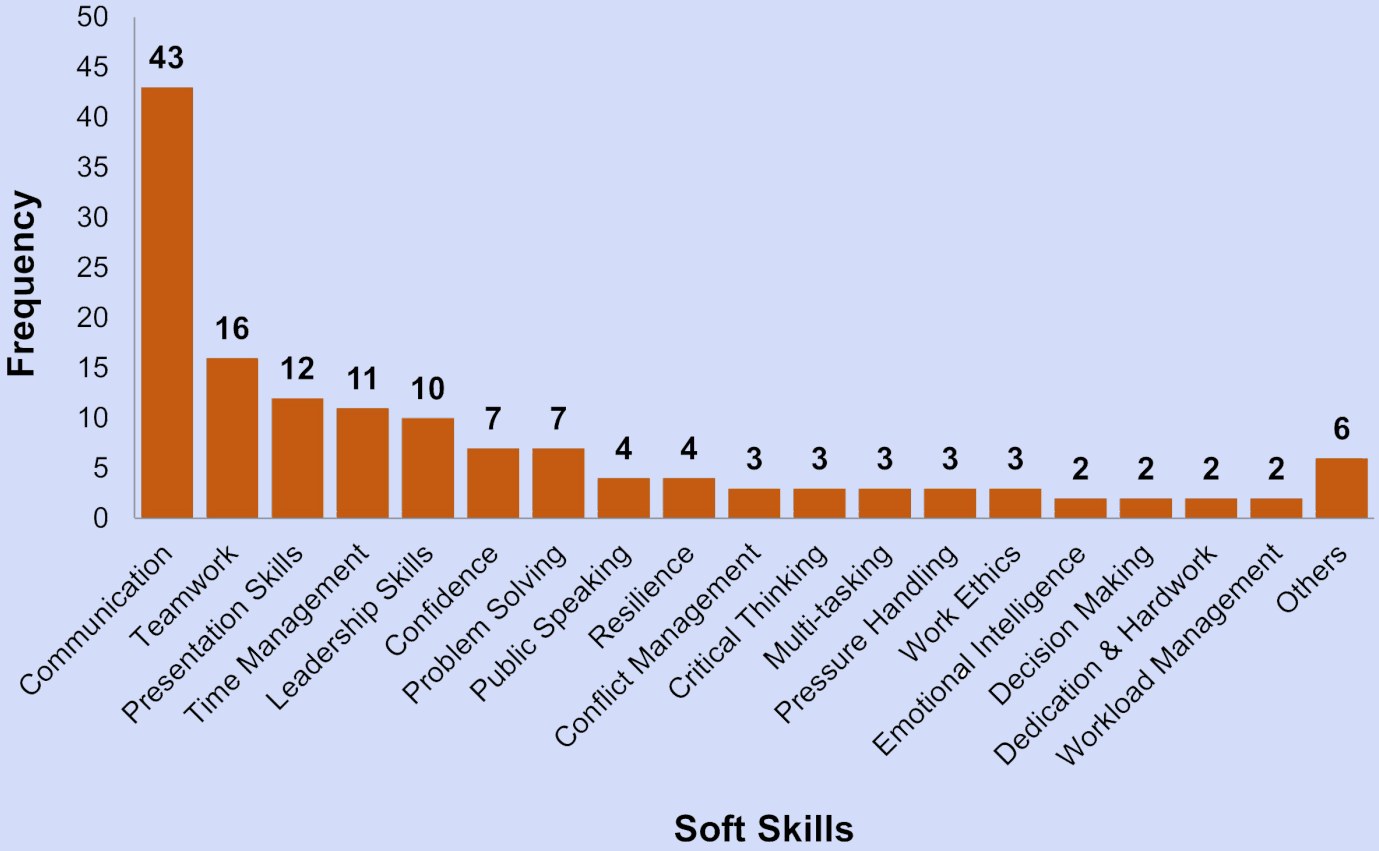

Figure 5: Soft skills that enhance employability of engineering graduates

7. DISCUSSION

The findings of this study emphasize a strong positive relationship between soft skills and employability. Among these skills, communication, teamwork, presentation, time management, leadership, confidence, and problem-solving are most frequently mentioned. This indicates that integrating these skills into educational programs, particularly for engineering students, could significantly enhance their readiness for job opportunities.

An analysis of the current Engineering curriculum reveals a noticeable gap in the inclusion of courses dedicated to the development of essential soft skills, such as teamwork, time management, leadership, and problem-solving. These are essential competencies that play a significant role in professional success, yet they are often overlooked in traditional engineering education. However, there is a deliberate focus on communication skills, with three distinct courses—English, Communication Skills, and Technical & Business Writing—dedicated to this essential area. These courses are designed to provide students with a well-rounded understanding of communication, aiming to bridge the gap between their technical knowledge and the ability to articulate ideas effectively in both academic and professional contexts. The curriculum covers a range of fundamental topics, including basic English writing, grammar, presentation skills, technical report writing, email communication, and mock interviews. However, a closer analysis of the content that is delivered reveals a significant shortcoming: it is heavily theory-based, with limited opportunities for students to engage in the practical exercises necessary to develop strong professional communication skills. While students are introduced to important communication concepts and techniques, the curriculum lacks the hands-on experiences that are critical for mastering these skills. This gap between theory and practice has become a point of concern, particularly considering feedback from recent graduates.

