International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979; Impact Factor: RJIF 5.72
Received: 27-05-2019; Accepted: 30-06-2019
www.allsubjectjournal.com
Volume 6; Issue 8; August 2019; Page No. 182-186

Engineering education in India: Prospects and growth

U Ramesh[1], Dr. Shine N Das[2]
[1] Research Scholar, Tilak Maharashtra Vidyapeeth, Pune, Maharashtra, India
[2] Joint Director, APJ Abdul kalam Technological University, Kerala, India

Abstract
Education is the most significant phenomenon instrumental to the development of any country. It should be transformed to the needs of the time and changing scenario of the technology. In particular, the Engineering education and the mode of its delivery should be tuned time and again for greater development and changes to cope with such challenges. The sector, in recent decades, has witnessed a tremendous growth in many aspects such as the institutional capacity, student enrolment, teaching – learning process, teacher-student ratio, etc. The rapid expansion of the Engineering education system, at the same time, has brought several pertinent issues related to equity, efficiency, excellence and access to higher education in the country. The unplanned expansion of higher education opportunities, bundling trend of the educated unemployed, commercialization of education, the mismatch of quantity with quality, ignorance equity and excellence, are some of the pertinent cases in point which pose continuous threats to the Engineering education in India. The present study is unique in the sense that it brings about better understanding of the scenario prevailing in the higher education system in India and its pattern of growth given the opportunities and challenges to the system under consideration.

Keywords: engineering, quality, education

Introduction
Higher education in India has experienced commendable expansion post independence. India has produced scientists, engineers, technologists, doctors, teachers and managers who are gaining top demand all over the world. Now India is one among the top ten destinations, in our industrial and technological capacity, because of the significant contribution of manpower and tools provided by the Engineering education. The programmes which have advanced the country and diversified and augmented production since independence are largely because of the manpower produced by engineering institutions of the country. *W.P. Lewis & E. Bonollo (2002),"* found Experimental evidence on the design skills and professional behaviour valued by design practitioners and managers is presented and reviewed in the context of an operational model of the design process. To meet the challenges, an ambitious programme of expansion of engineering education and institutes were undertaken to address the situation. However this growth has not resulted in improved quality of engineers passing out but rather has brought down the quality and hence the employability of fresh graduates. Though contributions of private unaided colleges and universities in meeting the demand for higher education are appreciable, the mushrooming growth of these institutions has resulted in the largest system of higher education with a deteriorating quality. Given the statistics, 37% of students are studying in the field of Arts, 19% of the students in Science, 18% of students in the Commerce and 61% of students in the field of Engineering. An attempt has also been made in this paper to discuss the trends in the growth of enrolment and the future prospects of engineering education.

Objectives of the Study
In the light of the discussions and the available literature relating to Engineering education in India the following specific objectives are framed to present this macro level study.

- To analyze the present status of Engineering education in India
- To highlight the opportunities and challenges faced by the Engineering education sector.
- To examine variations in the enrolment in higher education across states, gender and social groups.
- To discuss trends in the Engineering education
- To suggest measures to overcome the issues relate to enrolment and quality of engineering institutions.

Structure of Engineering Institutions
Initially, engineering education was based on the British model and emphasized the importance of engineering professional practice. After independence it has been constantly influenced by American education system in its contents. The 20th century witnessed tremendous progress and incredible developments took place in the field of engineering education. Technical education system is to produce trained manpower in adequate number for the economic and technological development of the country. It plays an important role for the economic and industrial growth, national developments and international competitiveness. It imparts technical knowledge, study, and research and facilitates technological transfer. In India the institutional framework consists of Universities established by an Act of Parliament (Central Universities) or of a State Legislature (State Universities), Deemed Universities (institutions which have been accorded the status of a

university with authority to award their own degrees through central government notification), Institutes of National Importance (prestigious institutions awarded the said status by Parliament), and Institutions established by State Legislative Act and colleges affiliated with the University (both government-aided and unaided). Universities and its constituent colleges are the main institutes of higher education in India.

The institutions offering Engineering courses in India could be broadly classified into 5 categories

- Indian Institute of Technologies (IIT)
- Technical Universities
- National Institute of Technology (NITs)
- Engineering Department/ constituent in traditional Universities
- Government/ Government Aided/Private Self-Financing Colleges

Growth

The beginning of formal technical education in India can be dated back to the mid-19th century. The major policy initiatives in the pre- independence period includes appointment of the Indian Universities commission in 1902, issue the Indian Education policy resolution in 1904 and Governor General's policy statement of 1913 stressing the importance of technical education. The establishment of IISc., Bangalore, Institute of Sugar, Textile and Leather Technology in Kanpur, NCE in Bengal in 1905 and industrial schools in several provinces and significant development includes:

- Constitution of technical education committee of the central advisory board of Education (CABA) in 1943
- Preparation of sergeant report of 1944
- Formation of All India council for Technical education (AICTE) in 1945 by the Government of India.

