



# Developing Engineering Education Universities in India

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## Abstract

The Government of India established four Technical Teacher Training Institutes in 1964 in Bhopal, Chandigarh, Chennai, and Kolkata to develop technician education. These institutes offered both short-term and long-term faculty development programs, revised the curricula, and planned new diploma programs to meet the needs of fast-growing Indian industries. Further, they offered diverse global faculty development programs, executive development programs for government departments, master's degrees, and interdisciplinary doctoral degree programs in engineering education. This research is based on the case study/action research approach. Based on the recommendations of expert committees, the Ministry of HRD elevated these institutes to the National Institute of Technical Teacher Training and Research. After completion of 60 years, the Ministry of Education offered Deemed University. Based on the needs, a set of faculty members, departments, and new interdisciplinary global programs, offering consultancy programs for MNCs, IDAs, and industries are suggested. Shortcomings of action research and suggestions for further research have been indicated.

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## 1. Introduction

### 1.1. Growth of Higher Education Institutes in India

India is one of the fastest developing countries in the 21<sup>st</sup> century. After gaining independence from the British in 1947, the Indian national government focused on higher education in all branches of agriculture, arts, law, management, medicine, music, sports, science, engineering, forestry, technology, teacher training, veterinary science, etc. These universities are contributing huge human capital and knowledge capital. Teacher education institutes offer required trained teachers for school education.

### 1.2. Establishment of Technical Teacher Training Institutes (TTTI) in India

India globalized its economy in 1991. Technical teacher training started in 1964. Initially, India established four Technical Teacher Training Institutes in Bhopal, Chandigarh, Chennai, and Kolkata as regional training institutes. All four institutes were registered under the Society's Act of 1860 and they were governed by a Board of Governors. These four institutes have granted academic autonomy, financial autonomy, and administrative autonomy. An Academic Council was established to undertake needed academic decisions. The institute offered short-term courses to the faculty members of polytechnics to update the contents, curriculum design, instructional materials development, measurement and evaluation, instructional aids, industrial training, and educational leadership. These four institutes ensure well-developed curricula for technicians who are middle-level workforce in all industries. The technicians need up-to-date knowledge in engineering, technology, applied physical sciences, and applied mathematics.

### 1.3. Status of Engineering Education in Various Countries

Most countries offer master's degrees and doctoral degrees in engineering education through an engineering education department. There is no separate university that offers needed short-term and long-term programs. Their regular engineering departments offer needed consultancy services to industries. Their schools of education concentrate on arts and science-based education. Only a few universities have established a separate department in engineering education. Ohio State University, Utah State University, Colorado State University, University of Illinois- Urbana Champaign, Virginia State University, and Michigan State University have some well-established departments in engineering education. In the UK there are many well-established engineering schools in leading universities. According to Abel Guerra (2023) <sup>[1]</sup>, the future of universities is embracing technological advancements and evolving education. Arnon Bentur, et al. (2023) <sup>[2]</sup> focused on the challenges faced by engineering education. Chris Donegan (2016) <sup>[3]</sup> stated that the evolution of

university tech transfer could result in invention. Denton(2013)<sup>[4]</sup> concluded that engineering education for the 21<sup>st</sup> century should focus on challenges and opportunities. Tascott and Wiliams (2010)<sup>[4]</sup> stated that 21<sup>st</sup> Century university has to innovate. According to Duderstadt (2000) <sup>[5]</sup>, the 21<sup>st</sup> century university has to take up new roles. Grosjean (2000) <sup>[6]</sup> suggested to use the performance models in higher education. Hylton and Otoupal (2016)<sup>[7]</sup> compared the engineering education in the United States with that of the UK. Boland and Hazelkorn (2023) <sup>[8]</sup> concluded that technical universities are a milestone. Noris, et al.(2006) <sup>[9]</sup> suggested an outcome-based approach for developing undergraduate education.

