Journal of Contemporary Educational Research

Research Article

Employment and Employability of Engineering Graduates in India

Jandhyala B G Tilak*

Pradeep Kumar Choudhury**

Funding: The paper draws from an on-going study on Growth of Engineering Education in India, a research project funded by the Indian Council of Social Science Research, New Delhi through its programme of National Fellows, awarded to the first author.

Abstract: While higher education system in India produces the second largest number of engineering graduates in the world every year, the employability of the graduates is questioned both in the domestic and international labour markets. Many rightly observe that India is overproducing engineering graduates with poor quality, who are not suitable for changing labour markets, as a result large numbers of graduates are either unemployed or mal/ under employed. Globally, the interface between technology and labour market is changing rapidly, making new demands on skills of the graduate engineers. The recent National Education Policy 2020 has clearly acknowledged this fact, and accordingly, proposes a variety of reforms for strengthening technical education in the country. In this short paper, an attempt is made to examine a few specific aspects relating to the unemployment and employability of engineering graduates, along with implications for engineering education.

Keywords: Engineering Education, Labour Market, Employment, Wages, Unemployment

Publication date: March, 2021
Publication online: 31 March, 2021
****Corresponding author:*** Jandhyala B G Tilak, Jtilak 2017@gmail.com

1 Introduction

Engineering, science and technology have transformed the world we live in, contributing significantly to longer life expectancy and enhanced quality of life for large numbers of the world's population (UNESCO 2010). In the expanding global knowledge economy, impact of specialised human capital for rapid economic growth is being realised and therefore, the demand for engineering education has gone up rapidly across the globe (Dubey et al 2019), as engineers are considered "the backbone and … the core of a nation to enable it come a leading country in the world" (Bhargava 2001, p. 77). Given the increasing use of technology in human life, the critical role of engineering education in addressing the pressing challenges of our societies is well recognized worldwide. The importance of technical education, engineering education in particular, was well acknowledged, in fact, for a long period all over the world, including in India. The contributions of engineering education in India that started largely with building roads and bridges is currently addressing several new and emerging challenges like providing more equitable access to information for our populations, environmental protection and natural resource management, artificial intelligence,

* Former Vice Chancellor, National University of Educational Planning & Administration. Currently ICSSR National Fellow & Distinguished Professor, Council for Social Development, 53 Lodi Estate, New Delhi 100003, India. Email: Jtilak2017@gmail.com
** Assistant Professor of Economics, Zakir Hussain Centre for Educational Studies, Jawaharlal Nehru University, New Delhi 110067. Email: pradeep.hcu@gmail.com

natural and man-made disaster mitigation etc. Even today a large number of engineering graduates from India have made an impact in the corporate world internationally. For instance, several Indian engineering graduates are working in the Silicon Valley of the USA and the survival and growth of IT sector in this region is said to be largely dependent on them.

There were only a handful of engineering institutions in India in the 19th century; but noticeable growth has taken place only after independence. Slow and steady growth took place during the first three decades after the launching of development planning in India in 1950. The growth has picked up since the beginning of the 1990s and a phenomenal expansion has taken place during the last three decades. Today there are, in addition to 23 Indian Institutes of Technology and 31 National Institutes of Technology (earlier known as Regional Colleges of Engineering), 3124 engineering institutions offering Bachelors and above studies in engineering and 3706 polytechnics which offer diploma level in engineering education (AICTE 2020). About four million students are enrolled in engineering education for their undergraduate (and above) studies (2018-19), and about one million graduates come out of the system.

However, it is argued that the expansion of engineering education in India (specifically in the private sector) has resulted in production of poor quality graduates who are not eligible to be employed in the labour market. The private sector, which accounted for just 15 percent of the enrolments in 1960, by 2019 accounted for 86 percent of admissions and around 86 percent of all engineering institutions in India (Kapur & Mehta, 2004; AICTE 2019). Unlike philanthropy-based private institutions, these self-financing private institutions exploit the weaknesses of the system, including the ineffective governance and regulation by the state, imperfections in the market, and attitudes of the gullible parents (Kirp 2003; Ley 2006; Kinser & Levy 2007; Hodgman 2010). The phenomenal growth of the engineering education in the country has raised serious concerns on the quality and employability of engineering graduates. Many employers in the labour market do not find engineering graduates worth employing. According to the All India Council for Technical Education (AICTE), in 2017-18, while 1.89 million students graduated from professional schools, including engineering and management schools, only a little over a third of them (6,72,369) got placements (Nanda 2018). Based on National Sample Survey (NSS) data, it was estimated that graduates in technical education face the highest rate of unemployment, 37.3 percent in 2018, up from 18.8 percent in 2012 (Mehrotra & Parida 2019). Employability has received huge attention in recent years. Specifically with respect to engineering graduates, the study by NASSCOM-McKinsey (2005) reported that only 25 percent of the graduates are employable in India. Likewise, the latest Annual Employability Survey 2019 (Aspiring Minds 2019) states that 80 percent of Indian engineers are not fit for any job in the knowledge economy.

The employment/unemployment and related issues of engineering graduates are particularly important issues that need to be examined in the rapidly changing demand for engineering manpower in the dynamically changing labour market in India and abroad. Technology is advancing at an unprecedented space across the world and has transformed the global labour market. The adoption of exponential technologies is disrupting industries by creating new markets and transforming existing markets through product or business innovations. In the new age of automation and unprecedented technological advances, the nature of job market in several economies is changing rapidly. In the labour market, job-roles are being drastically modified, re-defined and changed altogether, and certain types of jobs are becoming redundant and new occupations with new roles are created. Today, we are riding a new wave of uncertainty as the pace of innovation continues to accelerate and technology influences extensively the very basic characteristics of labour market (World Bank, 2019). Engineering being a technical field that produces specific human capital is affected most by the rapid technological developments. As a result, the nature and composition of skills that are required for an engineering graduate is going through a big change. Modern technology is changing the skills that employers seek, and therefore, the training imparted in the educational institutions needs to be revisited. In fact, graduates are not sure about the use of knowledge and the skills they obtained during their studies in the dynamically changing labour markets. Globally, engineering education is experiencing an increasing pressure on

graduate employability, particularly in the context of the changing environment in the labour market. The complexities found in the global engineering labour market have changed the discourse in the discipline. It is important to analyse what it means to be an engineer in the twenty-first century and how the skills and training imparted in institutions might better prepare engineers of the future (Winberg et al 2020).