All India Council for Technical Education (AICTE), a statutory body under Ministry of HRD, Govt. of India, approves and regulates the institutions falling under the category of Technical Education viz a viz those offering UG/PG and Diploma level courses in Engineering/technology, Pharmacy, Architecture, hotel management & catering technology, management studies, computer applications and applied arts & crafts. The scenario of Engineering Education sector during the last 5 years is depicted in the table shown below

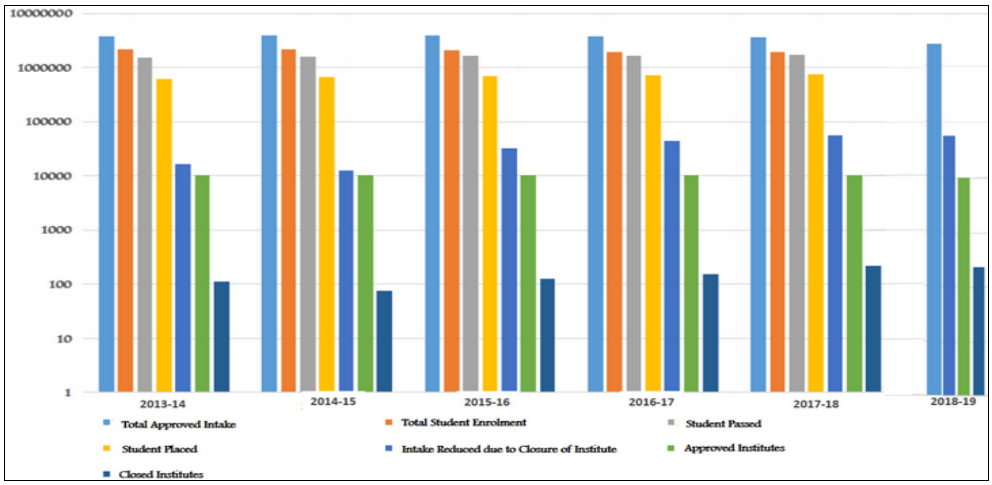

Fig 1: Scenario of Engineering Education in India

At the time of independence, the size of Engineering education in India was small and catered only to the elite brains. The tremendous expansion that we witnessed has democratized the system. Now, about 60% of the enrolments in Engineering Education is from the lower-middle Socio- economic strata. During, the late 80's, the growing demand for Engineering education exercised ample pressure on the Government to change its policy and allow the entry of Private enterprises to this sector thereby increasing the competition, both quality and quantity wise. But the enormous growth in quantity was indirectly posing to the deterioration in quality. The race to achieve the quantity started dilution in the overall system. The institutes and the total intake offered state wise is shown in the table 1

Table 1: State wise distribution of Engineering Institutions

Region	State	Institutions			Approved Intake			Institutions	Approved Intake
		Diploma	PG	UG	Diploma	PG	UG		
Central	Chhattisgarh	85	44	62	13460	4475	20314	**127**	**38249**
	Gujarat	147	224	200	68765	25962	67741	**418**	**162468**
	Madhya Pradesh	234	363	292	41391	46671	87238	**575**	**175300**
Central Total		**466**	**631**	**554**	**123616**	**77108**	**175293**	**1120**	**376017**
Eastern	Andaman and Nicobar Islands	2	0	1	480	0	90	**2**	**570**
	Arunachal Pradesh	8	2	1	1040	198	360	**10**	**1598**
	Assam	28	22	24	4395	1812	5505	**59**	**11712**
	Jharkhand	57	17	20	15177	3083	6681	**82**	**24941**
	Manipur	3	1	1	370	40	150	**4**	**560**
	Meghalaya	3	2	2	380	150	660	**7**	**1190**
	Mizoram	3	3	1	240	122	30	**4**	**392**
	Nagaland	9	2	2	585	120	540	**13**	**1245**
	Odisha	158	130	111	46321	15059	41985	**300**	**103365**
	Sikkim	3	2	4	570	234	800	**7**	**1604**

