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Rethinking Engineering Pathways

Psychological Factors Influencing Pakistani Pre-Engineering Students'

Educational and Career Choices in the Age of Artificial Intelligence

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Abstract

The advent of Artificial Intelligence (AI) has been changing the landscape of higher education and career choices in Pakistan, especially for the batch of pre-engineering students who have historically considered engineering as the most viable career option. In this study, the researchers study how pre-engineering students in Pakistan perceive, assess and discuss new educational and career opportunities of AI in the Fourth Industrial Revolution. It emphasizes students' awareness of AI, their perceived employability, influence of parents and institutions, career counseling access, and continued social value of traditional engineering degrees. According to the article, AI is not just taking the place of engineering dreams but reshaping them into a new hybrid, with a combination of computing, automation, data science and innovation-related jobs. The study brings to the fore the need to strengthen existing counseling systems, Psychological Factors. reimagine the curriculum, and implement policy support to ensure pre-engineering education better reflects the reality of the future job market in the rapidly evolving digital economy and society of Pakistan.

Keywords: Artificial Intelligence; Pre-Engineering Students; Career Choice; Higher Education; Pakistan; Fourth Industrial Revolution; Engineering Pathways; Educational Decision-Making; Labour Market; Career Counseling

Introduction

The Fourth Industrial Revolution is a major technological shift where the blending of physical, psychological, digital and biological systems represents a transformation. Emerging technologies like artificial intelligence, machine learning, automation, blockchain, the Internet of Things, quantum computing and advanced robotics are transforming industries, systems of governance, educational institutions and the labour market. The Fourth Industrial Revolution is changing the definition of human capital and professional skills and the jobs of the future, compared with the previous industrial revolutions that mainly brought changes to production processes and industrial efficiency. In doing so, educational institutions are now asked to produce students who

are digitally literate, who can apply knowledge from different disciplines, who are technologically agile, and who continuously acquire new skills (To et al., 2025).

Pakistan is important to consider in this context as one of the youngest countries in the world with about 64% of its population in the age group of under 30. This demographic profile has great potential for economic growth and national development, if educational institutions can adjust the training of their students to the new needs of the labour market. In Pakistan, engineering has been considered a prestigious field and a means to social mobility, status and economic security, and this has always been the belief of students enrolled in Pre-Engineering programs. The fields of civil engineering, electrical engineering, and mechanical engineering have traditionally been successful draws for intermediate college students and have been at the heart of traditional thinking about technical education and professional success (Fares et al, 2026).

But, new technology developments have started to change these educational and career choices. As a result of the advent of artificial intelligence and the digital and related disciplines, new employment opportunities have been established in various areas such as education, healthcare, finance, manufacturing, agriculture, cybersecurity and the digital services. Amongst the Pakistani students, there is a growing sense of AI, Software Engineering, Data Science, Cyber Security, and Computer Science being viable career options instead of traditional engineering disciplines. Results from surveys conducted with Pakistani students show that there is an increasing interest among students in computing-related careers, with more than 42 percent of the Science students interested in computer science and AI-related fields, while 31 percent were interested in the conventional engineering careers (Wang et al., 2026).

This change is tied to changes in view of employability, earning potential, opportunities abroad, opportunities for working remotely, and opportunities as an entrepreneur. It simultaneously prompts some serious questions about the quality of AI education, availability of technological resources, availability of trained faculty, institutional readiness, and the ability of higher education in Pakistan to react to dynamic technological environments. In this study, educational and career decision-making of pre-engineering students in Pakistan during 4th Industrial Revolution is explored. It examines the forces that have created a shift from engineering to artificial intelligence (AI) related fields and evaluates the impact of this shift on higher education reform, the alignment of the labour market and national development (Rajendra, 2026).

