# How Engineering and Technology Sectors are Derailed by Legislations: A Case Study of Pakistan

Tariq Umar[1], Nnedinma Umeokafor[2], Asad Zia[3], Charles Egbu[4], Sa'id Ahmed[5], Messaoud Saidani[6]

[1]University of the West of England, UK. Tariqumar1984@gmial.com

[2]University of Greenwich, UK. nnedinmaik@hotmail.com

[3]Slovak University of Technology, Slovakia. xzia@stuba.sk

[4]Charles Egbu, Leeds Trinity University. C.Egbu@leedstrinity.ac.uk

[5]Kingston University, UK. s.ahmed@kingston.ac.uk

[6]Coventry University, UK. cbx086@coventry.ac.uk

Corresponding Author: tariqumar1984@gmail.com

# How Engineering and Technology Sectors are Derailed by Legislations: A Case Study of Pakistan


## Abstract:

The engineering profession play a vital role in the socio-economic development of societies and contribute to the GDP of countries. This role, however, can be derailed by legislations that regulate such profession. This paper investigates the impacts of legislations on engineering profession in developing countries. The case of Pakistan where engineering profession is regulated by the Pakistan Engineering Council Act has been considered. A qualitative research approach in which 66 documents related to legislations, law cases, international standards, and practices, qualification frameworks have been reviewed to assess the impact of legislation on technology education and employment. Six semi-structured interviews were conducted with government officials to get their stance on the subject matter. The finding suggests that the absolute purpose of this legislation was to regulate the engineering profession, however, wrong interpretation of this regulation has barred qualified technology graduates from the practice of engineering within the country. The faulty regulations are required to be revisited enabling graduates to contribute to the development of Pakistan.



Keywords: Engineering Profession, Education & training, Government, Legislations, Pakistan


## List of Abbreviations:

B.Tech: Bachelor of Technology

CEBR: Centre for Economics and Business Research

CEng: Chartered Engineer

DAE: Diploma of Associate Engineer

EC: Engineering Council

EPSRC: Engineering and Physical Sciences Research Council

ESG: Environmental, Social and Governance

GDP: Gross Domestic Product

HEC: Higher Education Commission

HSSC: Higher Secondary School Certificate

IEA: International Engineering Alliance

IHC: Islamabad High Court

IntPE: International Professional Engineer

IPEA: International Professional Engineer Agreement

NQFP: National Qualifications Framework of Pakistan

NTC: National Technology Council

PEC: Pakistan Engineering Council

PNVQF: Pakistan National Vocational Qualifications Framework

SDGs: Sustainable Development Goals

SSC: Secondary School Certificate

WMS: Wafaqi Muhtasib Secretariate

# 1. Introduction:

Globally, engineering profession play a significant role in the development of countries and region (CEBR, 2016; Ishola and Olusoji, 2020). Engineers are responsible for designing, constructing, and maintaining essential infrastructure such as roads, bridges, dams, airports, and buildings. Access to well-designed infrastructure is vital for economic growth, social progress, and overall development (Ahlström, 2022). Professionals in engineering work on developing and implementing efficient and sustainable energy solutions such as power plants, renewable energy sources (solar, wind, hydro, etc.), and smart grids. Access to reliable and affordable energy is essential for powering industries, businesses, and homes, thus fostering economic development (Fragaszy et al., 2011). Likewise, engineers and technicians play a key role in managing water resources through the design and

implementation of systems for water supply, irrigation, wastewater treatment, and flood control (Babbar-Sebens et al., 2019). Effective water management is critical for agriculture, public health, and environmental sustainability (Russo et al., 2014). Transportation Systems is crucial for any country's prosperity and development (Shaaban et al., 2021). Efficient transportation networks facilitate the movement of goods and people, thus stimulating trade, tourism, and economic activity. It is the engineers and technologists to design and improve transportation systems including roads, railways, airports, and ports. Communication and technology infrastructure is another field which include a lot of contributions from engineering profession. Engineering professionals contribute to the development of communication networks, including telecommunications, internet infrastructure, and satellite systems. Access to reliable communication and technology infrastructure is essential for connecting communities, enabling access to information, and driving innovation (Ziphorah, 2014). Engineering profession is also important for pollution control measures, waste management systems, and renewable resource utilization. Sustainable engineering practices help mitigate environmental degradation and preserve natural resources for future generations (Wolniak, 2022). Engineering professionals works with urban planners and policymakers to design sustainable and resilient cities. This involves optimizing land use, improving transportation systems, enhancing public spaces, and implementing eco-friendly practices to create liveable and vibrant urban environments (Mendizabal et al., 2018). Similarly, access to modern healthcare facilities and technologies improves public health outcomes and contributes to human development (Dash et al., 2019). Engineers and technician contribute to the advancement of healthcare through the development of medical devices, diagnostic tools, and healthcare infrastructure. And finally, engineering professionals also play a role in education and skill development by training the

next generation of engineers and technicians. Investing in engineering education and vocational training enhances a country's capacity for innovation, entrepreneurship, and technological advancement (Munir, 2022).

Engineering and technology are central to the well-being and economic development of every country. Engineering is a broad field that encompasses the application of scientific principles to design, develop, build, maintain, and improve structures, machines, systems, materials, and processes to solve real-world problems. The scope of engineering is vast and diverse, covering numerous disciplines and specialties. "Technology graduates" typically refer to individuals who have completed undergraduate or graduate degrees in fields related to technology. Technology graduates have a wide range of career options and can pursue various roles depending on their specialization, interests, and skills. The field of technology is constantly evolving, offering a wide range of opportunities for individuals with technical skills and a passion for innovation. Both the profession of engineering and technology evolves continuously to meet the needs of human civilisation. Such profession is pervasive in our modern society, enabling every sector from communication and entertainment to finance and healthcare, as well as its more visible applications in construction, manufacturing, and transport (EPSRC, 2015). There is a clear relationship between the Gross Domestic Product (GDP) and Engineering profession. For instance, Ryoo and Rosen (2004) suggested that engineering market responds strongly to economic forces. The demand for engineers responds to the price of engineering services and demand shifters. Likewise, Beaudreau (2005) using the economic growth theory to study the relationship between GDP and engineering profession. Litvinenko et al. (2022) noted that the level of professional competence, education including technical, managerial and leadership skills of a company's extraction engineers is the equivalent of confidence in its

development and ability to meet environmental, social and governance (ESG) principles and sustainable development goals (SDGs).