	Tripura	7	3	3	1150	180	623	13	1953
	West Bengal	165	104	111	40170	10474	38598	286	89242
Eastern Total		**446**	**288**	**281**	**110878**	**31472**	**96022**	**787**	**238372**
North-West	Chandigarh	5	10	7	960	1065	1821	15	3846
	Delhi	20	52	24	5750	13034	9893	78	28677
	Haryana	203	185	188	50141	21039	46978	402	118158
	Himachal Pradesh	34	21	33	6870	1481	6333	66	14684
	Jammu and Kashmir	30	19	12	5685	1600	3975	54	11260
	Punjab	221	168	147	56935	16424	39262	393	112621
	Rajasthan	205	135	154	41335	13342	48563	371	103240
North-West Total		**718**	**590**	**565**	**167676**	**67985**	**156825**	**1379**	**392486**
Northern	Bihar	69	38	42	17855	3147	11290	134	32292
	Uttar Pradesh	753	539	418	152100	70574	118844	1261	341518
	Uttarakhand	136	67	48	20143	6380	11795	194	38318
Northern Total		**958**	**644**	**508**	**190098**	**80101**	**141929**	**1589**	**412128**
South-Central	Andhra Pradesh	317	581	418	79676	88499	167171	790	335346
	Telangana	203	545	363	52429	86801	130548	669	269778
South-Central Total		**520**	**1126**	**781**	**132105**	**175300**	**297719**	**1459**	**605124**
South-West	Karnataka	349	363	277	95808	49206	110318	751	255332
	Kerala	87	218	216	23615	20534	60195	384	104344
South-West Total		**436**	**581**	**493**	**119423**	**69740**	**170513**	**1135**	**359676**
Southern	Puducherry	9	13	19	2422	1688	8010	29	12120
	Tamil Nadu	501	704	593	198784	86212	304138	1334	589134
Southern Total		**510**	**717**	**612**	**201206**	**87900**	**312148**	**1363**	**601254**
Western	Dadra and Nagar Haveli	1	2	1	390	90	60	3	540
	Daman and Diu	2	0	1	540	0	180	3	720
	Goa	9	5	8	2935	675	1490	17	5100
	Maharashtra	741	688	622	153556	81410	164102	1555	399068
Western Total		**753**	**695**	**632**	**157421**	**82175**	**165832**	**1578**	**405428**
Grand Total		**4807**	**5272**	**4426**	**1202423**	**671781**	**1516281**	**10410**	**3390485**

Challenges

One of the greatest challenges to Engineering education in India is providing access to the growing segments of the population demanding post secondary education. The government data reveals that one out of seven children in India goes to college. Privatisation and commercialization of the higher education in India is a major concern as it will retard our human resource development at least in two ways.

- **Supply of Engineering Graduates exceeds much ahead of the Industry demands:** 60% of the total Engineering graduates coming out of the various Engineering institutions across the country remain unemployed.
- **Raise the standard of Engineering Graduates and to make them Industry Ready:** The Engineering colleges historically have developed its curricula to meet the needs and talents desired by Industry. Over the years colleges have also included 'hands on training' to their students through summer internships /doing some industry related projects, etc. These changes made by the academics have always been appreciated by Industry who is the recipient of these graduates. However the changes in curriculum need to be more dynamic to keep pace with ever changing needs of industry.
- **Lack of accredited programmes:** To assure consistence Quality and Relevance of Education, accreditation to NBA is indeed the way forward. 15% of the total Engineering courses offered by the 3700(approx) institutions are possessing accreditation by the National Board of accreditation.
- **Lack of latest trends and Technical knowhow amongst Teachers:** The resistance amongst the faculty members in engineering colleges to acquire additional skills, knowledge, certification and also the updating of technology is another major challenge faced by the sector.
- **Obsolete curriculum:** The curriculum followed by various Universities offering Engineering courses are obsolete and has not been updated for years. The frequency of syllabus revision is too low that the theory and practical's taught within the campuses never cope up with the Technology prevailing.
- **Low Entry Level Qualifications:** As the supply falls much behind the available seats, the primary objective prevailing amongst the Engineering Colleges is to fill the seats with a commendable number of aspirants and thereby compromising the merit secured in entry level thereby just abiding to the minimum marks. These students, in the later stage fail to cope up with the intellect and skills demanded by Engineering curricula.
- **Faculty Shortage:** The shortage of faculty both in numbers and in quality is the most serious problem prevailing Engineering education system and is the most difficult, but at the same time, most urgent challenge to be tackled. Even premier institutions such as the IITs have faculty shortages of 25% or more and the situation has persisted for a long time.