Literature Review

The issue of the relationship between technological change and educational adaptation has always been an important field of academic research in the field of education, labour-market research and development research. Economist theories such as human capital theory indicate that students' choices about education are driven by the prospect of economic gains, job stability and opportunities in the labour market. In the midst of technological change, new industries, occupations and skills are being created, and students are likely to shift from one educational choice to another based on an evolving sense of what is needed for employability and career advancement. Artificial Intelligence (AI) is one of the fastest-growing technology sectors in the world today and is receiving significant investment from governments, multinationals, universities and research institutions. The investments are primarily motivated by the promise of AI's potential to boost productivity, efficiency, innovation, and decision-making in various industries. AI-related skills are consistently cited as one of the most in-demand skills for future jobs by the World Economic Forum, underscoring the significance of AI in the current education and workforce system and its relevance for future employment (Pozzi et al., 2026).

Studies in engineering education have shown that technological developments have greatly broadened the scope of engineering work. Today's engineers are also required to have multi-disciplinary skills beyond standard engineering, with an increasing requirement for them to be able to approach problem solving through programming, data analysis, automation, machine learning, digital modelling and intelligent systems. Consequently, there is a growing ambiguity between the conventional engineering and computing fields of study. In Pakistan, this shift is seen in shifting preference and career aspirations of students. Educational surveys suggest that the interest of students in computer science and technology-related careers has increased recently. Among the science students, AI, cybersecurity, software engineering and data science are very appealing since they are believed to be more relevant to future jobs. Many Pre-Engineering students have started an engineering program but are now looking to pursue further studies in the computing field at university level (Bukhari, Khan, et al., 2026).

Research on the use of AI in higher education in Pakistan also shows that students are eager to use AI-integrated learning tools. A study at higher education institutions in rural areas revealed that students believe AI tools can support them in personalized learning, self-directed education, academic assistance, and enhancing learning efficiency. Infrastructural challenges, access to technological tools, uneven internet connectivity, and limited institutional support, however, still hinder effective AI integration. Furthermore, more public interest is being shown in studying AI in Pakistan, as indicated by additional studies. Extensive search behaviour analysis reveals a marked shift in focus on AI, ChatGPT and tailored learning tools, especially since 2023. This phenomenon is related to the increased social recognition of the transformative power of AI in the education and employment sectors, as well as in planning and preparing for future careers (Papyshev & Chan, 2026).

The existing literature also notes key structural barriers that prevent Pakistan from leveraging AI for educational transformation. Lack of specialisation in AI, advanced research facilities, quality technical training programmes and institutional capacity to cater for emerging technologies remain challenges in the country. There is still a significant gap between the learning and the needs of the industry, especially for the acquisition of skills, readiness for the work, problem-solving and technological application skills. Despite the growing number of STEM graduates in Pakistan, the job market is still facing the challenge of graduates who do not possess practical and professional skills demanded by the rapidly changing technology-driven job market. Thus, the increased enrollment of pre-engineering students in AI related fields cannot be viewed merely as an educational choice but as a new structural shift in the education system, as well as in the adaptation to the labor market and development of human resources in the country (Adi et al., 2026).

Research Methodology

The applied methodology in this study was qualitative and analytical research, which aimed to analyze the choices of education and careers of pre-engineering students in Pakistan in the era of artificial intelligence and Fourth industrial revolution. Secondary data was the primary source of data analysis as academic studies, education reports, labour market evaluations, policy documents, industry reports and surveys were used to analyze the student career preferences in Pakistan. The research mainly centered on three areas: pre-engineering students' educational decisions, attitudes towards artificial intelligence and new technologies, and career aspirations associated with traditional engineering and AI-related fields. Patterns of academic transitions and career decision making of students were analyzed by using comparative analysis of the data. Recurring themes were identified through thematic analysis of themes and included:

employability, technological awareness, economic incentives, institutional readiness, educational infrastructure, and social expectations. This way, it gave a clear picture of how technology is changing the educational landscape and career expectations in Pakistan.

Discussion

The Changing Nature of Engineering Education

The engineering education has traditionally been linked to industrial growth, infrastructure development, and manufacturing industries in Pakistan. In the previous decades, engineering graduates had good job opportunities in both the government and private sectors. The economic restructuring and technological development, however, have changed the requirements of the Industry. Digital skills are becoming more and more a necessity for modern engineering. Automation systems are used by mechanical engineers, computational design tools by civil engineers, and embedded systems, intelligent networks by electrical engineers. As a result, AI and computer science are increasingly becoming a part of the engineering practice and not just a theoretical domain (Mehmood, 2026).