To ensure that engineering profession contributes effectively to the economic development of a country, it is important the professional legislation and regulations are place in that country so that distinguishes qualified and competent professionals by restricting the practice of services to select individuals (Wilkie, 2019). Compulsory registration regime for engineers with professional body exists in some countries, while in other such as United Kingdom and in other European countries, registration of engineer is not compulsory, but highly desirable (EC, 2020-a). For example, registration with engineering council in UK is not mandatory by law, so one can practice engineering without registering with engineering council UK. In some countries this is mandatory by law which mean that an engineer should registered with a professional body to practice engineering in that country or jurisdiction. The main requirement for professional registration as engineer in many countries is an undergraduate degree in engineering or technology, however, there are many countries which provide paths to professional registration to individuals who do not have a formal degree in engineering or technology but can demonstrate competence at required level (EC, 2020-b). In all cases, it is important that the concerned organization responsible for implementation of legislation for compulsory professional registration have develop robust procedure that ensure a just a fair system. While such procedure already exists in many developed countries, there are issues reported in many developing countries. For instance, the discussion reported on the Institution of Engineering and Technology (IET) reports that PhD holders in engineering and Chartered Engineer from UK are not eligible to practice in Pakistan due to their local legislation (IET, 2022). This article therefore attempts to review the relevant legislations that govern professional registration of engineers in Pakistan. While

it is not possible to cover all the developing countries in this research, one developing country and legislation that govern professional registration of engineer in that country was selected. The developing country chosen for this purpose was Pakistan on the understanding that compulsory registration regime exists there and that it is a member of the International Engineering Alliance (IEA).

This review investigates the implication of PEC Act 1976 on engineering profession in Pakistan considering international practices adopted by many advanced countries including the members of the IEA. The findings of this article would be helpful to revisit the legislations that are governing the engineering profession in Pakistan so that the internationally recognized practice and procedure can be implemented. The findings of this research could also be useful for other developing countries where a legislation to regulate engineering profession exist or in the phase of development. The professional institutions responsible for accreditation and registration of engineers in developing countries will be able to learn from issues which has been developed in Pakistan due to a faulty legislation and its implementation in a controversial manner.

The next section reports relevant literature around the subject areas.

## 2. Literature Review:

The IEA is a global non-profit body, which comprises members from 41 jurisdictions within 29 countries, across seven international agreements. These international agreements govern the recognition of engineering educational qualifications and professional competence. (IEA, 2022-a). On one side Pakistan is a member of the IEA, but on other side Pakistan has no raking on the current Engineering Index which in developed by the Intelligence Unit of the Economist (Engineering Index, 2019). The Engineering Index of 2019

is based on six factors that induced i. Knowledge, ii. Labour Force, iii. Engineering industry, iv. Infrastructure, v. Digital infrastructure and vi. Safety standards. The index includes the ranking of 100 countries around the world. Surprisingly, all other member countries (developed or developing) of the International Professional Engineers Agreement (IPEA) are ranked in the Engineering Index of 2019 except Pakistan (Table 1). Pakistan is further ranked at 129 (out or 165 countries) based on the Sustainable Development Index which measures the progress of countries towards 17 United Nations SDGs that are set to be achieved by 2030 (UN SDGs, 2015; Sachs et al., 2021). The Sustainable Development Index provide a good insight of countries and regions in relations to their performance towards SDGs (Umar et al., 2020). Based on this index, Pakistan is facing significant challenges in 14 out of 17 goals that also include goal 6 (clean water and sanitation), goal 7 (affordable and clean energy), goal 9 (Industry innovation and infrastructure) and goal 11 (sustainable cities and communities). Engineering profession has a key role in the achievement of most of the SDGs (Umar and Umeokafor, 2022). Based on the compulsory registration regime for engineers in Pakistan, its membership of the IEA, no raking in engineering index and significant challenges in SDGs make Pakistan more suitable selection for the purpose of this research.

| **Country** | **Represented By** | **Membership of IPEA (since)** | **Engineering Index 2019 (Ranking Based on Knowledge)** |
|---|---|---|---|
| Australia | Engineers Australia | 1997 | 11 |
| Canada | Engineers Canada | 1997 | 12 |
| Chinese Taipei | Chinese Institute of Engineers | 2009 | 2 |
| Ireland | Engineers Ireland | 1997 | 32 |
| Hong Kong China | The Hong Kong Institution of Engineers | 1997 | 22 |
| India | Institution of Engineers India | 2009 | 20 |

| | | | |
|---|---|---|---|
| Japan | Institution of Professional Engineers Japan (IPEJ) (1999) | 1999 | 3 |
| Korea | Korean Professional Engineers Association | 2000 | 4 |
| Malaysia | Institution of Engineers Malaysia | 1999 | 29 |
| New Zealand | Engineering New Zealand | 1997 | 32 |
| Singapore | Institution of Engineers Singapore | 2007 | 17 |
| South Africa | Engineering Council South Africa | 2007 | 38 |
| Sri Lanka | Institution of Engineers Sri Lanka | 2007 | 87 |
| United Kingdom | Engineering Council, UK | 1997 | 6 |
| United States | National Council of Examiners for Engineering and Surveying | 1997 | 1 |
| Pakistan | Pakistan Engineering Council | 2018 | Nil |

**Table 1: IPEA Members Countries and their Engineering Index Ranking (IPEA, 2020; Engineering Index, 2019)**

The Engineering index which is used to measure the strength of engineering in around one hundred countries use factors such as engineering wages, exports, employment, businesses, graduates, as well as infrastructure quality and the gender balance in engineering to rank different countries (Engineering Index, 2016). For instance, UK was ranked 14$^{th}$ in the engineering index of 2016, however, the report indicates that if UK was ranked as first then its GDP per capita would have increased by 10% to £29,900, which was £27,100 in 2013 (Engineering Index, 2016). It is well established fact that technological advancement serves as a major key to a nation's development. Likewise, structured engineering knowledge plays a major role in the attainment of a high level of technological advancement. Most of the

developing countries, however, find it difficult to impact adequate knowledge and training to engineers at different levels of training and thus the engineers do not contribute the development of such countries (Akintola et al., 2002; Piwowar-Sulej, 2021; Pastrana and Tobón, 2020; Othman et al., 2021). Developing countries are required to utilize engineering activities to generate appreciable added value to their resources, which results in welfare of people and community and lead to a better ecology (Abu-Goukh et al., 2013).