With the help of secondary sources of data, in this paper a brief descriptive account is presented of a few major issues relating to employment/unemployment and employability of engineer graduates, preferences and aspirations of graduate engineers and implications for engineering education in India.

2 Unemployment among Graduate Engineers

In the fluctuating labour market conditions and unplanned growth of engineering education, mismatches arise between supply of and demand for engineering manpower. Mismatch in India can be divided into two broad categories. Firstly, there is skill deficit or skill gap, where a worker's skill is not up to the requirements of the job or employers' expectations (Blom & Saeki 2011). Secondly, there is skill underutilization (over-education or over-skilling), which arises when level of education and skill exceed those required by the job. The latter causes bumping down, low skilled jobs being offered to high skilled workers, and workers with lower skills get bumped out. But a more familiar mismatch refers to the numbers of graduates produced and hired. Sengupta (2017) estimated proportional mismatches with respect to educated manpower at all levels, using data of several rounds of NSS. In 1993-94 and 2004-5, there were actually shortages in the engineering manpower (degree level), but the quantum of shortages was very small. By 2011-12, the situation began to change, and there was a negative mismatch, the supply exceeding demand, but again by a very small proportion. We do not have such estimates for the period after 2011-12. But it is quite possible that the supply exceeds demand by increasingly larger proportions, as the available evidence on admissions versus student places available in engineering education institutions and employment and unemployment trends suggest. The latest data available from AICTE database (aicte-india.org) suggests that many engineering institutions are not in a position to fully use their intake capacity. Admission rate as a proportion of the sanctioned intake has significantly gone down in the recent past -- from 62.4 percent in 2012-13 to 51.1 percent in 2018-19. Interestingly, the decline in the student enrolment is largely in private engineering institutions, and not in public institutions. It is noticed that a large number of private engineering colleges are either closed or run the risk of being closed soon due to the low enrolments. According to AICTE data, of the 14.1 lakh[1]. BE/BTech student places available in 3124 engineering colleges across the country, close to half (53 percent in private self-financing institutions and 49 percent in all) were not taken in the academic year 2018-19; The mismatches between demand and supply of graduate manpower or disequilibrium in graduate labour market (Panchamukhi 1987) arises either due to imperfections in labour market or due to asymmetry of information or due to low/irrelevant quality of education the graduates receive.

As per data available from NSS, unemployment among the educated in India has been rather consistently rising over the years. Among the general graduates and above, the rate of unemployment increased from 16.1 percent in 1983 to 35.9 percent in 2017-18. While rate of unemployment is rising among the educated youth, the rate of growth is the highest in case of those with technical education. It was 37.9 percent in 2017-18, a sharp increase from 17.3 percent in 1983 and 19.8 percent in 1999-2000 (Khare & Arora 2021).

We do not have similar comparable data specifically for engineering graduates. We have instead, information on hiring rates and placement records available from institutions of engineering education, which help in analysing trends in employment/unemployment conditions. Then we examine employability of graduates as estimated by Aspiring Minds through the Aspiring Minds Common Aptitude Test (AMCAT).

In 2017 and 2018, not more than 50 percent of candidates got jobs from the AICTE-approved colleges: out of the 7.92 lakh graduates, only 3.52 lakh could get hold of employment through campus placements, as reported by the Minister for Human Resource Development in the Parliament (Roy

[1] Ten lakhs are equal to one million; and ten millions (or 100 lakhs) equal one core.

2020).[1] The rate of hiring of engineers has declined from 28 percent in 2014 to 22 percent in 2018, as shown in Figure 1. After a small increase in the following year to 23 percent, it rose by 8 points to 31 percent in 2020. According to this, nearly 70 percent of the engineers are unemployed in 2020; the figure was nearly 80 percent in 2018.

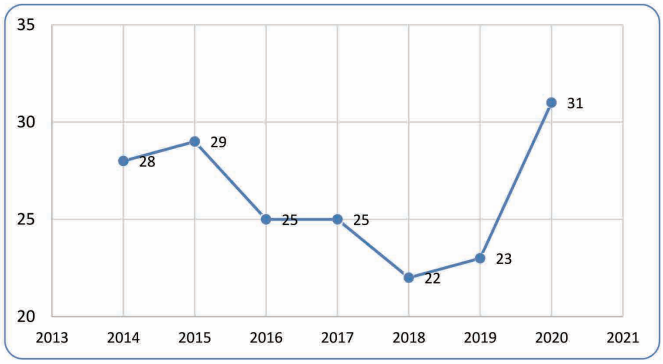

Figure 1. Fluctuating Rate of Hiring of Engineers in India (%)
Source: Statista Research Department
https://www.statista.com/statistics/1043283/india-hiring-rate-engineers/

Engineers in all branches do not face the same situation. Graduates in different streams of engineering perform differently. AICTE data on placements enables us to examine the same. The technological obsolescence in the labour market seems to have suddenly resulted a declining demand for graduates in branches like electronics & communications engineering, and computer science engineering compared to others between 2014-15 and 2017-18, except textiles engineering. With the boom in information technology (IT) sector in the preceding period, the placement record improved between 2012-14 and 2014-15 in case of electronics & communications and computer science engineering (and also in case of electrical and mechanical engineering). The overall placement rate increased from 27.2 percent to 42.6 percent between 2012-13 and 2016-17, and then declined to 36.8 percent in 2017-18 (Table 1).

Table 1. Number of Placements as a percent of Enrolment in Engineering Education, by Select Streams of Engineering

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Average
Textile Engineering	52.9	57.3	56.5	56.4	42.9	42.9	51.5
Electronics & Communications Engg.	34.1	42.2	56.9	59.8	55.6	55.6	50.7
Computer Science & Engineering	39.7	46.6	50.0	48.0	43.0	43.0	45.1
Electrical Engineering	28.4	31.6	41.4	43.9	48.1	48.1	40.2
Mechanical Enineerin.	17.3	19.0	26.0	31.4	40.1	40.1	29.0
Chemical Engineering	29.7	29.5	26.5	23.6	24.7	24.7	26.4
Civil Engineering	12.1	13.0	16.5	20.4	27.3	27.3	19.4
All branches of Engineering	27.2	30.4	37.4	40.4	42.6	42.6	36.8

Source: AICTE Data Base

Economic liberalisation in 1990s gave a major push to the Indian software services industry which further boosted the demand for engineers trained in electronics and IT-related disciplines of engineering such as computer science and engineering, electronics & communications, and IT. These streams were considered as more popular branches; and the traditionally popular branches such as electrical, civil, and mechanical engineering have gone considerably down in student preferences and employers' preferences as well. Graduates as degrees in electronics and IT-related engineering programmes secured jobs relatively easily and quickly as compared to degrees in traditional subjects like civil and mechanical engineering.

