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ORIGINAL ARTICLE

Facilitating outstanding engineering faculty members through training from recruitment to retirement

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ABSTRACT

Most of the higher engineering education institutions don't focus on continuous training of their faculty members from recruitment to retirement (R to R). Because of this, the quality of performance of untrained faculty members gradually reduces and this impacts the attributes of their graduates, sporadic contribution to knowledge capital, and poor return on the investments (ROI) in engineering education. There is a need for an integrated and dynamic model for the training and development of engineering faculty members. The objectives of this research are to assess the literature on faculty development; to identify the total needs of the engineering faculty members from recruitment to retirement (R to R); to suggest effective and efficient methods of planned faculty development; and to validate the suggested process of development through a set of engineering institutions. The action research method has been adopted to assess the global literature, and consult multinational companies, local engineering companies, and alumni on their needs. It is found that 'Faculty Development Courses' are required for all engineering faculty members from entry to exit to facilitate meritocracy. A critical review of the literature revealed that most of the researchers have focused their research on entry-level faculty members or some middle-level faculty members. Only a few institutes focused on the senior members. Hence, this study focused on lifelong faculty development courses from entry-level to exit level. The training needs assessment was based on the feedback from 396 entry-level faculty members who were purposefully included in this research. The outcomes are presented in seven parts: (1) Entry-level faculty development programs (FDPs), (2) Getting recognized, (3) Middle-level FDPs, (4) Student personnel administration, (5) Senior-level FDPs, (6) Advanced-level FDPs, and (7) Radical innovations. This research provides a 360-degree assessment and creates a guide both for the educational administrators and faculty members to reach excellence. Learning is a lifelong process. The suggestions were validated through a set five of institutions. and they started implementing them. The continuous process of faculty development from recruitment to retirement has been appreciated but it may take several years to institutionalize it. Limitations of this study are a smaller number of faculty members (396) and suggestions for future research have also been indicated. This gave a promising cost-effective faculty development process at every stage of faculty growth and resulted in outstanding institutes with high-performing faculty members. Further, these faculty members contributed to human and knowledge capital.

Key words: faculty development, getting recognized, student personnel administration, senior-level faculty development

INTRODUCTION

To improve the attributes of engineering graduates, a system approach is followed in developing curriculum but the outcome was limited due to poor faculty performance in planning outcome-based curriculum, planning participative instructional design and delivery, absence of industrial exposures, and undertaking

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industry-sponsored research projects. All these demand strategically planned curricula and well-trained faculty teams. Faculty development is a continuing effort to transform engineering education at any institution. Collaborations often strengthen faculty development initiatives. Gaikwad[1] stated that faculty development is about planned change throughout one's academic career. Just as learning represents changed behavior, faculty development reflects a conscious effort to recognize the skills necessary to succeed in analysis-design-prototype development- improvement- mass production- and maintenance. Further, it leads to innovation.[2–6] Faculty development is a planned process of providing professional growth-oriented scaffolding, counseling, coaching, and mentoring to engineering faculty members to assist them in reaching excellence in teaching, research, and professional services. It is well organized, goal-directed process to achieve career progression and growth. Most faculty development initiatives center around reactive solutions without creating needed links to combat various problems. Hence, there is a need for an integrated model of training and development of engineering faculty members.

Most of the well-accomplished graduates wanted to take up research, development, and teaching professions. Since many developing nations are growing by leaps and bounds, engineering institutions have to employ them and offer the needed environment to grow further. Their contributions will enhance the growth of graduates, Their continuous contribution will improve the regional competitiveness of the country. Outstanding faculty members are fully qualified, produced excellent dissertations, and interdisciplinary Ph. D. theses, published a significant number of research papers in international conferences and journals, planned well-designed textbooks, and prepared design and drawing manuals. When they are selected for teaching professions, they need to be developed and scaffolded to reach excellence. They need a set of faculty development courses at the entry level to develop skills in planning and implementing programs for students to meet the industrial demands. At the second level, they need courses to strengthen their decision-making skills in engineering education. At the third level, they need more management skills to offer many development courses to the executives of state-level companies. At the fourth level, these faculty members need to be trained in advanced courses to reach the chief executive officers of the educational institutions. Faculty development for engineering faculty members in India is offered by the All-India Council for Technical Education (AICTE) through AICTE Training and Learning (ATAL)[2] Academy, Indian Society of Technical Education, National Institute of Technical Teachers Training and Research in Bhopal, Chandigarh, Chennai, and Kolkata,[7] Academic Staff Colleges (ASC) of various universities, In-house Faculty Development Departments of various Engineering Colleges, Indian Institute of Technology in various cities, National Institute of Technology (NIT) in various states, various organizations like Indo-Universal Collaboration in Engineering Education, World Bank assisted projects in Technical Education Quality Improvements (Tech QIP), foreign countries under bilateral agreements, Fulbright Scheme of the USA, and DAD scheme of Germany. In addition, many international organizations offer massive open online courses in collaboration with leading universities. Now many institutions and universities offer faculty development courses through Pandit Madan Mohan Malaviya Initiative in Teaching and Learning.