There are two main streams of engineering and technology degrees that are offered by different Higher Education Institutions in Pakistan. Most of these institutions are approved by the Higher Education Commission (HEC) in Pakistan, which is the sole body for the evaluation, improvement, and promotion of higher education, research, and development (HEC, 2002). The commission was established by the government of Pakistan through an ordinance issued in 2002 which was approved by the Cabinet of sitting government.

After completing the secondary school certificate (SSC) in science, which is a 10-year schooling, the students in Pakistan mainly have two options if they want to pursue their education further. as noted in the figure 1, the first option is that they can choose is the higher secondary school certificate (HSSC) which has a duration of 2 years. The student can choose either medical or engineering disciplines for their HSSC. The students with a HSSC can then move to engineering institutions to study a four-year engineering degree programme. This is the mainstream of engineering.

The second option for the SSC qualified students is to enter to technical education stream. The students can choose a variety of diploma programme in different technologies offered by polytechnics institutions or colleges of technology. This is a three-year programme after successful completion, the students are awarded with a Diploma of Associate Engineer

(DAE) qualification. These graduates then normally work as a technician in the industry in their relevant discipline. If these graduates with a DAE want to pursue further education (higher education) then they can go for a degree programme which is known as Bachelor in Technology (B.Tech – Hons) – a four year degree programme.

Controversially, degrees in engineering and technology classified as two different streams of education in Pakistan although the content and duration of the degrees are the same. In fact, the technology degree involves 17 years of education as compared to engineering degree which require 16 years to complete (PNVQF, 2015; NQFP, 2015). There is, however, no reference to the technology degree in the National Qualifications Framework of Pakistan as shown in figure 1. The engineering degrees are accredited by the Pakistan Engineering Council (PEC) while there was no regulatory body for the technology degrees since 1973 till 2015 when the government decided to establish National Technology Council (PEC, 1976; Ministry of Education, 1973; NTC, 215). This council is, however, not fully functioned yet even though there are over 350,000 technology graduates and around 10,000 are passing out each year (Dawn, 2022; NTC, 2021). The PEC restricts the technology graduates for employment both at graduate and professional levels. They are declared as non-equivalent to engineering graduates therefore, most the technology graduates are working at technician levels. Thus, their contributions to the success of projects are quite limited.

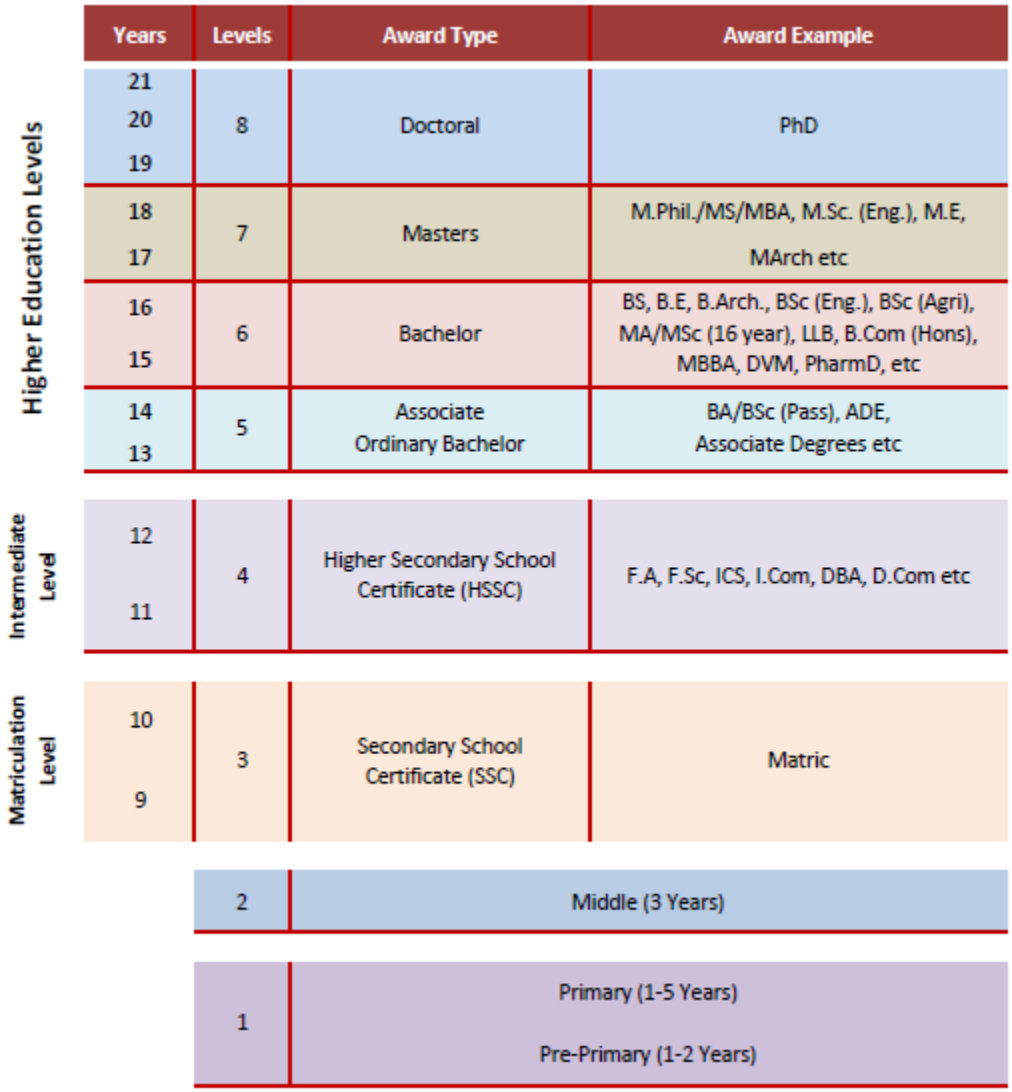


**Figure 1: National Qualifications Framework of Pakistan (2015) - (NQFP, 2015)**

## 3. Research Approach:

The main areas which were considered in this research was to investigate the implications of PEC Act (1976) on technology graduates in relations to their employment and further education at Master and PhD levels. This research also investigates that how PEC Act (1976) and its interpretations are aligned with international practices and procedures of engineers' registration. Finally, the research reviews the PEC Act (1976) and its effects on the holders of PhD degrees in Engineering. The research approach adopted for this purpose was