How to explain the high rate of unemployment among the engineer graduates in India? In several cases engineering graduates in India are employed in non-engineering occupations that offers them substantially low salary. The issues of employment and unemployment of engineering graduates are coupled with the slowdown in overall employment of the India economy. The unemployment rate in India has increased significantly over the last decade and

[1] This is based on data available with AICTE. It is important to note that data on placements provided by AICTE or the individual institutions do not normally include data on those who secure employment later, after leaving the college.

this figure is 6.1 percent in 2017-18 (PLFS, 2019), and the graduate unemployment is 16.3 percent in 2019 (Statista Research Department, 2020). In an interview to italics (December 13, 2017), Vice Chairman of NITI Aayog, Rajiv Kumar sees the decline in the demand for engineering graduates in the labour market as a sectoral shift that might be happening in the Indian economy – a shift from traditional factory manufacturing jobs to jobs in emerging sectors like e-commerce, financial services and other services. But there are also problems with the kind and nature of graduates and the engineering education they receive. This takes us to the issue of employability.

3 Employability of Graduates

Due to weak labour market signals, even when employment is not high, many graduates still go for engineering education, and end up in unemployment – open or disguised. Graduates who are managing to get jobs are either mal-employed or employed at very low wages. That several engineer graduates are applying for posts of peon, gardener, sweeper, watchman and bailiffs is well-documented in several media and newspaper reports in India. For instance, in 2019, Gujarat High Court appointed 450 engineers as peons and bailiffs[1]. Similarly, a sizeable number of engineering graduates applied for the posts of sweepers and sanitary workers at the state assembly secretariat in Chennai in 2018[2]. These instances are indicative of the lack of employment opportunities for the engineering graduates in the country. As it is often argued, the prevailing labour market indications -- low employability of engineering graduates coupled with abysmal record of job placement, are the reflections of the poor quality of engineering education in the country. The quality attributes in terms of inter alia, skills and knowledge, with which the graduates come out of the colleges determine the employability of graduates. After all, employability is a measure of human capital – skills and knowledge, embodied in the graduates which is valued in the labour market for productive employment.

As per the India Skills Report (Wheebox 2020), the employability of engineer graduates remain static around 50 percent with marginal fluctuations between 2014 and 2018. There has been no change in the employability prospects of Indian engineering graduates in the past nine years! Then suddenly it improved to 57 percent in 2019, after which there was a steep fall to below 50 percent (Figure 2). The fluctuating trends should indeed be a matter of serious concern, as they make any forecasting and planning difficult.

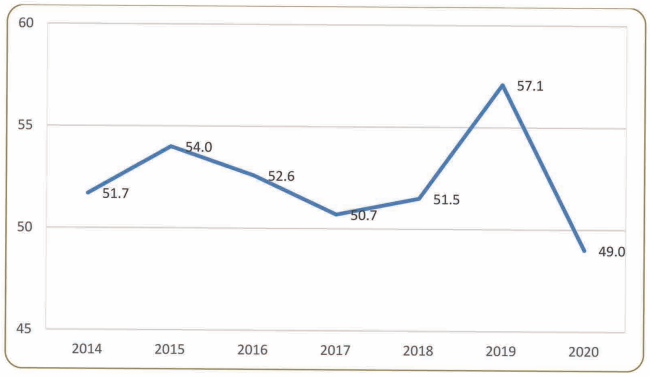

Figure 2. Employability of Engineer Graduates (B.E./B.Tech.) in India

Source: Based on Aspiring Minds (2019)

The rate of employability of graduates also differs by sub-streams of engineering. Graduates in electrical engineering and in I&T are most employable, with a rate of above 45 percent, and the employability is the least in case of civil engineering with a rate of 26 percent (Wheebox 2021). The variations between 2018, 2019 and 2020 are also wide as given in Table 2. The higher employability of IT graduates in the recent years may be due to the digitalisation and more use of IT-services in the labour market. In fact, eeconomic liberalisation in 1990s gave a major push to the Indian software services industry which further boosted the demand for engineers trained in Electronics and IT-related disciplines such as computer science and engineering, electronics and communications, and IT.

[1] https://www.nationalheraldindia.com/india/engineers-doctors-post-graduates-take-up-jobs-of-peons-and-bailiffs-in-gujarat-hc

[2] https://www.hindustantimes.com/education/over-4000-applicants-including-mtech-and-mba-apply-for-14-sanitary-workers-posts-in-tamil-nadu/story-vZSe3csNzzx5h3ZnsHk3gO.html

Table 2. Employability of Engineering Graduates, by Sub-Stream

	2020	2019	2018
Civil Engineering	26.50	50	44
Mechanical Engineering	34.15	53	43
Computer Science Engineering	38.43	58	44
Information & Technology	48.27	60	52
Electrical Engineering	47.35	60	50
Electronics & Communications	39.90	61	58
All Engineering branches	46.82	57	52

Aspiring Minds Team (2019) made an interesting analysis that shows that employability of graduates (in IT services) is low in those states where there are too many colleges like Tamil Nadu, Andhra Pradesh and Maharashtra and Karnataka, and it is reasonably high in those states which have fewer colleges like Delhi, Bihar, Jharkhand and Uttarakhand. Note that the former group of states also has a larger number of IT companies than the others. In fact, Aspiring Minds Team (2019) found a clear inverse relationship between the number of engineering colleges in a state and the employability of graduates, as shown in Figure 3. This clearly shows that expansion has taken place at the expense of quality of engineering education.[1]

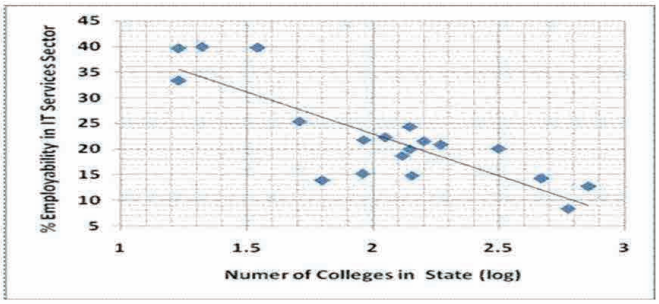

Figure 3. Employability and the Engineering Colleges in States
Source: Aspiring Minds Team (2019). (Reproduced with permission)