#### 1.4. Status of Technical Teachers Training Institutes

India established four Technical Teachers Training Institutes in Bhopal, Chandigarh, Chennai, and Kolkata exclusively to develop polytechnic education. These four institutes offered faculty development programs and periodically revised the curriculum based on technological advances, and industrial needs. They also offered consultancy services to various organizations. These institutes started growing in developing needed faculty development programs for engineering college faculty members, and executive development programs for industries. Their performances and contributions are well received. Based on the recommendations of assessment committees, the Ministry of Education redesigned them as National Institutes of Technical Teachers Training and Research in 2004. Now based on the stakeholders' needs, the Ministry of Education has elevated them to Deemed Universities. The following departments of these institutes offered needed knowledge-based courses: Civil Engineering, Center for International Affairs, Computer Science, Community Development through Polytechnics, Curriculum Development Center, Education, Educational Technology, Educational Video Production, Library, Multimedia Learning Package Production Center, Electrical Engineering, Electronics Engineering, Physics, Chemistry, Mathematics, Workshop, and Extension Centers in various states. There is a need for a Technology Department to train the faculty members in Chemical Engineering, Ceramic Technology, Textile Technology, Leather Technology, Costume Design and Dress Making, Instrument Technology, Wood Technology, Mining Engineering, Automobile Technology, and Pharmacy.

#### 1.5. State-Specific Extension Centers of TTTI Chennai

This Chennai institute established State-Specific Extension Centers in Madurai for Tamil Nadu, Bangalore for Karnataka, Kalamessery for Kerala, and Hyderabad for Andhra Pradesh to serve the Polytechnics and Vocational Schools in these states. They conduct needed short-term courses, periodically revise the curricula of all courses, and develop instructional materials. They assisted the State Directorates of Technical Education of the southern states in establishing new polytechnics and introducing state-specific diploma courses. They further assisted the states in preparing detailed project reports for capacity development, quality improvements, and efficiency improvements. As such there is no such institute in any state in the southern region. They also assist the out-of-school students by offering short-term skill development courses through the community development scheme of the Ministry of Education. They often train vocational teachers in the southern region.

## 1.6. Long-term Programs of TTTI Chennai

They offered long-term courses like Diploma in Technical Teaching, (DIP. T.T.), Dip. Science as Correspondence Course for Science Teachers, B. Tech. Ed. for engineering degree holders, and M. Tech. Ed, to update the educational knowledge. Later they planned a master's degree program in Human Resource Development [(M. Tech (HRD)] and Ph.D., (interdisciplinary doctoral research). TTTI Chennai established four extension centers in all four southern states. Since these institutes are not empowered to offer degree programs they are affiliated to the University of Madras. Recently, many new postgraduate programs and Ph.D. in engineering programs were affiliated with Anna University, Chennai.

## 1.7. TTTI Faculty Development Programs under the International Development Agencies

The faculty of TTTI have been trained under the British Commonwealth Program, UNESCO's Asia Pacific Center for Educational Innovation for Development, Bangkok, Thailand, and overseas programs under the bilateral agreement with the government. This institute has become an Associate Institute of APEID, Colombo Plan Staff College for Technician Education, Singapore, and UNESCO's APEID program.

## 1.8. Training Programs for Service Personnel

The faculty of this institute offered short-term training courses to the armed forces, Navy, and Airforce Staff Training Colleges in India. After the globalization of the Indian economy, many engineering departments modernized their services and they underwent executive development courses at TTTI Madars. In 1994, the World Bank assisted the polytechnics in capacity development, quality improvement, and efficiency improvement. The faculty of this institute assisted the polytechnics in capacity development, quality improvement, and efficiency improvement.