LITERATURE SURVEY

Under PUBLIC LAW- 480, during 1965 the American government provided funds to organize summer schools and winter schools to train the faculty members of engineering colleges and polytechnics. Later Indian Society for Training and Development (ISTE) got funds to organize these courses. AICTE has offered funds to develop engineering faculty members. Indian Institutes of Technology (IITs) also offer many faculty development courses. Four National Institutes of Technical Teachers Training Training and Research [7] offered short-term courses, M. Tech. (HRD),[7] interdisciplinary postgraduate programs in engineering education. Many state universities are also offering faculty development courses. IITs offer Ph. D. programs under the Quality Development Program (QIP) for engineering college faculty members. Based on the National Education Policy 2020 (NEP2020)[8] many universities are offering online faculty development courses. Force School of Management offers courses in higher education and policy directions as identified in NEP-2020,[8] induction of multi-disciplinary programs, online and digital education, process of supportive and student-centric learning environment, capacity building, and multidisciplinary research. Jadavpur University, Kolkata developed a strategic plan for the engineering faculty. The focus areas are the modernization of classrooms and laboratories; adopting pedagogical means comparable to the digitally sensitized mindset of students; thrust on learning through hands-on training and experiment; creation of diverse knowledge centers above the critical core size of faculty members; and promotion of innovation and entrepreneurial spirit. Medical Council of India (MCI)[9] initiated a National FDP in 2009 covering all medical colleges in India. MCI has established 12 Regional Centers and 10 Advanced Centers. Imperial College, London[9] offers continuing professional development through modules and short-

term courses. Velayudham *et al.*[10] has centered his research on the challenges faced by faculty members that can be solved by faculty training programs. Ramachandra College of Engineering planned FDPs for outcome-based education. NIT, Warangal offers FDPs through its Center for Continuing Education. The Teaching Learning Center (TLC) of the Indian Institute of Technology, Madras [11] has been collaborating with the Institute of Engineering Education and Innovation (IEEI) at Texas A&M University, USA, since 2009. TLC also collaborates with WIPRO Technologies. The success of several FDPs demonstrated a need to foster dedicated effort to cater to the challenge of retaining the learning abilities of the information-intensive generation.

Phelps[12] suggested the following five fundamentals for designing and delivering effective faculty development: (1) Begin with a clear vision, (2) Maintain the right perspective, (3) Network, (4) Be responsive and take the initiative, and (5) Exhibit integrity. Gaikwad[13] stated that faculty development is a critical element of institutional effectiveness in engineering education. According to her, a faculty who gets involved in continuous professional development earns benefits in terms of vitality, informed andragogy, skills in developing outcome-oriented curricula, teaching innovations, teaching, and learner participation. Further, faculty development effectively contributes to the efficient use of emerging technologies and establishes a solid foundation for the overall development of human and knowledge capital. Well-trained faculty develops outcome-based curricula, with ethics, plans effective instructional design, prepares interdisciplinary postgraduate programs, and offers industry-specific services.

Brent *et al.*[14] suggested to use of a faculty development model viz, SUCCEED Coalition. This consists of a faculty development coordinator, linkages to campus-wide faculty development, learning and networking opportunities, and programs for new faculty. Further, the following workshops are to be conducted: teaching effectiveness workshops, student success workshops, effective teaching with technology, and teaching leader networks.

Critical review of the literature

No researcher considered the total needs of the faculty from recruitment and retirement. No one focused on the need for an integrated model of training and development of engineering faculty members. There is no mention of counseling, coaching, and mentoring of the newly recruited faculty members. As they grow in their cadres, new faculty members have to be equipped with higher-order cognitive abilities, motor skills, and the right attitudes. There is no mention of developing an outcome-based curriculum. None of the researchers focused on the needs of middle-level faculty members and senior faculty members. Unless lifelong training is planned, it will be very difficult to develop outstanding faculty members who will develop interdisciplinary postgraduate and doctoral programs, bidding for research and development programs under various transnational companies (TNC) and international development agencies (IDAs). The newly joined faculty members should get the full picture of total growth and reach the status of a global leader. This research work considers total development from recruitment and retirement (R to R). This approach will intrinsically motivate the faculty members and they can create human capital and knowledge capital. It is hoped that many initiatives will arise to consider the whole development process by the institutional administrators.

RESEARCH OBJECTIVES

The following research objectives have been chosen for this research: (1) Assess the literature on faculty development; (2) Identify the total needs of the engineering faculty members from recruitment to retirement (R to R); (3) Suggest effective and efficient methods of planned faculty development; (4) Validate the suggested process of development through a set of engineering institutions.