A large number of colleges in the states where employability is low are also private colleges. We observed a clear employability difference between elite and non-elite colleges in India. According to National Employability Report - Engineers 2016, 25 percent of engineers in tier 1 (elite) colleges are employable while this figure is 16 percent in tier 2 colleges and 13 percent in Tier 3 colleges. Further, the mean expected salary of students is ₹ 41.8 thousand[2]. with a significant difference between elite (₹ 42.3 thousand) and non-elite colleges (₹ 33.4 thousand). A minority of engineering students receives high quality training in elite institutions while the majority of students receive low quality training in non-elite institutions Loyalka et al (2014). This makes it clear that expansion has taken place at the cost of quality measured in terms of employment, and private colleges have not cared much for quality. In fact, not only in terms of mere number of colleges, one also finds an inverse relationships between private dominance and employability. States are grouped into four quartile in the National Employability Reports by the level of employability of graduates. Graduates belonging to states having a high proportion of private institutions are found to be least employable, as shown in Figure 4. It obviously refers to the quality of education being provided in the private institutions. The top quartile belongs to the states where share of private sector is relatively less (around 75 percent, average of 2013, average of 2016 and 2019 being 77.5 percent), and the share was near above 90 percent (average 92.3 percent) in case of the bottom quartile consisting of least employables. Thus it is clear that employability is seriously affected by the massive growth of engineering colleges. More importantly, it is the growth of private colleges in large numbers that led to production of graduates who are least employable. That many of the private colleges do not adhere to quality assurance mechanisms and other standards and regulations prescribed by the state is well known among the policy makers in India. Many of these institutions remain unaccredited for long by the accreditation bodies. All this calls for effective regulation of growth of private institutions and for ensuring strict compliance to quality assurance mechanisms.

[1] Even with respect to IITs, recent expansion is feared to cost quality and excellence that IITs are known for. The "the IIT 'system' has expanded be yond its capacity to maintain its high standards and is in danger of sinking into mediocrity" (Altbach & Mathews 2021).
[2] At the current rate of exchange, ₹ (INR) 70 = US$1 (approx.).

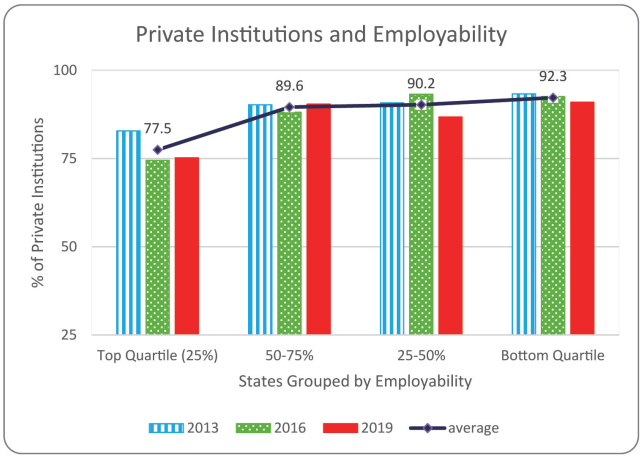

Figure 4. Private Institutions and Employability by Groups of States in India

Source: Based on Aspiring Minds and AICTE database for relevant years

In general, a large proportion of graduates receive very poor quality education. It has been found that 61 percent of the graduates did not have any internship during their engineering studies, 83 percent did not conduct any technical project, and 54 percent never attended any talk by the industry experts (Aspiring Minds 2019). In the AMCAT (conducted by Aspiring Minds AMCAT, taken by over 2 million graduates in 4000+ campuses, spread across 25 states, and used by a large number of employers for recruitment) the average score in any module crosses 50 percent. In core engineering modules, the marks were below 400 (out of 900), and in English language, logical ability and quantitative ability, it was between 400 and 500 (in 2019) (Aspiring Minds 2019), while normally 550 is considered as a minimum or a 'good' score.

What steps should be taken for improving the poor employability of engineering graduates in India? Apart from economy and structural factors, it emerges that the quality of engineering education one receives is an important factor that explains employment/unemployment and wages in the competitive labour market.

Several studies and reports provide compelling reasons why undergraduate engineering education is in need of change to respond to the complex challenges in the labour market (Badran 2007; Sahin 2010; Adams et al 2011; Winberg et al 2020). For instance, literature on employability of engineering graduates emphasises on the curricular and pedagogical arrangements to prepare graduates for work and also to address several other risks and uncertainties they are going to face in the changing labour market. Therefore, higher education institutions must keep pace with rapidly evolving technology, to enable individuals to be future ready and reduce their rate of obsolescence (Ernst & Young 2017).

The nature of engineering skills that a graduate need to get employment in labour market is going through a big change in India. In addition to the foundational skills gained from mathematics, physics and engineering sciences, graduates should also learn key professional skills such as communication, collaboration, team-work, project management, professional ethics, and broader environmental and societal issues.

The National Employability Report further finds that only a handful of engineering graduates possess next generation technical skills that give them better employment prospects while majority seem to have difficulty finding suitable employment. Only 2.5 percent of Indian engineers possess the skills in artificial intelligence (i.e., machine learning and data science), important skills required in the changing labour market, 1.5 percent to 4.5 percent of engineers possess the necessary skills in data engineering, and while only 2.8 percent to 5.3 percent are qualified in wireless technologies that industry requires (Aspiring Minds, 2019). According to the Aspiring Minds' National Employability Report on Engineers (2019), only 40 percent of engineering students in India get opportunities for internships and only 36 percent undertake projects outside their assigned coursework. Even today, the engineering discipline in India is very theoretical, and students learn primarily through lecture method. Similarly, the report also highlights that engineering students in India have very little industry exposure as they are trapped in a college bubble all the time. Only 47 percent of students attend industry talks, and more importantly, 60 percent of faculty do not discuss how engineering concepts apply to industry. Most talks that students attend are intra-departmental, rather than seminars, workshops, conferences or webinars that typically feature outside experts and scholars who present complementary or alternative perspectives.

Providing on-the-job training to engineering graduates is also found to be quite costly and risky for many employers, and therefore, not a viable

option for many. It is argued that after getting a good on-the-job training, they bargain for higher wage and if employers do not concede to their demand, they might leave the company and join some other. Also, providing training in the job market need a threshold level of learning during the under graduate studies which is also not found among a majority of the engineering graduates. Therefore, it is important to see whether the 4-year course in engineering after senior secondary education adds any employable skills among the graduates. Students need to be better equipped with employability-enhancement skills such as critical thinking, problem-solving, teamwork, decision making and adaptability among others.