## 1.9. Development Programs for Technical Institutes in Nepal and Bhutan

Further, the faculty of this institute undertook executive development courses for the cement industry under the World Bank-DANIDA-CMA project. They trained the part-time trainers and assisted in establishing four Regional Training Institutes (RTIs) for training the employees of various cement companies in each region. This institute developed training modules for training the employees through the RTCs. The faculty bid for consultancy projects under the Asian Development Bank-assisted project for Nepal No. ADB NEP 974 to train the faculty members of vocational higher secondary schools of the Council for Technical Education and Vocational Training (CTEVT) and UNDP-assisted project for Bhutan for preparing faculty development of the Royal Technical Institute and Bhutan Polytechnic.

## 1.10. Diverse Global Faculty Development Programs under the Government of India

In 1977, TTTI Chennai was nominated as an Associated Center of UNESCO's Asian Center for Educational Innovation for Development and the faculty of this institute conducted technical working group meetings in various branches of engineering in Seoul, Australia, and Malaysia. Based on the needs this institute offered a Peripatetic Seminar on Teacher

Education to the heads of Asian vocational schools. Further, UNESCO- sponsored many development programs at TTTI Chennai for faculty members of Asian technical schools. This institute offered diverse global faculty development medium-term and short-term courses under Special Commonwealth African Assistance Programs (SCAAP) and Indian Technical Education Cooperation (ITEC) of the Ministry of External Affairs, and the Technical Cooperation Scheme of the Ministry of Finance of the Government of India. A faculty development program for the vocational teachers of Vin Phue Paper Mill's Vocational School, Viet Nam in 1984. This program was sponsored by SCAN Management of Sweden. An office manager's program for the staff of Balaju Technical School, Kathmandu, Nepal was organized in 1994 and it was sponsored by the Swedish International Development Agency (SIDA). Around 3000 faculty members from about 150 countries have undergone these programs. Initially, the diverse global participants have been coached to analyze a problem in technical education and solve it as a part of 16-week courses. More than 15 different programs have been offered. Later senior faculty members were exposed to human resources management, developing outcome-based engineering curricula, water management, updating computer skills, women development through technical education, and library management.

#### 1.11. TTTIs were Upgraded into the National Institutes of Technical Teachers Training and Research in 2004

TTTI Chennai has become a partner in the National Development Group of the Ministry of Human Resource Development of the Government of India. Based on the suggestions of the high-power committee headed by Dr. Bhattacharya and Dr. Indiresan, the Ministry of Human Resource Development upgraded all four institutes as National Institutes of Technical Teachers Training and Research. Since these institutes were not permitted to award degrees, postgraduate degrees, and doctorates in technical education, they had to be affiliated with the University of Madras. Even though an interdisciplinary doctoral program was approved by this university, the part-time candidates were not approved who were from far away from the approved jurisdiction of the university. Later all the engineering programs were to be affiliated with Anna University, Chennai the M. Tech. (HRD) and Ph.D. programs could not be affiliated with Anna University, Chennai. Since there is no Engineering Education Department at Anna University, the postgraduate courses in engineering education could not be affiliated with this university.

#### 1.12. Significant Achievements of Well-Accomplished Faculty Teams of NITTTR Chennai

- Establishing graduate, postgraduate, and interdisciplinary programs
- Establishing extension centers in all southern states
- Assisting the state governments to plan and implement new diploma programs like Wood Technology, Paper and Pulp Technology, Footwear Design, Architectural Engineering
- Revising all existing curricula periodically based on the advances and industrial needs
- Assisting states in preparing capacity development, quality improvement, and efficiency improvement and implementing them under the World Bank-assisted project
- Assisting the states in training their faculty members through the extension centers