qualitative in nature as explained by Umar and Egbu (2018). A similar approach was used by Hoque and Tshutsha (2022) in their study on factors affecting the attraction and retention of academic employees. Briefly, the difference between quantitative and qualitative research methods is given below.

Quantitative research stresses quantification in the data collection and examination. It applies a deducible approach to the connection between theory and research, and stress is kept on the confirmation of theories. The quantitative research method integrates the norms and practices of the natural scientific model and positivism. It views social phenomenon as an outer objective truth (Cooper et al., 2006; Asdiou and Mokhtari, 2019; Galli et al., 2021).

On the other side, a qualitative research method stresses words and contexts rather than quantification in data collection (Opdenakker, 2006; Dev and Sharma, 2021). It stresses an introductory approach in the relationship between theory and research, and the focus is on the formation of theories. The majority of researchers prefer to incorporate both qualitative and qualitative methods, referred to as a mixed research method and highly appreciated in the literature due to certain advantages (Umar, 2021; Choi, 2021). Since the research presented in this paper is exploratory in nature, a qualitative method was considered as the most suitable method to collect the data. Relevant documents that include PEC Act 1976, legislations, acts of parliament, case law, notifications of relevant organizations, qualification frameworks, international practices and procedures, and newspapers advertisements for engineering and technology jobs in Pakistan were reviewed considering the scope of this research. The inclusion criteria should match one of the purposes noted in table 2. The source of the documents should also be authentic for example it can be

government websites, legal entities, universities, newspapers, and international relevant professional institutions.

Qualitative research, such as document review, allows researchers to delve deeply into complex phenomena, exploring meanings, contexts, and nuances that quantitative approaches may overlook. By examining documents in detail, researchers can uncover rich insights that contribute to a deeper understanding of the subject under investigation (Bulmer, 2021). Likewise, document review is often used in the early stages of research to explore a topic or phenomenon. It helps researchers generate hypotheses, identify key variables, and refine research questions before conducting more extensive data collection. This exploratory phase is valuable for gaining initial insights and shaping subsequent research efforts (Morgan, 2022). The documents review approach has the ability to provide in-depth understanding, explore complex phenomena, contextualize research findings, complement other methods, and address ethical considerations, among others (Wood et al., 2020). It is a valuable approach for researchers seeking rich, nuanced insights into a wide range of social, cultural, organizational, and historical phenomena.

The views of PEC and HEC/NTC officials were captured using a semi-structured interview approach. This approach provides a framework of pre-determined questions while allowing flexibility for the interviewer to delve deeper into specific topics based on the interviewee's responses (Adeoye-Olatunde and Olenik (2021). As the time and resources for this research were limited, convenience Sampling approach was adopted. Thematic analysis approach for data analysis was adopted. The process systematically reviews the themes to interpret the data. It looks for patterns, relationships, and differences within the data and then identify how different themes interact and contribute to answering the research question. A total of

six interviews, with three participants from HEC/NTC and three from PEC were conducted. Each interview last for around 45 minutes. The main criteria used for the selecting the respondents were (i) an experience of 5-10 years in accreditation of engineering programmes and or registration of engineers. (ii) working at a position of (minimum) as assistant manager or assistant registrar or similar (iii) willingness to participate in the interview. The semi-structured interview approach is used because it provides a lot of benefits in terms of flexibility, depth of understanding, participant engagement, contextualization, participant-centred approach, triangulation, and suitability for exploratory research (Adams, 2015). The main purpose of the interviews was to know the views of the PEC and HEC/ NTC officials on the results arriving from the documents review. The questions asked during the interviews were related to respondent's role in the employment of technology graduates, impact of PEC Act on the self-employment of technology graduates, implications of PEC Act on further education of technology graduate and the implementation of international standards in Pakistan in the context of engineering and technology education.

The final key documents selected and reviewed in this research are noted in table 2.

The results and discussion arriving from this research are outlined in next section.

| Document Name (reviewed) | Source of Document | Purpose and Scope of Documents included in Research | Number of Documents Finally Considered in Research |
|---|---|---|---|
| Pakistan Engineering Council Act (1976) | Pakistan Engineering Council Website | to review different clauses of PEC Act with a specific reference to its functions, definition of engineering profession, employment of graduates, registration of engineers and firms | 1 |
| National Qualification Framework | Higher Education Commission Website | To review the National Qualification Framework with a specific reference to Technology programmes | 1 |
| Pakistan National Vocational Qualifications Framework | National Vocational and Technical Training Commission | To review and interpret technical education systems and different path for technology education in Pakistan including higher study | 1 |
| IPEA | IEA Website | To know the member of IPEA, Different clauses of the agreement relevant to obligations of members, and requirements for IPEA. | 1 |
| Admission Criteria in Engineering Programmes | National University of Science and Technology | To know the admission criteria for engineering programmes with a specific reference to admission criteria for technology programmes | 1 |
| Admission Criteria in Technology Programmes | National Vocational and Technical Training Commission | To know the admission criteria for technology programmes in Pakistan with a specific reference to engineering programmes | 1 |
| Duration of Engineering Programmes | 1. National University of Science and Technology<br>2. Higher Education Commission | To know the duration of engineering degree and establish the total number of years required to complete an engineering degree in Pakistan | 2 |