Engineering institutions should aim to develop 21st century skills (beyond core academic subjects) among youths. The engineering institutions should lead in preparing professionals in cutting-edge areas such as artificial intelligence, 3-D machining, big data analysis, machine learning, robotic process automation, cloud computing, data engineering, and data science that would create a huge wave of transformation across industries in the coming decade. But, even today the curricula and pedagogies in a majority of the engineering institutions focus on imparting traditional technical knowledge, and ignore the new skills that are demanded in the changing labour market situations; therefore, they fail to possess hard skills in a soft context.

Emphasis needs to be given to strengthen the interdependent relationship between engineering knowledge and professional skills among engineering graduates to improve their employability. It is argued that, in the changing labour market situations, apart from having a good conceptual understanding of basic science and mathematics, engineering students also need to develop generic skills, such as creative and critical thinking, problem-solving abilities, decision-making etc (Badran 2007). The new engineers need to know how to work in teams given the importance of social skills in the workplace (Sahin 2010). Also, in the changing labour market situations, there is a need for engineers to acquire soft skills like cooperative working, communication and presentation skills, business ethics, inter-personal relationships, and skills to handle contemporary societal changes (Adams et al 2011; Jha 2005). Accruing these skills (in addition to gaining technical knowledge) would prepare graduates better to compete in the new world economy and in finding gainful employment in the labour market.

As argued for long, there is a need for strategic policy interventions to strengthen the industry-academia interactions to improve the linkage between engineering education and labour market in India. However, the latest AICTE-CII survey (CII 2018) has revealed that 78 percent of the total institutes have some linkages with industry, while 22 percent have no linkages at all. Only about 7.4 percent of the engineering institutions (710 out of 9,581) have received some funds from industry for setting up a department, cell or a laboratory. Out of the 710 institutions that received funds, about 419 (60 percent of the total) have received up to ₹ five lakh, while only 46 institutes received ₹ one crore and above. Strong linkages with industry might not only help in mobilising more financial resources, but also human resources in the form of experienced industrialists, and more importantly help in modernising the curriculum and content of engineering education. This may help in better planning of the growth of engineering education in the country.To minimise the gap between demand for and supply of engineering graduates, India should develop the mechanism that can better anticipate demand for different skills and vocation in the labour market and give that feedback to the technical education sector. This may be difficult in a fast changing dynamic environment. But some important signals can as well be drawn from such an exercise. With the policy inputs, engineering education should prepare youths to participate in the future labour market, where they will work together to address global challenges using technical and social skills. The aspirations of the 21st century engineering education require new thinking and new ways of doing, and those require engineering graduates to get advanced knowledge and skills in technical and professional areas. With globalisation, the technical education in India faces twin challenges, it has to be extremely useful for the domestic economy and at the same time made internationally relevant (Subramanian 2015, p. 118).

4 Graduates' Preferences and Aspirations

Now let us briefly examine the changing labour market aspirations of the engineering graduates produced by the universities and colleges. The

students' preferences and aspirations for and from different jobs also play an important role in explaining the phenomenon of unemployment. These are also not static; they are also rapidly getting altered over the years. Aspiring Minds (National Employability Reports for engineers 2014, 2016 and 2019) had surveyed students' preferences towards the kind of job roles, classified as software development, core engineering jobs (like mechanical, electrical, electronic or civil engineer) and management related jobs. Interestingly, majority of the engineering graduates have strong preference either for software jobs or core engineering jobs, and it is found to be true in all three points of time with small variations (Figure 5). It is noteworthy to mention that despite of the mushrooming job opportunities in managerial roles like technical sales, marketing and content development, engineers do not seem to prefer these jobs as yet, even though quite a few of them end up in those jobs. It is widely viewed that engineering graduates take up non-engineering jobs in the labour market as they don't get the suitable job of their preference in engineering, with very few exceptions.

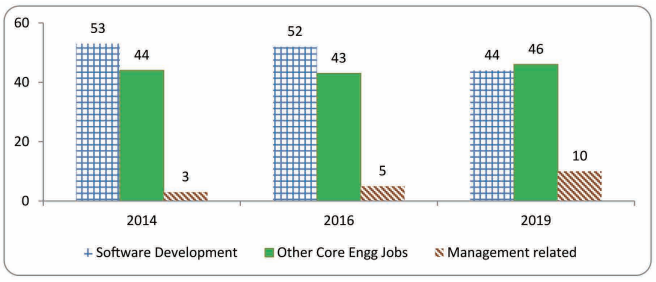

Figure 5. Job-role Preference of Engineering Graduates in India
Source: Based on Aspiring Minds' National Employability Report - Engineers 2014, 2016 and 2019

The reports by Aspiring Minds have also reported on graduates' job aspirations by their branch of study, gender, tier of college they study (ranks of the colleges based on the employability of their students[1]) and by tier of city. There are variations between them. For instance, graduates with computer/IT background are mostly interested in software jobs, while students with core engineering branches prefer equally software and core engineering jobs. Surprisingly, for management related roles, students from tier 1 colleges (colleges with higher rates of employability of students) show maximum inclination. Similarly, women in large numbers aspire to work in managerial positions, compared to men.

Obviously, students go for engineering education, considering labour market returns. Engineering being a privileged profession associated with high salaries, fresh graduates normally expect high salaries. National Employability Reports for engineers (of the Aspiring Minds) for the last three years have collected information of expectations of engineering graduates regarding their salaries in the job market. There are variations in the expected salary by branch of study, by the quality of college and by gender (Figure 6). Graduates of mechanical engineering and civil engineering aspire for higher salaries, followed by computer/IT (computer science and IT-related branches) and then circuit branches (electronics engineering, electrical engineering, and instrumentation engineering). However, this is not in-line with general perceptions, according to which graduates in computer/IT-related subjects of engineering command the highest pay due to their increasing demand in the labour market. Probably because of a recent fall in demand for IT graduates in the labour market, they tend to limit their monetary aspirations.

The salary expectations also vary by the level of college one attended and by gender. As expected, graduates from tier 1 colleges (proxy of better quality) aspire for a much higher salaries in comparison to tier 2 and tier 3 college graduates. While the difference between mean aspired salary of engineers from tier 1 colleges and tier 2 colleges is ₹ 68,000, the difference between those from tier 1 and tier 3 is ₹ 1.1 lakhs in 2019 (figure 7).