This change is familiar to many pre-engineering students, who are looking for learning opportunities that integrate engineering principles and skills with digital technologies. Therefore, the fields of software engineering, AI engineering, robotics, mechatronics, and data science are becoming popular among students(Zinchenko et al., 2026).

Artificial Intelligence as a Career Attraction

Artificial Intelligence has emerged as a top choice for students in Pakistan because of its predicted future significance. The applications of AI are growing in healthcare, finance, education, transportation, manufacturing, agriculture and national security. Students perceive that there are some benefits to careers in AI. One of the main ways is through remote work and outsourcing platforms that are available internationally, which allows AI professionals to find work opportunities all over the world.One of the primary methods is through international employment platforms for remote work and outsourcing that offer positions around the globe. Second, wages for careers in AI-related roles are typically higher than in other sectors of traditional engineering. Third, it allows individuals to create digital products and services, which requires minimal investment, which is an aspect of entrepreneurship enabled by AI(Warsi et al., 2025).

These perceptions are reflected in the growing public attention around AI technologies. AI programs are becoming a catch-all for institutions to advertise as degrees for the future, and students are beginning to recognize that this is indeed the case.Institutions are increasingly hawking the AI programmes as degrees for the future, and students are beginning to understand that this is true. There has been a significant increase in the study of AI within Pakistan (Sharjeel & Hussain, 2026).

Employment Prospects and Labor Market Dynamics

Student decision making is greatly affected by the employment. Economic instability, industrial constraints and decreased investment in infrastructure have affected the traditional engineering sectors of Pakistan. Students think that jobs in computer science and AI have better employment opportunities. The industry is expected to see a rising demand for software developers, data analysts, cybersecurity specialists, AI engineers, and cloud computing professionals. Employers,

especially technology firms, are more interested in graduates who have digital skills in addition to traditional engineering skills (Carrillo, 2026).
It is observed in online discussions that Pakistani students have shared their concern about the lack of employment opportunities in the traditional engineering fields. Engineering versus the technology field is frequently discussed by students in terms of salary, availability of jobs, and career advancement. AI and machine learning are seen as areas of high growth with better economic returns (Kumar, 2026).

Role of Universities and Educational Institutions

The university is very important in influencing the student's decision. In the last ten years, many institutions have established AI, data science, software engineering, and cybersecurity courses in Pakistan. But quality cannot be assured by sheer growth. There is a lack of qualified faculty, high-end laboratories, research funds and industry linkages in many institutions. There are programs that focus on theory and offer little hands-on practice(Zhang et al., 2026).
There is a regular complaining about lack of skills in graduates by industry stakeholders. While thousands of graduates are produced in technology each year, only a relatively small percentage will be hired into jobs related to technology. This indicates that there is a need for curriculum updates and greater cooperation between universities and employers (Song et al., 2026).

Challenges Facing Pre-Engineering Students

While opportunities are expanding, there are a number of important hurdles for pre-engineering students as they move toward the world of AI careers. A difficulty is the lack of knowledge about new topics. There are many students and parents who lack understanding of the career pathway of AI, machine learning, and data science. Schools and colleges are lacking in developing educational guidance services.
A second challenge is related to unequal access to technology. Generally, the internet connection, computing devices and training programs are better for students in urban areas than for students in rural areas. In the context of rural institutions, infrastructure constraints are found to be significant challenges for implementing AI. There are also three obstacles in the realm of curriculum rigidity. The typical intermediate pre-engineering curriculum tends to emphasize memorization and test-taking skills instead of problem-solving, programming, and creativity; interdisciplinary thinking is not a major part of the curriculum. These restrictions hinder the preparedness of students for further study of AI.
One of the fourth challenges is uncertainty about future labor markets. New possibilities created by Artificial Intelligence could mean that some job roles will disappear as a result of automation. Students are thus confronted with complicated choices in specialization and career planning.