Population

Newly recruited faculty members who had excellent portfolios and expressed their plan to excel in various areas of professional development and are ready to contribute to both knowledge and human capital have been purposely selected. This research considers the population of young, healthy, and achievement-oriented faculty members. It is assumed that all the recruits were selected based on an in-depth assessment of their abilities and attitudes to reach excellence in teaching, research, publication, consultancy services to the industry, offer diverse global FDPs. These faculty members are employed in state engineering colleges, private engineering colleges, deemed to be universities and state technical universities.

Sample

Three hundred and ninety-six fresh faculty members were purposely selected who enrolled for various in-service FDPs that are offered by various professional faculty development institutes, ASC, Human Resource Development Institutes (HRDI) of the University Grants Commission (UGC), short-term courses offered by the Indian Society for Technical Education (ISTE) and the AICTE over five years. Every year four batches were trained and 25 participants were there. Both men and women were included. All of them are below 28 years old.

Research methodology

In every course, the overall objectives of the FDPs, number of courses, duration of each course, range of development activities, and industrial visits are presented to the Faculty Development Directors of four Southern States of India, Expert Committees of Amitabha Bhattacharya, and P. V. Indiresan Committee. Further, every year the FDPs and the feedback were presented to the Joint Review Committee of the World Bank. Their suggestions were integrated and an attempt has been made to offer desired courses to the faculty members from recruitment to retirement. The follow-up assignments and a desired list of courses were collected from the participants of the last five years. Based on their rating and suggestions a few courses were deleted and a few more were added to the next year. This enabled us to develop lifelong education and training courses. Most of the courses were offered to faculty members of various types of engineering colleges. Based on their feedback, a few programs have been included here. The most important factor for success comes from achievement motivation followed by continuous improvement of the faculty members. Tracer studies on the alumni of various colleges helped to add needed courses, industrial training, and interdisciplinary research programs.

PART-I ENTRY-LEVEL FACULTY DEVELOPMENT COURSES

These courses are to be offered in the first five years. If the faculty members have undergone a similar set of these courses, they can be given the option to choose the desired courses.

Faculty development [11,12,15,16]

Faculty development has to be planned and offered to the newly recruited faculty members as soon as they join the institutes. It is desirable to establish an in-house faculty development center (IHFDC). If there is a need, the institute can employ adjunct faculty members or visiting faculty members. Further, the institute sufficient books on faculty development could be added to the library**.** Many state technical universities and private technical universities have established IHFDC. Many liberal arts universities have also established ASCs or Human Resource Development Centers (HRDC).

Process of scaffolded development of the faculty members [13,17-19]

Almost all the fresh recruits are excellent in their technical areas but they are novices in the art of transformation of cognitive skills to students. Hence, they have to be scaffolded to reach their excellence**.** This is a long-term process but can be achieved over some time. The leaders have to make strategic planning, with a vision and mission to achieve.

Guidance

The newly appointed faculty need appropriate guidance through a planned program of orientation and development. The institute can display various handbooks, textbooks, modules, video programs, case studies, and monographs in engineering education. The achievements made by the institute can also be displayed. The outstanding performance achieved by the alumni can also be included. A Handbook on teacher guidance which includes rules, regulations, and the process to be followed in all related activities is to be included. Many changes are introduced that are to be clarified through guidance.

Counseling

Counseling is the first step for clarifying the rules, norms, process, and development of a fresh faculty member. A senior faculty or the head of the department (chairperson) can counsel the faculty members. It centers around the courses that he/she can enroll in, laboratory classes that he/she can handle, *etc.* The day-to-day doubts can be clarified easily.

Coaching

There is a need for coaching when the newly recruited faculty members start their curriculum design, instructional materials development, preparation of question papers, designing industrial training, or planning a continuing education program. Senior faculty members can coach the fresh appointees. Fresh faculty members need coaching when they prepare technical and financial proposals for bidding.

Mentoring

This is very important for the growth of fresh faculty members. Mentors are experienced senior faculty members who have achieved many successes in various academic activities. They can help faculty with immediate needs, helping them solve pressing problems, getting needed information, or learning a skill quickly. Mentors can provide long-term support and guidance. Normally the head can select a mentor for the faculty member. Mentors should be ready to offer significant suggestions, processes, and modes of implementing the solution. Without mentoring many faculty members will waste their valuable time and resources.

Outcome-based curriculum design process [20-26]

The fresh faculty needs to learn about planning outcome-based curriculum design process. The attributes of fresh graduates are to be identified. They may take from the job description or job specification. One can consult an industry that may employ the

graduates. The tasks to be performed, tools to be used, analyses to be followed, designs to be completed, prototypes that are to be assembled and tested, improved, mass production to be chosen, and marketing to be implemented are part and parcel of a variety of outcomes. Based on the planned outcomes, the Program's Educational Objective (PEO) is to be identified. The faculty has to develop needed course objectives, instructional materials, and instructional design.