| | | | |
|---|---|---|---|
| Duration of Technology Programmes | 1. National Vocational and Technical Training Commission<br>2. Higher Education Commission/ National Technology Council | To know the duration of technology degree and establish the total number of years required to complete a technology degree in Pakistan | 2 |
| Subjects in Engineering Programmes | 1. National University of Science and Technology<br>2. Higher Education Commission<br>3. Higher Education Institutions Offering Engineering Programmes | To know what subjects are covered in engineering programmes in Pakistan with a specific reference to technology programmes | 12 |
| Subjects in Technology Programmes | 1. National Vocational and Technical Training Commission<br>2. National Technology Council<br>3. Higher Education Commission<br>4. Higher Education Institutions offering Technology Programmes | To know what subjects are covered in Technology programmes in Pakistan with a specific reference to engineering programmes | 13 |
| Admission criteria for MSc Engineering | University of the West of England Website | To know the admission criteria of MSc Engineering and compared with Pakistan | 1 |
| Accreditation of MSc programmes in Civil Engineering in UK | Institution of Civil Engineers Website | To review the accreditation status of MSc programmes offered by UK Universities where technology graduates from Pakistan can take admission | 5 |

| | | | |
|---|---|---|---|
| Requirement for Chartered Engineer Registration in UK | Engineering Council UK | To review requirement of Chartered Engineer registration with a specific reference to Technology graduates | 1 |
| Requirement of International Professional Engineer (IntPE) | 1. Engineering Council UK<br>2. IPEA | To review the requirement of IntPE with a specific reference to Technology graduates | 2 |
| Letters and Memos | 1. Higher Education Commission<br>2. National Technology Council | To review the facts related to Engineering and Technology programmes and graduates in Pakistan | 10 |
| Newspapers Advertisements | 1. Daily Jang Newspaper<br>2. Daily Express Newspaper<br>3. Daily Dawn Newspaper<br>4. Daily Nawaiwaqt Newspaper<br>5. Daily the Nation Newspaper | The review the advertisements of engineering and technology jobs and its terms and conditions | 10 |
| Case Law/ legal proceedings/ decisions | 1. Islamabad High Court<br>2. Wafaqi Muhtasib (Ombudsman) | To review current case law. Proceedings and decision pertaining to PEC Act 1976 and its implications on PhD holders | 2 |
| **Total:** | | | **66** |

**Table 2: Key Documents Reviewed**

# 4. Results and Discussion:

## 4.1. Employment of Technology Graduates:

As defined in the PEC Act, engineering profession means the engineering education and practices of engineering and technology, however, the technology education is totally ignored Pakistan. As the PEC Act considered, it covers both engineering and technology as considered in many other countries – for example in the UK. An engineering graduate with a 3-year degree become an incorporated engineer equivalent to a Technologist in many other countries and when they top up their qualification with a master's degree they become as a Chartered Engineer – equivalent to a professional engineer in many other countries. However, as PEC was through its PEC Act mandated to look both the engineering and technology, they only considered engineering profession ignoring the technology. While engineering and technology run parallel to each other, currently technology graduates in Pakistan are not allowed to compete for the jobs at graduate levels due to the provisions in PEC Act 1976 and its misinterpretation. All the employing organizations only hire the graduates which are registered with the PEC. This was also confirmed through the review of the terms and conditions of 10 advertisements published in five different newspapers for the engineering and technology positions both in public and private sectors. It was clearly stated in the eligibility sections of these positions that only candidates registered with PEC can apply for these vacancies. In this regard, the article 27(5) of the PEC Act 1976 state that "No person undertaking any professional engineering work shall, unless he is registered under this Act, be entitled to recover before any court or other authority any sum of money for services rendered in such work". Likewise, the article 27(5)B of the said Act outline that

“No person shall, unless registered as a registered engineer or professional engineer, hold any post in an engineering organization where he has to perform professional engineering work” (PEC, 1976). This force the researcher to review the definition of “professional engineer work” which is defined under the article of 2(xxv) stating ““professional engineering work” means the giving of professional advice and opinions, the making of measurements and layouts, the preparation of reports, computations, designs, drawings, plans and specifications and the construction, inspection and supervision of engineering works”. This article is further supported by several sub articles in which tasks related to engineering works are outlined. The Act under article 2(xxv)-j also empower the PEC to declare any other work as “engineering work” which is not stated in the Act. The PEC Act article 2(xii) under which the engineering professional is defined as “engineering profession means engineering education and practices of engineering and technology”. While the PEC Act incorporate the practice of technology in the engineering profession, however, technology graduates in Pakistan are not able to get registration with PEC, thus unable to practice in engineering profession, and ultimately not able to get employment at graduate levels. This forces many technology graduates to search a job base on their Diploma of Associate Engineer (DAE). Such discrimination does not allow technology graduates to contribute in their capacity to the profession and projects at national level. Interviewees from the PEC is given mandate by the law of land; thus, it is completely the preview of the PEC to regulate the engineering profession in Pakistan, do the accreditation of engineering programmes, define the scope professional engineering works and set the criteria for relevant engineering jobs both in the government and private sectors. While interviewees from the HEC/NTC mostly agreed with the PEC participants, however, they argued that setting a requirement for an engineering job fall under the preview of HEC not PEC.

## 4.2. Impact on Self-employed Technology Graduates:

According to article 8(a) which is related to the functions of the PEC wherein one of the functions of the PEC is to maintain a register of constructors and operators working in the country. This article states “maintenance of a Register of persons qualified to work as registered engineers, professional engineers, consulting engineers, constructors and operators”. This mean any firm or company which want to operate as constructor or operator should be registered with PEC. Apart from this the company should also be registered with other relevant bodies as described by the government. The condition of registration of firm with PEC is applicable on both local and foreign firms. The firm can only be registered with PEC by a registered engineer of PEC or by employing a PEC engineer in that firm (PEC, 2017). Since the technology graduates are not able to register with PEC, this restricts their options to become constructor or operator. The government has recently established the National Technology Council (NTC); however, it has no legal status through an Act of Parliament of Pakistan as the PEC has, thus registration with the NTC does not give technology graduate the required benefits as the engineers get from the PEC. If technology graduates want to register their firm with PEC, then they need to hire a PEC engineer and use their registration certificate to register their firm. Since the requirement of to register a firm with PEC is a registration certificate of an engineer, this opens the door for unethical practice of selling and purchasing PEC registration certificates. All the interviewees confirm that as technology graduates are not registered with PEC, they cannot register a firm/company as an operator or contractor on their name.