Having been aware of the relatively low quality of education they received in the tier 2 and tier 3 colleges, and the reputation of those colleges, the graduates of these colleges obviously expect lower salaries. It is also possible that second order small and medium firms might come to these colleges for campus recruitment and recruit graduates of these colleges, while multinational companies and reputed firms may choose graduates from tier 1 colleges.

[1] All the colleges included in the Aspiring Minds' survey were ranked based the employability of their students. Those in the top 33 percentile were considered as tier 1 colleges, those in mid-33 percentile range were considered as tier 2 colleges while those in the bottom 33 percentile set were taken as tier 3 colleges.

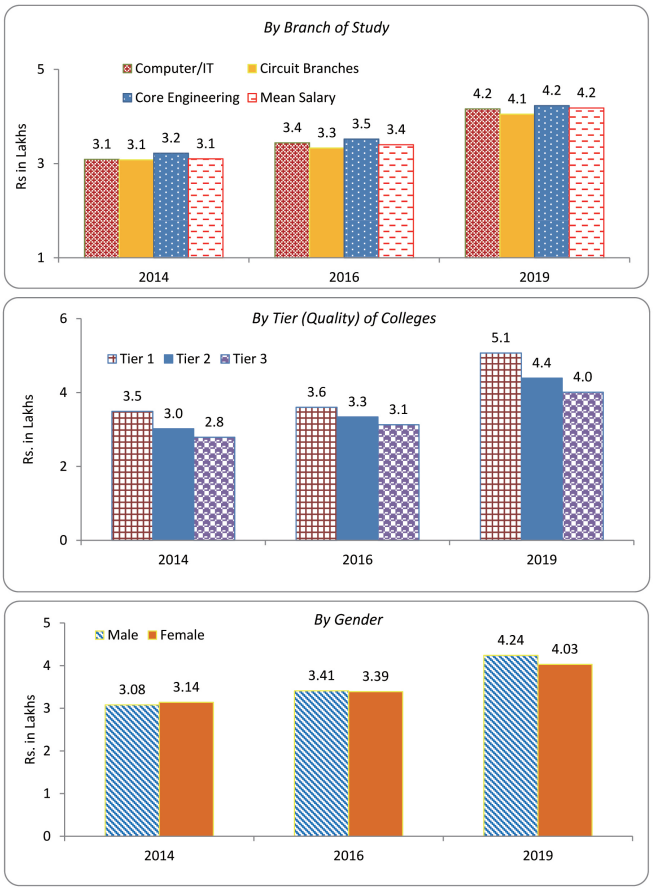

Figure 6. Graduate Engineers' Expectations on Salary (₹ in lakhs per annum)

Source: Based on Aspiring Minds' National Employability Report-Engineers 2014, 2016 and 2019

Students from poor quality engineering colleges do not get placement in large companies, also in some cases major employers in the job market do not participate in the placement exercises of these institutions. Therefore, graduates from these colleges limit their salary aspirations likewise and do not aspire for high pay. On average, women seem to aspire for a slightly lower level of salaries than male engineering graduates in 2016 and 2019, while in 2014 the salary expectations among women were higher than the expectations of men. It is also observed that women students often access tier 2 or 3 colleges, and accordingly they get offers with low salaries. On average, on the whole, the salary expectations of engineering graduates are not high: around ₹ 4 lakhs per annum. Inter-college, or inter-branch of study or by gender the variations in aspired salaries are small in a given year. They were around ₹ 3 lakhs in 2014, which increased to about ₹ 4 lakhs in 2019. Only in 2019 we find marginally higher differences between the students of the three tiers of colleges. In 2019, graduates from tier 1 colleges expected high salaries (₹ 5.1 lakh); this is the maximum figure we find in Figure 5, and in the same year, those from tier 3 colleges expected ₹ 4 lakhs as their salary on average. Perhaps by 2019 quality differences in the graduates (identified by colleges) are being clearly noticed by the employers.

5 Summary and Concluding Observations

The massive expansion of engineering education over the last three decades provides technical training to a large-chunk of youths in India. But, understanding the impact of changing nature of job due to the the new age of automation and unprecedented technological advances on employment and employability of engineering graduates remains limited and fragmented.

Based essentially on secondary data, an attempt has been made in this paper to understand the changing labour market conditions that influence the demand for engineering education. With massive expansion of poor quality engineering education, the employability of the graduates is greatly questioned in the labour market. Several surveys have come out with the fact that only about one-fourth of the graduates are employable as the rest do not possess the required skills as per the labour market needs.It is argued that majority of the engineering graduates in India receive low quality training in non-elite institutions while very few get high quality training in elite institutions. Also, little is understood about the contours of the changing labour market in the country and its influence on the demand for and supply of engineering education. The labour market is currently witnessing new age of automation and driven by unprecedented technological advances that requires a new set of skills among the engineering graduates. How far the engineering institutions in India are fulfilling such needs? It appears there is not much emphasis on the curricular and pedagogical arrangements to prepare graduates well for work in the changing contexts. The poor academia-industry interlinkage is another grey area in the engineering education sector in India. Additionally, most of the engineering colleges in the country (including many government institutions) are facing faculty crunch, keep aside the lack of physical infrastructure and laboratories to impart quality education and training.

All this suggests that there is a need for major restructuring of the engineering education sector, specifically with a better understanding of the emerging market dynamics. Leaving the market to operate freely in engineering education (as continued for the last three decades) may lead to a great distortion in the sector which has started with the devaluation of engineering degree. Therefore, there is an urgent need to focus and discuss the critical changes the engineering education sector has experienced (and continued to be experiencing) in the recent years. These may include: understanding the changing aspirations of parents for engineering education, revisiting the role of private sector, searching for new strategies to cope up with the declining demand, and above all, effective intervention of the state (if any) to regulate and restructure the engineering education sector to address the recent changes etc. Lack of data is one of the important reasons for not addressing several of these concerns and, therefore we argue for building a strong comprehensive database that covers historical as well as current data on a large set of dimensions of engineering education that would contribute to quality research, informed and effective policy making and planning of technical higher education in the country.