- Offering executive development programs to various private organizations, government departments, Air Force, Navy, and Army training units
- Establishing diverse global faculty development programs under the Government of India
- Assisting Academic Staff Staff Colleges in planning and implementing faculty development programs
- Developing textbooks, drawing manuals, laboratory manuals, and item banks
- Publishing them through reputed publishers
- Developing educational video programs and televising them through government television channels for the benefit of students, faculty members, and engineering departments
- Assisting all four southern states in preparing Capacity Development, Quality Improvement, and Efficiency Improvement under the World Bank Assisted Projects Tech Ed I and II.
- Revising all existing curricula and planning new curricula
- Upgrading the competencies and skills of the faculty members
- Undertaking the Tracer studies for the southern region
- Offered Faculty development program for the engineering colleges under the World Bank-assisted Project, viz Technical Education Quality Improvement (TEQIP-I)
- Assisting all engineering colleges under the World Bank-assisted project” TEQIP-I” to conduct tracer studies
- Assisting the Indian Council for Forestry Research and Education (ICFRE) in Dehra Dune in preparing the M.Sc. (Forestry) program, faculty development programs, and the process of accrediting the M.Sc. (Forestry ) Programs with ICFRE.
- Assisting UNESCO’s Asian Center for Educational Innovation for Development in planning various faculty development programs in innovations
- Preparing diverse global faculty development programs under the Government of India’s funding bilateral schemes covering around 150 countries and 3500 participants
- Assisting Nepal in training the instructors of the Council of Technical Education and Vocational Training under the Asian Development Bank Assisted Program
- Completed all sponsored research programs under the World Bank
- Assisted the North Eastern States (Meghalaya, Mizoram, Tripura, Sikkim, and Andaman Nicobar Islands), in faculty development, Tracer Studies, and Impact Studies
- Assisted the Ambedkar Institute of Technology and the Second Polytechnic in Port Blair in faculty development, establishing continuing education, revising all diploma programs, modernizing the laboratories, internal revenue generation, and foreign training of the faculty members.
- Conducted in-house faculty development courses for engineering colleges, deemed universities, and the state technical universities in the southern region

### 1.13. Global Recognition for the Faculty Members of NITTTR Chennai

- One faculty was offered a Fulbright Senior Research Fellowship in Media by the USA



- One faculty member completed his M.S. (Instructional Systems Technology) at the School of Education, Indiana University, Bloomington, USA
- Three faculty members completed an M.S. in Education at the College of Education, University of Illinois, Urbana-Champaign, Illinois State USA.
- Three faculty members served as faculty consultants at the Colombo Plan Staff College in Technician Education, Singapore, and Manila, Philippines.
- Offered keynote address to the participants of the International Conference on Felicitology conducted by the Far Eastern University for Humanities, Khabarovsk, Russian Federation in 2012
- Offered a model in Radical Innovations in Engineering Faculty Development to the participants of the American Universities in Washington DC, USA. The program was conducted by the Organization of American States (OAS).
- Conducted courses on the globalization of engineering education to the senior students of Purdue University, West Lafayette, Indiana State, USA, in 2013.
- Conducted a seminar on the Globalization of Engineering Education at Purdue University in 2009.
- Offered a lecture on Comparative Education at the State University of New York in Albany in 2011.
- Conducted two international conferences on the Globalization of Engineering Education in 2009, and the Global Networking of Engineering Institutions in 2011.
- Well-accomplished faculty members offered many invited lectures by various engineering colleges and Deemed Universities in India.
- A textbook on Quality Control was translated into Portuguese and published by McGraw Hill Publishers in Sao Polo for Brazil.
- Around 100 Ph.D. theses in interdisciplinary engineering education have been approved by the University of Madras.
- Around 1000 reputed professors in the USA, UK, and other leading countries have evaluated and adjudicated these theses.
- Around 2000 research articles in engineering education have been published by the faculty members of this institute in many national, and international conferences and journals.
- Many faculty members have been invited to review the articles by a large number of national and international journals of repute.
- Many faculty members have received best paper awards for their publications at various international conferences.
- A few of the outstanding faculty members have received Fellowships from various global organizations
- Many outstanding faculty members generated millions of rupees through consultancy projects under various International Development Agencies like the Asian Development Bank, UNESCO, UNDP, USAID, SIDA, DANIDA, and GTZ.
- This institute has developed an excellent reputation in South Asia for its diverse global faculty development, offering consultancy programs to various government departments, industries, and International Development Agencies.
- Outstanding faculty members are serving leading global journals as peer reviewers
- A few faculty members have been invited to join professional associations in education like Pi Lamda Theta, USA.
- The institute has created an active link with Huddersfield University, UK.