## 4.3. Implications on Further Education:

Currently the technology graduates in Pakistan are not only facing problems in relations with their employment at graduate levels, but they are also facing problems for further education. Most of the Universities in Pakistan do not allow technology graduates to pursue Master and PhD degrees in engineering. The admission restrictions are not only there for engineering programme, but such restrictions are also imposed on non-engineering programmes. An admission advertisement of Punjab University clearly written that technology degrees holders are not eligible for admission in a post graduate diploma and in MSc programme in Total Quality Management (Punjab University, 2022). Although admissions criteria in different programmes in Pakistan are set by the concerned Universities under the guidelines of HEC, however, PEC went beyond its authority and have written different letters to higher education institution stating the technology graduate are not eligible to registration with PEC therefore they should not the given admission in the programmes where PEC registered engineers can take admission. On the other hand, the HEC notification dated 8$^{th}$ December 2021 in which both degrees in Engineering and Technology were considered at par for recruitment, pay scales and grades. This notification states “Bachelor’s degree in Engineering (minimum 16 years education) and bachelor’s degree in equivalent technology (minimum 16 years education) are at par for recruitment, pay scales and grades” (HEC, 2021). Clearly, this notification is silent on the admission aspects in MSc and postgraduate programmes, however, by virtue of common sense once a degree is declared at par for recruitment, pay scales and grades with another degree, by an authorised body in a jurisdiction, the admission eligibility could not be varied.

Interviewees from the PEC argued that PEC is has the right to set the criteria for admission in Master and PhD engineering programmes in Pakistan as they are mandated by the law. They confirmed that as technology graduates are not registered as engineers with PEC, they are not allowed to practice engineering profession and thus are not eligible for admission in postgraduate (Master and PhD) engineering programmes. The respondents from the HEC/NTC however, stated that HEC does not put any bar on the admission of technology graduates in engineering programmes. They noted that Universities in Pakistan are independent to set a criterion for any postgraduate programme either in engineering or science. HEC does not dictate in such matters.

The comparison of engineering and technology degrees in Pakistan indicates that technology degree holders spend seven years studying technical and engineering modules before the award of degree in technology. This includes the three years they spend in the completion of DAE before they continue their technology degree where they spend a further four years (figure 2). On the other hand, the exact duration of a typical engineering degree that is also recognized by the PEC, where the graduates then can compete for jobs at graduate levels is four years. The duration of engineering degree is not only available on the National Qualifications Framework of Pakistan (NQFP, 2015) but is also provided on the universities which offered such programmes. For instance, the National University of Science and Technology which offered a degree of Bachelor in Civil Engineering has eight semester over a period of four years (NUST, 2022). The Pakistan National Vocational Qualifications Framework provided in figure 2 clearly show the next levels of qualifications i.e., Master and PhD, however, there are few universities which offer Master of Technology programmes for technology graduates. A technology graduate in Pakistan even after completing a Master's degree are not considered for PEC registration, therefore, such

degree don't add any value to the careers of technology graduates. Currently, there is no university in Pakistan which offered PhD programmes in technology where technology graduates are eligible to take admission. As noted earlier, technology graduates are not eligible for admission in engineering programmes at Master and PhD levels.

The mapping and comparison of the modules that technology and engineering graduates' study during their programmes. indicate that a technology graduate cover more than 50 engineering related subjects during their DAE and B.Tech(Hons) programmes while an engineering graduate cover around 37. This comparison clearly indicate that technology graduates could be more competent in knowledge domain than engineering graduates, and their skills can add values to the country economy by brining efficiencies to engineering and construction industry, however, as noted earlier, these graduates are not able to get employment at graduate level as they are not considered by PEC for registration as engineer.