Survey results show that graduates feel the current curriculum does not adequately prepare them for challenges of the professional world. They often revisit material from earlier stages of their education, such as matriculation/O-levels and intermediate/A-levels, instead of engaging in advanced, real-world communication practices. This repetition of basic content suggests the curriculum may lack progression, preventing students from developing the sophisticated communication skills needed in today's job market. Graduates emphasize the need for more practical, hands-on communication training to meet the demands of the professional world, where engineers must effectively convey complex technical information, lead presentations, and collaborate in team settings. Similarly, teamwork, time management, leadership, and problem-solving are also recognized as essential skills that influence employability across diverse industries. Teamwork is crucial because it promotes effective collaboration, allowing individuals to contribute to and achieve collective goals, which is vital in any work environment that relies on group efforts. Time

management enhances productivity by enabling individuals to prioritize tasks and meet deadlines efficiently, thus ensuring that work is completed in a timely manner. Leadership is important for steering teams, making strategic decisions, and motivating others, thereby driving organizational success. Problem-solving skills are key to addressing and overcoming challenges, leading to innovative solutions that can propel a business forward. Collectively, these skills significantly boost an individual's effectiveness and adaptability in the workplace, making them highly sought after by employers who need capable and well-rounded professionals. Graduates with strong soft skills find themselves at a significant advantage in the workforce, as they are crucial for success across industries. Their ability to articulate ideas, listen actively, and engage in meaningful dialogue helps them build relationships, adapt to new environments, and collaborate effectively. These skills are vital for networking, teamwork, and problem-solving, making them valuable assets to their organizations and positioning them for early career growth and leadership opportunities.

7. POLICY RECOMMENDATIONS

The current curriculum, with its strong emphasis on theory, may not provide enough opportunities for students to practice soft skills in a controlled setting before facing real-world situations. Without practical training, students might struggle with the complex demands of their jobs, potentially impacting their performance and limiting career advancement. To overcome all these challenges, the curriculum is undergoing a revision that aims to streamline its focus by limiting it to just two key courses for communication: expository writing and functional writing. This change is designed to concentrate on developing students' ability to express ideas clearly and effectively in both academic and practical contexts. Expository writing will emphasize the skills needed to explain and analyze complex concepts, while functional writing will focus on practical communication tasks, such as professional emails, reports, and other workplace-related documents. Although this revision is still in the planning phase, it reflects a shift towards a more targeted and skill-based approach to writing education, aiming to equip students with essential communication tools that are directly applicable to their future careers. Similarly, courses need to be designed with their emphasis on time management, teamwork, leadership, and problem solving. Addressing these concerns will significantly enhance the soft skills of graduates, preparing them to survive in a competitive job market, stay confident in their abilities, and better positioned to seize new opportunities and excel in their chosen fields. Therefore,

- Soft skills for undergraduates need an equal emphasis as technical skills. Educational institutions should integrate soft skills training into their curriculum, providing students with opportunities to develop interpersonal abilities alongside their technical knowledge. Pakistan Airforce's Jinnah Centre for Character and Leadership (JCCL) at Pakistan Airforce Academy established is a step towards building the essential ingredients in the officers and cadets of PAF. Other institutions may also follow the lead to establish such establishments for grooming of the students and professionals.
- Considering the prime importance of communication skills, time management, leadership and problem solving, special training sessions should be conducted. By organizing workshops, seminars, and practical training sessions, educational institutions can help students develop strong communication skills. These sessions should cover various aspects, including active listening, clear articulation of ideas, persuasive speaking, and professional writing, ensuring that graduates are well-prepared to convey their thoughts and collaborate effectively in their future careers.

8. CONCLUSION

The results of this study indicate that communication skills are overwhelmingly identified as the most crucial skills by fresh graduates, highlighting their vital role in the employment process. This underscores the importance of integrating communication training into undergraduate engineering programs. By emphasizing these skills in addition to teamwork, problem solving and leadership skills during academic training, educational institutions can better prepare students for the job market, enhancing their ability to secure desirable positions.

9. LIMITATIONS & FUTURE DIRECTIONS

This study primarily focused on fresh graduates from an engineering institute in Islamabad, making it a case study with a specific context which might affect the generalizability of results. Future studies could broaden the scope by including data from various universities and covering all four years of study to provide a more comprehensive view. Additionally, since data was collected at only one point in time, further studies might include data collected at multiple intervals during the degree program to analyze trends over the years.

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DEPARTMENT BRIEF

Engineering Management (EM) is a specialized field of management concerned with the engineering sector. By its very nature, EM is a multi-disciplinary subject, so the scope of topics available for specialization is broad within engineering and management, as well as some topics that blend both fields. Through the combination of business and management acumen with technical expertise, EM degrees are expected to play a key role in preparing the next generation of managers for public (including defence) and private sectors. Department of Engineering Management (DEM) was established in Colllege of Electrical and Mechanical Engineering (CoEME) under National University of Sciences and Technology (NUST) in 2006 for Masters and Doctoral programs. Total of 327 scholars have completed their Masters' degree and 16 scholars have completed their PhD degrees from the department so far.