Besides setting up an institutional structure that would build such a robust and comprehensive database, the study highlights a few important policy implications. First, there is a need to effectively regulate the growth of engineering education in the country. Permissions and approvals to open new institutions – public or private, and to offer new programmes need to be based on reliable and transparent and scientific data on the need for such institutions, and programmes, rather than being influenced by political and economic considerations. Leaving this to market forces results in different kinds of imbalances and chaos as we have already seen. As the AICTE (2018) committee has recommended, no new college may be allowed to be started. Permissions may be deferred for opening of new colleges for a few years. In the meanwhile; the government may have to take up consolidation of the engineering education system, adopting closures and mergers of institutions, and weeding out the substandard institutions. It is not only those where enrollments are less than intake that they need to be closed, but also in case of the institutions in those states, where the intake is higher than national average, as argued by the U R Rao committee (AICTE 2003). As it is mandatory that all institutions and all the programmes they offer need to be subject to a national assessment, the mechanisms of assessment and accreditation need to be made robust, scientific and transparent, leaving no chance for manipulation. Several loopholes in granting permissions to open, and in assessment and accreditation of the institutions, apart from shortfall in accreditation, are highlighted often in the media. The process of approval by the AICTE for opening new institutions or new degree programmes is based on a set of criteria including the credibility of the management, teachers, assurance of compliance to AICTE norms and standards, approval by the state government, and market relevance of the curriculum, etc. In addition, there is a further process of accreditation by the NBA, which is regarded as having higher standards, relating to capability of the institution, teachers, and the programmes to adhere to strict quality criteria. But these mechanisms have been proven to be insufficient and ineffective, as many institutions are often reported to be flouting these criteria and still functioning. Several loopholes in granting permissions to open, and in assessment and accreditation of the institutions are highlighted often in the media, stressing the need for very effective regulatory mechanisms and quality assurance systems.

Second, a clear focus has to be laid on improving the quality and standards in higher education. Besides consolidating existing institutions, and regulating the future growth, special attention has to be given to the recruitment of quality faculty and the provision of a good learning environment that includes good infrastructure consisting of libraries, classrooms, laboratories and modern equipment, which will be conducive for good teaching and learning and also for research.

The Technical Education Quality Improvement Project (TEQIP) project (www.teqip.in), launched by the government of India with the assistance of the World Bank in 2003 as a 10-12 year project, for improving the quality of engineering institutions partly addresses some of the quality concerns in government and government-aided private institutions, and in phase II and III in addition, the self-financing private institutions. But is felt that "due to shortage of academic and non-academic staff and

other factors, the scheme has not been able to achieve its targets as desired" (Patel 2016). Educational institutions – either public or private, cannot be left with such high rates of vacancies as we have found. The overall research environment needs massive improvement in majority of the institutions.

There is not much emphasis on the curricular and pedagogical arrangements to prepare graduates well for work in the changing contexts. The need for major curricular reforms needs no emphasis. The curricula may have to include knowledge and skills in the core domain, but it also deeds to add many other individual traits and social, cultural, and human values. The aim in all this should be not just to improve the employability of the graduates, but also to produce holistic personalities who will be able to serve society better. Vertical linkages between high quality institutions like IITs on the one end and the under graduate institutions on the other end, as envisaged under TEQIP, and horizontal linkages between several institutions of the same level may go a long way in enhancing the standards of education in the system as a whole. Otherwise, we may continue to have a few pockets of excellence amidst a myriad of institutions characterised by mediocracy. Institutions should aim at preparing professionals in cutting-edge areas of technology which would enhance the employability of Indian graduates in professional and technical education.

The National Education Policy 2020 (Government of India 2020) has recognised the problem of poor quality of graduates of technical education and their low employability and rising unemployment. The policy document has laid out the importance of quality technical education for India's overall development. Given the changing labour market needs, and the need to produce creative individuals to cater the needs of the 21st century requirements, the Policy argued that the graduates need critical and interdisciplinary thinking, intellectual curiosity, scientific temper, and more importantly the spirit of service. Currently, the technical graduates produced from the system are mostly lacking the 21st century skills needed to build a knowledge economy and society. The existing silos between technical education and other disciplines of higher education is considered as a major hindrance for this. Despite ever-increasing influence of technology on human endeavours, technical education in India is offered with early specialisation and streamlining of students into narrow areas of study. Hence the policy insists on transforming all technical and professional institutions into multidisciplinary institutions and offering programmes that would provide opportunities to engage deeply with other disciplines. It is also noted that India must take the lead in preparing professional in cutting-edge area such as artificial intelligence, 3-D machining, big data analysis, machine learning, genomic studies, nano-technology with important applications to health, environment, and sustainable living. Imparting a variety of skills -- generic, social and cultural skills, communication skills, and advanced skills in technical and professional areas along with business ethics and human values in a multi-disciplinary set-up, as proposed in the National Policy, may enhance considerably the employability of engineering graduates. To improve the quality in technical higher education institutions, the Plicy also argues for closer collaborations between industry and technical education institutions, an unsettled issue often discussed in the academia and policy space in India (e.g., AICTE 2015, 2018).

The choices of students in choosing engineering studies, the sub-stream there in, the institutions and their labour market aspirations critically depend upon labour market information. Hence regular manpower surveys and labour market surveys are needed that provide detailed information, which will be helpful to the students/graduates, to the institutions and also public authorise in planning engineering education for future. Such information will also be immensely useful for institutional planning. Though manpower planning per se, is no more found to be meaningful, manpower analyses and labour market analyses that are a part of manpower planning, would be extremely useful (Tilak 1995), particularly for specialised human capital categories like engineering manpower.

Conflict of Interest

No conflict of interest was reported by the authors.

References

[1] Adams, R., D. Evangelou; L. English; A. D. de Figueiredo; N. Mousoulides; A. L. Pawley; C. Schifellite; Reed Stevens; M. Svincki; J.M. Tenor; & D.M. Wilson (2011). Multiple Perspectives on Engaging Future Engineers, Journal of Engineering Education, 100(1): 48–88.

[2] AICTE. (1999): Technical Education in India in Independent India: 1947-1997. A Compendium to Commemorate the 50th Anniversary of Independence. New Delhi: All India Council for Technical Education, New Delhi.

[3] AICTE (2003): Revitalising Technical Education: Report of the Review Committee on AICTE [Chairman: U R Rao]. New Delhi: AICTE.

[4] AICTE. (2015): Technical Education in India: A Futuristic Scenario (Report of the AICTE Review Committee, 2015). [Chairperson: M.K. Kaw]. New Delhi: All India Council for Technical Education.

[5] AICTE. (2018): Engineering Education in India: Short- and Medium-Term Perspectives. [Report of the Committee chaired by B V Mohan Reddy]. All India Council for Technical Education, New Delhi.

[6] AICTE. (2019, 2020). All-India Council for Technical Education. https://facilities.aicte-india.org/dashboard/pages/dashboardaicte.php (accessed 20 May 2020).