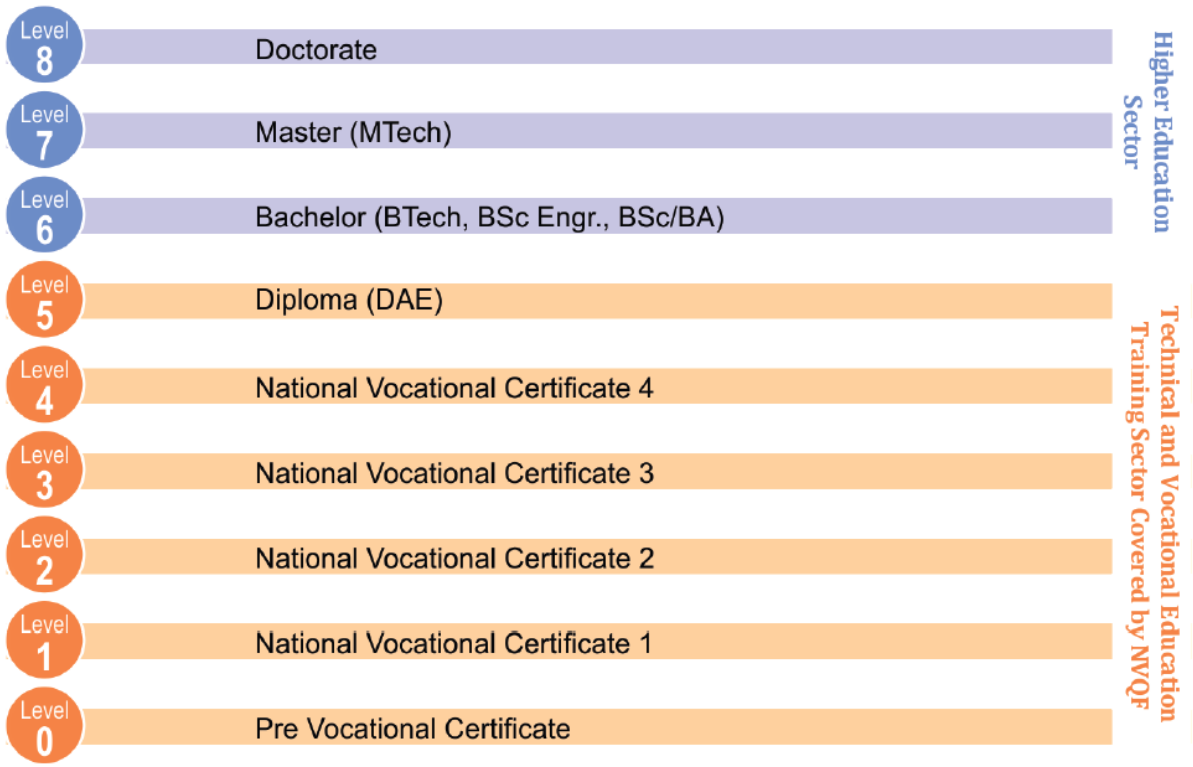

**Figure 2: Pakistan National Vocational Qualifications Framework (NVQF) (PNVQF, 2015)**

## 4.4. Contradictions with International Practice:

In international context both technology and engineering graduates are treated equally for employment opportunities, professional registration. There are examples of Pakistani technology graduates who have completed Master and PhD degrees in engineering from developed countries including United Kingdom, United States, Australia, and other European countries where these graduates are successfully registered with the respective professional institutions. In this regards several admission criteria for Master and PhD programmes in several universities were checked to ensure the claim is accurate. For example, the entry requirement for MSc degree in Civil Engineering in the University of the West of England is honours degree at 2:2 or above in Civil Engineering or a related discipline. They also consider applicants who do not meet the normal entry requirement, but who do have relevant professional experience or qualifications (UWE, 2022). This course is accredited by the Institution of Civil Engineers for Chartered Engineer registration (ICE, 2022).

The comparison of technology and engineering graduates and their consideration by different international professional institutions was further reviewed. For instance, the registration criteria for Chartered Engineer registration with engineering council in UK is a bachelor's degree in Engineering or Technology.

The criteria as noted on the Engineering Council website states that "the application process for CEng registration is more straightforward for those with exemplifying academic qualifications. For CEng this is one of the following (EC, 2020-c):

i. A Bachelor's degree, with Honours, in engineering or technology, accredited for CEng, plus an appropriate and accredited Master's degree or Engineering Doctorate (EngD), or appropriate further learning to Masters level
ii. An accredited integrated MEng degree".

There are several examples where Chartered Engineer with a technology degree were refused from registration in Pakistan. This claim was further verified through the information available on the PEC website. Surprisingly, the entry number 111 of second schedule available on PEC website, indicates that Chartered Engineer shall be eligible to be registered as "Professional Engineer" in the relevant discipline provided he/she possesses four years of engineering qualification and satisfies the PEC Regulations for Engineering Education" (PEC, 2018). The second schedule on PEC website provide a list of foreign qualifications that are recognized by PEC. After reviewing the information on PEC website develop a general assumption was that PEC recognize Chartered Engineers from UK, However, there are evidence which clearly show that many Chartered Engineers from UK were refused from registration in Pakistan and thus they are unable to practice there. For instance a letter issued by the PEC to Chartered Engineer states "Your request for registration as Professional Engineer with PEC on the basis of membership of Institution of Civil Engineers (EC UK) Chartered Engineer was placed before enrolment committee in its meeting held on 30th March 2017, but could not be approved due to reason that you did not qualify as per entry No. 111 SRO dated: March 31, 2015, hence your request for registration with PEC is denied" (PEC, 2017). The entry 111 Statutory Regulatory Orders (SRO) as mentioned in the PEC website states ""Chartered Engineer" shall be eligible to be registered as "Professional Engineer" in the relevant discipline provided he/she possesses four years of engineering qualification and satisfies the PEC Regulations for Engineering Education". This

clearly reflect that regulations made by PEC are not align with international standards and procedure.

The interviews held with six respondents (three from PEC and three from HEC/NTC) reported that as technology graduates from Pakistan do not have an undergraduate four-year degree accredited by the PEC, thus they do not meet the local (Pakistan) registration requirement. The registration of such technology graduates with international professional institutions such as Engineering Council UK become irrelevant when it comes to their registration with PEC in Pakistan.

The information available on the IEA indicate that in 2018 Pakistan has signed the IPEA under which any IntPE registered in one member jurisdiction will be recognized by other member country (IEA, 2022; IPEA, 2022). Due to several legislations issues and misinterpretation of regulations, there are several IntPE from different jurisdictions who were not recognized in Pakistan despite the fact that IEA competence agreement of IPEA under article 2.8 states that “Authorized Members undertake that in dealing with applications for registration in their own jurisdiction, the extent of further assessment of those persons appearing on any section of the IntPE Register should be limited to the minimum reasonably necessary to establish confidence that the specific jurisdictional registration, licensure or other recognition scheme requirements are met” (IPEA, 2020). The non-acceptance of internationally recognized engineering including Chartered Engineers from UK and IntPE from different IPEA jurisdictions clearly indicate that there are serious issues current either in legislations or in organization responsible for the implementation such legislations which failed to implement international practices, standards and agreement in Pakistan.

## 4.5. Implications on PhD Holders:

The documents reviewed as part of this research show that it is not only the technology graduates, Chartered Engineer or IntPE which are affected by the acts of maladministration, injustice, inefficiency, and lack of transparency at organization level, but there are PhD engineers who have completed PhD in engineering from different local and international universities and they are unable to practice both in industry or work as faculty as they are not recognized by the PEC. As technology graduates are not able to secure admission in MSc and PhD in the local universities in Pakistan as PEC put a bar on the Universities asking them not to give admission to technology graduates. There are, however, technology graduates who have done Master and PhD degrees from foreign countries including UK and USA. Having gained qualifications at master and PhD levels, they are not registered with PEC and thus cannot practice engineering. There were few science graduates who did Master and PhD in Engineering from Pakistani University; however, PEC also do not recognize them. For instance, the findings of Wafaqi Mohtasib (Ombudsman) in a complaint WMS-HQR/4885/15 filed by Dr. Fawad Zaman and other against PEC for not registering them on the basis of their PhD in Engineering. state "In view of the position stated above, the acts of maladministration, injustice, inefficiency, and lack of transparency have been established against the agency (PEC)" (WMS, 2016). The observation made by the federal ombudsman states "Pakistan Engineering Council introduced the policy of registration of PhD (Engineers) in 1996 and thus many individuals who had basic degrees in science and both graduate degrees in engineering got registered with PEC as professional engineers. But unfortunately, the PEC in 58$^{th}$ meeting changed its policy in May 2010 without assessing its adverse effect and negative implications. The change in policy was neither intimated to the PhD students