## 2. Statement of the Problem

“Suggest needed engineering education departments, faculty members, and needed programs in engineering education at the Deemed University ( National Institute of Technical Teachers Training and Research, Chennai) to become an outstanding Deemed University in Engineering Education” based on the assessment of the needs of the stakeholders in India and as well as diverse global faculty members.

### 2.1. Research Objectives

- Assess the needs of stakeholders in engineering education
- Suggest needed departments, centers, and schools for developing graduate, interdisciplinary postgraduate, and doctoral programs
- Identify the initiatives to be taken to network with other global schools of engineering education
- Develop faculty teams to offer consultancy services to industry, universities, international development agencies, and overseas institutions
- Establish digital media programs for developing various human resource development courses and offer massive open online programs.
- Undertake advanced and interdisciplinary research programs to meet the challenges of vulnerability, uncertainty, complexity, and ambiguity (VUCA).

### 2.3. Needed Faculty Members

The Deemed University needs faculty members (Professors and Associate Professors) in the following Centers/Departments:

**Table 1.** Tentative Number of Faculty Members



Engineering Department	No. of Faculty.	Education Related Depart.	No. of Faculty	Performance Related Dept.	No. of Faculty	Production Related Department.	No. of Faculty
Electrical Eng.	5	Engineering Edn & Research	4	Curriculum Development	4	Educational Technology	2
Electronics	5	Applied Science, Material Science	4	Human resources needs, Economics	2	Video Production	2
Mechanical	5	Applied Maths & Statistics	4	Extension Centers	8	Working Model Production/ Workshop	1
Civil, Environment, Urban Planning	6	Communication	2	Educational Management, Inst. Dev.	3	CRD & Entrepreneurship	2
Technology (Chemical, Textile, Ceramic, Leather, Mining, Pharmacy, Costume Design-Interdisciplinary)	4	Computer Science & MMLP	6	Center for International Programs	3	Global Consultancy, Sponsored Research, HRD/HRM	3
Emeritus Prof.	1	Emeritus Prof.	1	Emeritus Prof	1	Emeritus Prof.	1
Adjunct Prof.#	2	Adj. Prof.#	1	Adj. Prof.#	1	Adjunct Prof.#	2
<b>Subtotal</b>	<b>28</b>	<b>Subtotal</b>	<b>22</b>	<b>Subtotal</b>	<b>22</b>	<b>Subtotal</b>	<b>13</b>

Note: "#": Project Specific

Additional departments can be established based on the emerging needs to meet the demands of fast-growing industrialization.

#### 2.4. Desired Contributions to Engineering Education (Sample Areas)

- Developing New Interdisciplinary Graduate and Postgraduate Programs Based on the Advancements in Engineering and Technology and Industrial Needs
- Offering Diverse Global Faculty Development Programs under Various Funding Agencies
- Bidding, Negotiating, and Undertaking Global Consultancy Projects under IDAs and MNCs
- Undertaking Sponsored Research and Development Programs for Asian and African Countries
- Planning and Conducting National and International Seminars and Conferences
- Publication of Textbooks, Design and Drawing Manuals, Laboratory Manuals, Item Banks, Case Studies, Video Programs, and MMLPs.
- Publishing an International Journal in Engineering Education
- Planning and Conducting Diverse Global Faculty Development Programs in Various Foreign Countries under IDAs, Bilateral and Trilateral Agreements of the Government of India
- Offering Internships for Diverse Global Faculty Members
- Sponsoring Faculty Members to Various Global Universities as Visiting Faculty Members
- Creating Centers of Excellence in Engineering Education
- Globalizing Engineering Education