The Fourth Industrial Revolution and National Development

Pre-engineering students' future education decisions have wider repercussions on the economic future of Pakistan. When a country is successful in creating its own talent pool, it can be expected to benefit in terms of innovation, productivity and technological sovereignty. This has great potential in Pakistan as there is a huge youth population as well as a growing digital ecosystem. The government support for digital transformation, freelancing, startup development, and technology exports has given an edge to the growth of AI.The government's digital

transformation, freelancing, startup development, and technology export promotion efforts have provided a conducive environment for the growth of AI.

However, substantial reforms must be made for any progress to be realized. The educational systems should be in tune with the changing technological realities. The ability to conduct research needs to be strengthened within the universities. All partnership between industry and academia should support practical training and innovation. The government needs to nurture the development of AI infrastructure, entrepreneurship, and the workforce. If Pakistan continues to do so, it will create a workforce that does not equip them to meet the changing needs of the job market. On the other hand, adaptation might put the country at a vital role in the global digital economy if it is done successfully (Bukhari, Waheed, et al., 2026).

Results and Findings

Based on the findings of this study, several important findings emerged in relation to the educational and career preferences of Pakistani pre-engineering students in the era of AI and Fourth Industrial Revolution. The results indicate that students' academic choices are becoming more driven by employability, technological consciousness, institutional capabilities and changing labour-market demands.

Shift from Traditional Engineering to AI-Related Fields

One of the key results of the study is that while the traditional engineering fields are slowly being replaced by the new and emerging fields of artificial intelligence, software engineering, data science, cybersecurity and computer science. Although traditional courses like civil engineering, mechanical engineering, and electrical engineering are still of value to society, many students are more interested in courses related to computing and jobs in the future. Computer science related courses have been found to have a higher percentage of science students who enrol in them compared to certain traditional engineering courses from surveys. This is a larger paradigm shift in student thinking about technical training and career success.

Employment Prospects as the Main Career Driver

One of the most significant factors affecting students' choices of course and college was employment opportunity. Students feel that careers involving AI and technology will have greater jobs demand, higher earning capacity, have the opportunity to work abroad, be remote work friendly, and provide better career advancement. Other traditional engineering careers, however, are perceived as less certain as a result of low levels of growth, economic instability and lesser employment opportunities within the public sector. This indicates that students are making career decisions that go beyond just social prestige but rather based on what the labour market offers.

Growing Awareness of Artificial Intelligence

The findings also reveal that there has been a tremendous rise in the awareness of AI among the youth of Pakistan. The introduction of AI, or artificial intelligence, into various aspects of everyday life is happening at a rapid pace and is being introduced to students via social media, online learning, digital tools, university ads, and public conversation. This newfound awareness has resulted in the increasing accessibility and attractiveness of AI as a career path. But knowledge is not necessarily understanding. While some students may be familiar with the field of AI as a potential profession, they might not be aware of its academic qualifications, technical skills, or future prospects for employment.

Institutional Response and Programme Expansion

In Pakistan, the educational system is catching up with the growing demand by students for the degree programmes in AI, data science, cyber security, software engineering, and other related

fields. The expansion reflects the fact that universities are starting to realize the value of new technologies in higher education. But there are concerns about curriculum quality, practical training, competencies of faculty members, labs, research culture, and industry inputs. AI programmes cannot be introduced without institutions making sure that the quality of education is maintained and the qualifications are relevant to the labour market.

Urban-Rural Inequality in Access to AI Education

The study revealed significant differences between the urban and rural school contexts. Generally, access to internet connectivity, computer labs, private academies, career counseling and access to AI learning resources are higher for students in big cities. Students in rural and resource-limited communities, on the other hand, have more challenges accessing digital tools, trained teachers, technological infrastructure and timely and accurate career advice. The inequality could restrict access of disadvantaged youth to new areas of AI related studies and could exacerbate existing educational disparities.