Opportunities

India already has emerged as a global knowledge economy. It offers facilities of education, training and research in almost all spheres of disciplines ranging from arts, science, humanities, mathematics, management, engineering, medicine, agriculture, law, linguistics, communication, etc. Engineering education benefits the individuals specifically as it equips young people with skills to cope with the rapidly changing Technology and societal demands. It gives individuals powers to get better employment, higher salaries and higher propensity to consume and save. Altogether, investment in Engineering education enhances the labor power in order to trade it for higher wages.

- India is also attracting a large number of foreign students to its central, state and private universities and colleges.

Asian and western students find India a place of higher education hub due to the fact that the education provided here is inexpensive, higher quality and in the learner friendly environment.

- Also it is being revealed through various reports that all the Top Global Multi National Companies and recruiters are aiming at the Indian Engineering graduates due to the adaptability of the candidates and quick learning skills.
- Also, India's median age is about 26 years and nearly 600 million people are in the working age group. This demographic dividend is to be contrasted with the ageing population in most developed economies such as China, European Union, US, Japan, etc. thereby leaving a decreasing fraction of their population as work force.
- Innovation is identified as almost synonymous with young age and good education. Government coming up with mandatory innovation clubs in all Engineering institutions and also the much acclaimed Smart India Hackathon series have rejuvenated the Indian Engineering students by waking up the innovative minds hidden within them.
- English is considered as the Global language and Indians are considered to be the 2nd biggest population having decent command on the language next to the US.
- India has a fairly good and wide information, communication and technology (ICT) network, which is getting better day by day. Globally, ICT is playing a commendable role in the Engineering education sector, so that state-of-the-art quality education can be accessed by people everywhere, including rural areas.
- The average per capita income and therefore, the middle income population in India is growing rapidly. This translates into market for more manufactured goods and, even more importantly, demand for quality education in Engineering sector. More public recognize the importance of Engineering education as the way to move ahead in life and to have the resources and willingness to spend on good education.

This trend evinces that Indian higher education has more potentialities to cater to the need of growing global demand. The unconditional co-operation in curriculum development, preparation of instructional materials, implementation of innovative practices, use of new technologies, exchange of experts and promotion of collaborative research are the need of the hour. The system is confronted with the second wake-up call on Engineering education. It highlights the need for well-trained, motivated teachers and researchers; innovative research for societal needs and new products; joining global knowledge economy; converting our unique advantages into solid strengths; gaining respect for Indian technological prowess and Indian research.

Suggestions for further improvement

- To establish a vibrant Board of Governors – The presence of a strong board and academic council with passion and freedom to try new initiatives and question the status quo has proved wonders in the Globally ranked institutes.
- Curriculum revision and Innovation – Introduction of engineering exploration projects in first year and inter disciplinary projects in final year. Encourage students to pursue minor degrees
- Industry involvement in the framing of curriculum – Involvement of industry experts in board of studies and courses taught by industry experts as adjunct faculty shall give the students a fresh outlook on the subject and its applications in realty
- Funding for faculty for industry internships – The salary paid to the faculty members in majority of the Private Self Financing institutes, forcefully prevents them from taking any activity concerned with their knowledge updating. The institutions should generate and provide ample financial assistance for the faculty members to undergo training programs and internships in relevant Industries.
- Identification of socially relevant projects with interdisciplinary participation
- Generative role in regional development: Attract and support external entrepreneurs. Introduction of minor in Entrepreneurship.
- Research experience for undergraduate students.
- Need based job-oriented additional certification courses should be provided in colleges and universities that would fulfill the skill- based educational needs of the society.
- Effective Usage of ICT in teaching learning activities and encouraging students and teachers to undergo online courses through MOOCs, SWAYAM etc.
- Unique R&D theme for each department with structural change from top-down to lateral
- Setting up of center for educational research and propagating best practices across departments
- Global benchmarking of the university with surveys from students, international faculty and advisory board
- Strong alumni network with participation of alumni in development of the institute

Conclusion

The system of Engineering education has become a formidable reservoir of technical expertise in terms of the magnitude of human resources and expertise available and of the physical facilities created over the last three decades. The present paper throws light on the current scenario of Engineering education in India. The bulk of it is of poor quality, producing graduates many of whom are unemployable. The main reason for this pathetic situation is rapid expansion of the education system without adequate number of qualified teachers, shortage or absence of infrastructure and lack of autonomy in all aspects of the technical education system. Other contributing factors are: poor linkage with industry, poor visibility in terms of publications, patents, new products and low or no international collaboration in teaching and research. A cautious review of these weaknesses will help in the improvement of quality of the programme, institute as well as the Engineering education system of India.

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