- Development of Leadership with Equity, Integrity, Ethics, Humility, and Outstanding Culture
- Creating an Inspiring Culture of Appreciation for High-Performing Faculty Members
- Developing a Winning Culture in Autonomous Engineering Institutions
- Developing Strategies for Planning the Radical Development of Engineering Education
- Empowering Communities Through Engineering Education
- Faculty Equity Issues and Challenges: Analysis of Problems and Obstacles
- Faculty Engagement and Performance Improvement in Engineering Graduates
- In-house Leadership Development Programs for High Potential and High Performing Engineering Faculty members
- Dynamic Process for Enhancing Engineering Faculty Competence
- Performance Audit and Improvement of Engineering Institutions for Sustainability of Human Capital Development
- The Process of Bringing Excellence in Engineering Education by Nurturing and Engaging High-Performing Faculty Teams
- Developing and Supporting High-Performing Faculty in Engineering Institutions
- Creating a Happy Educational Environment in Engineering Institutions to Sustain Outstanding Performance by Well-Accomplished Faculty Teams and Scaffolding them from Recruitment to Retirement
- Creating a Sustainable and Outstanding Institutional Culture in Engineering Institutions to Develop High-Performing Faculty Teams
- Creating Effective and Efficient Ways of Developing Corporate Executives
- Generating Smart Goals for Engineering Institutions
- Identifying Methods to Facilitate Industry-Institute Cooperation and Collaboration
- Planning a Multidisciplinary Human Resource Development Institute under Public-Private Partnerships
- Facilitating Global Leadership Competencies of Tenured Faculty Members to Offer International Engineering Programs
- Creating a Flexible Curriculum with a Dual Program
- Creating Performance Models in Engineering Education
- Comparative Studies in Engineering Education
- Evolution of University Tech Transfer for the 21<sup>st</sup> Century
- Research on Engineering Institutions to Strengthen Regional Economics
- New Roles for the 21<sup>st</sup>-Century Engineering Education University
- Innovating the 21st-Century Engineering University: Student-Focused and Self-Paced Collaborative Learning
- Advances in Accreditation Processes

## 2.5. Selected Ongoing Innovative Programs in Global Universities

- Princeton University's Keller Center for Innovation in Engineering Education <sup>[10]</sup>
- Marquette University's focus on inclusivity, innovation, and collaboration to revolutionize the engineers of the future <sup>[11]</sup>
- Stanford University's global engineering program <sup>[12]</sup>
- Princeton University's metropolis project to create a future ecosystem of sustainability <sup>[10]</sup>

- Carnegie Melon's program to develop engineers for the global workforce through the Carnegie Bosch Institute (CBI) <sup>[12]</sup>
- Drexel University's internships and cooperative programs in Germany <sup>[13]</sup>
- Cornell University's Diversity Programs in Engineering (DPE) <sup>[12]</sup>
- The University of Texas at Austin's Innovationworks <sup>[12]</sup>
- Massachusetts Institute of Technology's Microsystems Technology Lab <sup>[12]</sup>
- Case Western Reserve University's Global Network, Exchange Programs, and Corporate and Industry Partnerships <sup>[12]</sup>
- Georgia Tech's Strategy: AI Manufacturing <sup>[12]</sup>

### 3. Focused Areas in Engineering Education (A Sample)

- Integration of Research and Teaching
- Nation-wide Cooperation
- Assessment of the Impact of Deemed University
- Strategic Plan
- Interdisciplinary programs and micro-credentials
- Reshaping the graduate education of engineering and technologists
- Rewards for excellence in engineering education
- Grant opportunities for academic liaisons with Industry
- Human-centered design and entrepreneurial experience
- Project-based learning
- Statistical quality control and quality management
- Social innovation
- Learning organization
- Innovative alternatives to traditional classroom lectures
- Teamwork, experiential learning, project-based learning, innovative and entrepreneurial thinking
- Capstone projects
- Collaborative knowledge production
- Linking Deemed University with Regional Industry Clusters
- Digital engineering and its assimilation into engineering education
- Lifelong learning
- From frontal teaching to remote learning to active online education
- University-Industry Relations-Evidenced Based Insights
- Self-directed Learning
- Education of engineers In the 21<sup>st</sup> Century: Paradigms, insights, and implications
- Student work in real engineering problems