[7] Altbach, Philip G., & Mathews, Eldos (2021). Too many IITs, Unrealistic Expectations. The Hindu 20 (February).

[8] Aspiring Minds (2019). National Employability Report: Engineers. 2019. Gurugram, India.

[9] Badran, I. (2007). Enhancing Creativity and Innovation in Engineering Education, European Journal of Engineering Education, 32(5): 573–585.

[10] Bhargava, R.N. (2001): Present Engineering Education in India — An Emerging Economy — And a Glimpse of the Scenario in the 21st Century. In: Educating the Engineer for the 21st Century. (Eds.: Weichert, D., Rauhut, B., & Schmidt, R.) (pp. 77-80). Springer, Dordrecht.

[11] Blom, Andreas & Saeki, Hiroshi (2011): Employability and Skill Set of Newly Graduated Engineers in India. Policy Research Working Paper 5640. World Bank, Washington DC.

[12] Dubey, A., A. Mehndiratta, M. Sagar, & S. Kashiramka (2019). Reforms in Technical Education Sector: Evidence from World Bank-Assisted Technical Education Quality Improvement Programme in India, Higher Education 78 (2): 273-299.

[13] Ernst & Young (2017). Future of Jobs in India – A 2022 Perspective. Kolkata.

[14] Hodgman, Matthew, R. (2018): Understanding For-Profit Higher Education in the United States through History, Criticism, and Public Policy: A Brief Sector Landscape Synopsis, Journal of Educational Issues 4(2) (July): 1-14

[15] Government of India (2020). National Policy on Education 2020. New Delhi, Government of India.

[16] Khare, Mona & Sonam, Arora (2021) Job-less Growth in India: Employment-Unemployment of Educated Youth, In: Higher Education, Employment and Economic Development (eds. R K Mishra, S K Kujur & K Trivkram), Routledge. (in press)

[17] Kinser, Kevin, and Levy, Daniel V. (2007): For-Profit Higher Education: U.S. Tendencies, International Echoes, in: International Handbook of Higher Education (Eds.: Forest, James J. F.; & Altbach, Philp G.) (pp. 107-19). Springer, Netherlands.

[18] Kirp, David, L. (2003): Shakespeare, Einstein, and the Bottom Line: The Marketing of Higher Education. Cambridge. MA, Harvard University Press

[19] Loyalka, P., Carnoy, M., Froumin, I., Dossani, R., Tilak, J.B.G., & Yang, P. (2014). Factors Affecting the Quality of Engineering Education in the Four Largest Emerging Economies, Higher Education 68(6) (December): 977–1004.

[20] Mehrotra, Santosh & Parida, Jajati K. (2019). India's Employment Crisis: Rising Education Levels and Falling Non-agricultural Job Growth. CSE Working Paper 2019-04. Centre for Sustainable Employment, Azim Premji University, Bengaluru

[21] MHRD: Ministry of Human Resource Development (2011). All India Survey on Higher Education 2010-11. Government of India, New Delhi.

[22] MHRD (2019), All India Survey on Higher Education 2018-19. Ministry of Human Resource Development, Government of India, New Delhi.

[23] MHRD (2020). National Education Policy 2020. Government of India, New Delhi.

[24] Nanda, Prashant K. (2018). India Jobs Crisis: How Accurate is EPFO Payroll Data? Mint (31 Oct 2018).

[25] NASSCOM & McKinsey (2005): NASSCOM and McKinsey Report 2005: Extending India's Leadership of the Global IT and BPO Industries. New Delhi: National Association of Software and Service Companies and McKinsey and Company

[26] Panchamukhi, P.R. (1987). Graduates and Job Markets. Occasional Paper 74. Paris: UNESCO- International Institute for Educational Planning.

[27] Patel, Pravin J. (2016): Research Culture in Indian Universities, Social Change 46(2): 238-59

[28] Roy, Subhashri (2020). 80 Percent of Indian Engineers Unemployed: AISHE 2019, (July 15, 2020). https://www.collegedekho.com/news/indian-engineering-graduates-employability-trends-18148/

[29] Sahin, M. (2010). The Impact of Problem-Based Learning on Engineering Students' Beliefs about Physics and Conceptual Understanding of Energy and Momentum, European Journal of Engineering Education 35 (5): 519–537.

[30] Sengupta, Aninndita (2017). Mismatch between Skills and Jobs in Indian Labour Market during the Post-Reform Era: Estimates with Unit Level Data. IARIW-ICIER Conference

on Experiences and Challenges in Measuring Income, Inequality and Poverty in South Asia. New Delhi, India (November 23-25). http://www.iariw.org/India/sengupta.pdf

[31] Statista Research Department. (2020). Reports. https://www.statista.com/statistics/1043283/india-hiring-rate-engineers/

[32] Subramanian, B. (2015). Engineering Education in India: A Comprehensive Overview. In: International Perspectives on Engineering Education. Philosophy of Engineering and Technology (Eds.: Christensen S., Didier C., Jamison A., Meganck M., Mitcham C., & Newberry B.) Vol 20. (pp. 105-23). Springer, Cham.

[33] TEQIP (2020). Technical Education Quality Improvement Programme, The Government of India and the World Bank. https://www.teqip.in/ (accessed 24 February 2021)

[34] Tilak, Jandhyala B.G. (1995). Has Manpower Planning any Future in Educational Planning in a 'Marketised' Economy? In Impact of New Economic Policy on Manpower and Employment in India (eds.: K. Raghavan, K., Sharma, & Harsh Sekhar, L.) (pp. 252-70). New Delhi: Agricole for Institute of Applied Manpower Research.

[35] Tilak, Jandhyala B.G. & Choudhury, P.K. (2021). Paradoxes and Contradictions in the Growth of Engineering Education in India: Challenges and Prospects. Working Paper CSD 1/2021. New Delhi, Council for Social Development UGC. (2018). Annual Report 2017-18. New Delhi

[36] UNESCO (2010). Engineering: Issues, Challenges and Opportunities for Development. United Nations Educational, Scientific and Cultural Organization, Paris, France. Wheebox (2020). India Skill Report 2020. Gurugram, India.

[37] Winberg, C., Bramhall, M., Greenfield, D., Johnson, P., Rowlett, P., Lewis, O., Waldock, J., & Wolff, K. (2020). Developing Employability in Engineering Education: A Systematic Review of the Literature, European Journal of Engineering Education 45 (2): 165-180.

[38] World Bank (2019): World Development Report 2019: The Changing Nature of Work. World Bank, Washington, DC.