enrolled before May 2010 nor it was published in print or electronic media. The complainants have therefore been discriminated against those who got themselves registered before the decision about change in policy in May 2010". The finding of Wafaqi Mohtasib is further supported by the Islamabad High Court decision in Writ Petition number 1987 of 2017, where hight court rejected the position of PEC and ordered PEC to register the petitioners as Engineer on the basis of their PhD degree in Engineering (IHC, 2017). The court noted that the decision made by the governing body of PEC to withdraw the policy of registration of engineers on the basis of PhD in engineering was not sustainable as it failed to consider the existing students which were already enrolled in the programme. The findings of these two cases clearly indicate that there no effective system within the PEC which look into the decision taken of its registration department and ensure that these decisions are in line with its own Act and law of the country. If this system exists, the highly qualified engineer would not require getting their rights through Ombudsman or high court. The PhD holders in Engineering would have great contributions towards the development of Pakistan in general and engineering profession is specific, however, due to several policies developed by the PEC, these highly qualified professionals are unable to pursue a carrier in engineering and thus their possible contributions to both national and profession are restricted.

## 5. Conclusion:

This article demonstrates that how the misinterpretation of legislation and the faulty regulations made under legislation can affect the highly qualified professionals in Pakistan when the law and regulations affect their employment and access to higher education. A qualitative research approach in which PEC Act 1976, legislations, acts of parliament, case law, notifications of relevant organizations, qualification frameworks, international practices

and procedures, and newspapers advertisements for engineering and technology jobs in Pakistan were reviewed considering the scope of this research. A total of 66 documents were reviewed to deliver the aims and objectives of this research. In the second part of the research six interviews with officials from HEC/NTC and PEC were conducted to confirm that results arriving from the documents review.

The engineering profession in Pakistan in regulated by the PEC Act 1976. While the engineering profession in the PEC Act is define as the engineering education and practices of engineering and technology, however, the technology side is totally ignored in the regulations made based on this Act. Currently, there are more than 350,000 technology graduates who do not have access to employment at graduate and professional levels due to the several contradicted clauses in PEC Act and regulations made under this Act. These regulations states that engineering related work should only be assigned to engineers registered with PEC. HEC appears to be the sole authority to decide the equivalency of degrees in Pakistan and have declared technology degree at par to engineering degree for recruitment, pay scale and grades. Despite this, technology graduates are still not able to get jobs both at graduate and professional levels and thus unable to contribute to the profession and social economic development of country. The finding of this research indicates that the technology degree requires 17 years of education while an engineering degree is completed in 16 years however, the legislation and regulations made in Pakistan not only affect the employment of technology graduates, but also restrict their options to take admissions in Master's and PhD programmes in engineering and technology. Recently, the government has established the Technology Council in Pakistan to regulate the technology education in Pakistan, but its legislation is still pending, thus practically it is not function nor has any legal status to direct government and private organizations to hire

technology graduates on all technical positions. Currently, by the virtue of PEC Act, engineering graduates are working in all engineering and technical positions in public and private sectors, thus it will be quite challenging to develop a mechanism to induct technology graduates on technical positions. This issue needs to be addressed in the legislations so that it does not contradict with the PEC Act. Apart from this, in most of the organizations either in public or private sectors, there is no bifurcation in engineering and technical positions. The induction policy for technology graduates should also needs to be developed engineering organizations clearly stating the technical positions where only technology graduates will be inducted. The results of this research also indicate that many regulations made under the PEC Act contradict international practices, standards and procedures. The current regulations do not allow a technology graduate to become a professional engineer in Pakistan irrespective whatever experience or further qualification that graduate attain. The case on Engineering Council UK and different paths for Chartered Engineer registration were specifically discussed. The PEC regulations indicate that Chartered Engineers from UK are eligible for registration as professional engineer in Pakistan but if they hold a degree in technology, they automatically become ineligible. Pakistan being a member of the IPEA under the IEA is obliged to consider the IntPE from other member countries and allow them to practice in Pakistan by registering them as Professional Engineers, however, there are several IntPE who were not accepted as Professional Engineers in Pakistan. This clearly indicates that although Pakistan has attained the membership of IPEA, but current legislation and regulations made under that legislation do not allow to implement this agreement in Pakistan. Finally, the result of this research shows that the PEC Act and regulations not only affect technology graduates, Chartered Engineers, and IntPE but it also affects PhD holders in engineering. The findings cases filed

against PEC in the federal ombudsman and Islamabad High Court shows maladministration, injustice, inefficiency, and lack of transparency in PEC due to its act of restricting PhD holders to practice in industry and academia. The findings of this research will not only be helpful for Pakistan decision makers to review the provisions of engineering profession legislation and the regulations made under this legislation. It is particularly important to ensure that technology graduates are allowed to practice both at graduate and professional levels so that they can contribute to the social economic development of the country. equal opportunities need to be provided to technology graduates so that they can pursue higher degrees including Master and PhD. The government need to ensure that it comply with the obligations of IPEA and ensure that IntPE registered in other jurisdictions are recognized in Pakistan to avoid isolation in global arena. The research suffered from a number of limitations including limited literature, access to relevant data as some information are not openly available, and small numbers of participants agreed to take part in the research. having all these limitations the research provides a good insight of the law and regulations application on engineering profession in Pakistan and how it is derailing both engineering and technology profession. The findings of this research will also be helpful for other developing countries which may have developed or in the developing or in reviewing stage of legislation to regulate engineering profession. They will be able to avoid errors in legislation and regulations so that the issues arise in Pakistan can be precluded in their legislation and regulations. further research to develop a framework on how the issue between the engineering and technology profession can be resolve in Pakistan avoiding conflicting laws and regulations.

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