- Role of design and innovation
- Entrepreneurship, creativity, and innovation
- Sustainability, Health, and Vulnerability
- Managing Vulnerability, Uncertainty, Complexity, and Ambiguity (VUCA)
- Minimizing the Gap between the Industry and the Academy
- Creating Research Clusters
- Creating Linkages between the University and Global Organizations in Engineering Education

### 3.1. Key Result Areas of Deemed University's Contribution

- Outstanding Models in Interdisciplinary Graduate and Postgraduate Programs
- Generating Income through Royalties on Publications, Services Rendered to External Organizations, and Licensing Intellectual Properties
- Developing Sustainable Models to Create Human and Knowledge Capital
- Outstanding Faculty Development Programs
- Effective and Efficient Diverse Faculty Development Programs
- Global Networking with Outstanding Universities
- Creating Outstanding Graduates
- Creating Outstanding Faculty Members
- Collaboration with the International Federation of Engineering Education (IFEE) and Global Engineering Deans Council (GEDC)
- Institutional Membership with the Indian Society for Training and Development (ISTD)
- Institutional Membership with the Indian Society for Technical Education (ISTE)

### 3.2. Internal Revenue Generation

- Grants in aid from the Ministry of Education
- Consultancy fees from industries
- Royalty on books, video programs, MMLP
- Tuition fees from the students
- Fees for offering diverse global faculty development programs from sponsoring departments, IDAs
- Fees from undertaking sponsored research projects

### 3.3. Globalization of Engineering Education

- The University has to focus on the globalization of Engineering Education/ Technology Education
- Conduct research studies on the innovations in engineering education and meet the current needs of industries
- Create links with EU Universities, UK Universities, and US Universities

- Continue to be an Associate Center of Colombo Plan Staff College for Human Resource Development, Manila, the Philippines, and UNESCO's ACEID, Bangkok, Thailand
- Create a consortium of Global Engineering Faculty Development Institutes

### 3.4. Synthesis

Based on the 60-year performance NITTTTRs have been recognized by various national and international organizations for planning and offering needed engineering programs, and consultancy services. These institutes can offer many advanced programs in human resource development, interdisciplinary doctoral programs, diverse global faculty development programs, and supply needed instructional packages. These institutes can contribute to the regional competition due to flawless academic autonomy.

### 3.5. Discussion

Every independent country needs dedicated technical teachers' training institutes that can offer needed faculty development programs, plan appropriate cutting-edge curricula, and modern instructional packages, and create needed human resources to enable the country to become economically competitive. So far no industry suffered for want of technicians. Significant technicians have contributed to the success of new industries in the Middle East. Most of the doctorates were absorbed as principals of engineering colleges. These institutes can plan more advanced programs not only for India but also for Asia, Africa, Eastern Europe, Oceania, and Central and South America.

## 4. Conclusion

NITTTTRs are innovative faculty development institutes and their 60-year performance has been rewarded so that they can innovate in their contribution to human and knowledge resources. They can become a set of global institutes in human capital and knowledge development to meet the demands of industries. They already demonstrated their contribution to diverse global faculty.

### 4.1. Shortcomings in This Research Study

This research study was based on action research principles. The problems faced by them were not considered in this action research. However, their outstanding contributions were considered.

### 4.2. Suggestion for Further Studies

Further studies can be undertaken rigorously by systematically getting feedback from stakeholders and unmet beneficiaries. Such a study will provide more guidelines for expansion.

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