Mismatch Between Graduate Skills and Labour-Market Needs

Another significant observation is that the output of graduates from the educational institutions has not been matching the demand of the job market in Pakistan. There has been a growing emphasis on employers requiring students to have practical skills in programming, problem-solving, data analysis, communication, collaboration, and applied project experience. But many of the graduates still have limited practical skills and theoretical knowledge. The disparity suggests that higher education needs to revise the curriculum, training, internships, and industry relationships to equip students for jobs in the age of AI.

Changing Educational Aspirations in the Fourth Industrial Revolution

Last, but not least, a fourth Industrial revolution is changing the expectations on education within Pakistan. Future success requires more than just a degree; digital literacy, adaptability, interdisciplinary learning, creativity, and life-long skill development are increasingly recognized by students as being necessary for career success. This is a significant change in student thinking from career planning based on degrees to skills and technology-based. The results indicate that Pakistani pre-engineering students are not only aware of the technological changes happening in the world but are also actively engaging in them, and with support from their institutions, policy reform, and access to quality AI education, they will become successful participants in the technological changes.

Conclusion

The Fourth Industrial Revolution has made a significant impact on how Pakistani pre-engineering students make their educational and career choices. The old engineering disciplines remain relevant, but a range of new fields involving AI have become strong options that are increasingly seen as providing more opportunities for employment, innovation and global engagement. As AI gains traction, it's also emblematic of shifts in workplaces, educational institutions, and the tech landscape. Pupils are making sensible choices about their education in response to the economic climate of the times, choosing subjects relevant to the requirements of the world in which they will live. However, there are still many challenges, such as poor infrastructure, lack of curriculum, lack of matching skills, and the lack of technology resources. The Fourth Industrial Revolution is going to improve the lives of Pakistanis to a great extent, which is dependent on how well we are able to prepare the students for the challenges that lie ahead in the field of technology. Pathways to integrate engineering knowledge and advanced digital skills must be developed to meet the needs of educational institutions, policymakers and

industry stakeholders. This integration will facilitate students to play a role in the global knowledge economy and technological innovation as well as the development of the nation.

Recommendations

Curriculum Modernization and Digital Integration

The engineering curricula must be updated in the universities to incorporate AI, ML, programming, data analysis, automation, and computational thinking into engineering disciplines. This would enable pre-engineering students to acquire the skills that are relevant to the future labour-market requirements. There is a need to not eliminate, but augment, the traditional engineering education with emerging digital skills.

Career Counselling and Student Guidance

Pre-engineering students should have a structured career counselling programme in place in the educational authorities. Clear details of the traditional engineering, artificial intelligence, software engineering, data science, cyber security and other emerging engineering disciplines are needed in these programmes. Guidance and information would assist students to make informed decision in academic and vocational aspects in terms of employability, interest, skill demands and career prospects.

Investment in AI Infrastructure and Faculty Development

More efforts should be put in the development of AI laboratories, research centres, digital libraries, technological facilities, high-speed internet facility at universities and colleges. In addition to infrastructure, there is a need to increase faculty development programmes which will keep teachers abreast of the latest industry practices, technologies and pedagogy. Knowledge on AI can be theoretical and not effective if there is a lack of trained faculty and sufficient space.

Industry-Academia Collaboration and Practical Training

The cooperation between industry and academia should be enhanced to offer internships, hands-on training, joint research projects, mentoring and job opportunities to students. University and industry, in particular, should collaborate closely with technology firms, engineering companies, start-ups and the government to provide students with skills they will require in the workplace. This would help narrow the mismatch between knowledge and expectations of the labour market.

Inclusive National AI Workforce Strategy

It is imperative for Pakistan to design a comprehensive national AI workforce strategy for the development of globally competitive talent.Pakistan needs to have a holistic national AI workforce strategy in place to cultivate globally competitive talent. The following elements should be part of this strategy: scholarships, innovation grants, startup incubation programmes, digital skills initiatives and special support for rural and underserved areas. Creativity, Innovation, Problem solving, Interdisciplinary Learning and Lifelong Learning should be emphasized in national education policies, aiming at creating effective contributions from the students to the country's economic development, technological advancement and competitiveness in the Fourth Industrial Revolution.

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