Assessment of employers' needs [10,23-25,27]

There are different types of employers like government, Micro Small Medium Enterprises (MSMEs), large-scale industries, multinational companies, *etc.* Most employers specify the entry-level skills and attitudes of the newly recruited employees. Hence, the curriculum should meet their needs. Most of the campus-based recruiters specify the range of skills that they expect in the graduates. If the existing courses do not offer all the needed cognitive skills, the faculty can plan finishing courses in consultation with the employers.

Planning flexible courses

There can be many electives to meet the professional needs of the graduates. The faculty members/advisors should indicate the utility of the electives. Some graduates may plan internships in desired companies. The faculty/adviser could arrange appropriate internships.

Massive online open courses (MOOCs)

MOOCs are planned by various universities. The faculty can undertake suitable courses to meet their career goals. They need guidance and reimbursement of fees that they paid for MOOCs. Moocs will help them to plan modern courses for their students.

Curriculum evaluation process there are many models in the curriculum evaluation process. The Context, Input, Process, and Product (CIPP) model is almost near the needs of engineering programs. here, the product, viz, graduates have to meet the job specifications of employers. analysis, design, prototype development, and testing of products demand very high cognitive skills, advancements in material science, and computer-based analytical methods.

Traditional evaluation models

Draft curriculum has to be approved by the Board of Studies and the updated curriculum has to be approved by the Academic Council of the University. The members will evaluate the curriculum against the present context of technology, industry practices, needed inputs like advanced materials, laboratory testing, and user needs. Manufacturing needs in-depth expertise in manufacturing methods, safe work practices, quality maintenance, and productivity. Marketing demands an in-depth knowledge of the needs of the buyers, management principles, and maintenance. Hence, the courses offered should enable the achievement of the graduates. Hence, the fresh faculty members are to be trained in these methods. The faculty members have to be trained in these methods.

Tracer studies [28]

Tracer studies will provide needed authentic feedback on the whole curriculum undergone by the alumni. They can point out the strengths and weaknesses of the curriculum, courses to be deleted and additional industry-relevant advanced courses to be added, industrial training to be undergone by the graduates, and projects from the industry. Hence, the faculty members need to be exposed to develop questionnaires, administer them, analyze the feedback, and plan to implement better courses and delete the obsolete courses. Feedback from employers has to be obtained as a part of tracer studies. Their views are very important in revising the curricula and practical training.

Instructional material development [27]

The fresh faculty members need to prepare curriculum-specific instructional materials, edit them, and publish them so that the well-prepared materials will be available to the students. The art preparing textbooks, design and drawing manuals, laboratory manuals, and workshop manuals are needed for getting cognitive skills by the students. Conduct an in-house workshop to develop instructional materials. This will eliminate the habit of dictation in the class. When the print materials are published through a reputed publisher, they will be readily available to students in all cities. The faculty can revise these based on the advancements of content matter. Assist the faculty in the evaluation and editing of the instructional materials. Suggest appropriate royalty for books. Introduce appropriate software to correct grammar mistakes and improve the language. Encourage to protection of the publication through copyright. Never encourage plagiarism. Suggest uploading the materials to their preferred websites like Research Gate Net, Academia Edu, or www.issuu.com. Suggest to get copyright for all the publications. It is suggested to establish a publication center in the institute to bring dynamic initiatives in publication.

Instructional design and delivery

The newly joined faculty members need thorough exposure to the advancement in instructional design and delivering them in the classes. They have to plan for the class interaction for the whole semester so the students will be prepared. The art of delivering, creating participation, and use of appropriate audiovisuals like

video programs, models, and multimedia learning packages are essential. Let there be a video and multimedia library in the institute. Provide appropriate working models. Introduce micro-teaching exercises and conduct appreciative inquiry. Offer microteaching exercises to all recruits.

Case studies

In engineering case studies are essential for solving complex problems and reducing errors in design, testing, manufacturing, and maintenance. Consider the failures of many projects and develop case studies around such incidents. Every year develop more case studies and validate them. While solving case studies, the students are given opportunities to analyze the mistakes, the overconfidence of the designer, and how these mistakes could be corrected.

Measurement and evaluation of student performance

Plan an in-house course on measurement and evaluation of student performances. Introduce a table of specification of skills (Matrix) to be a sample to prepare the question papers. Introduce open-book testing and research-based reports for the problems given. Give objective tests before the start of class discussions that will reveal the most difficult concepts, models, and product development. Introduce projects as a part of cognitive abilities development. Suggest presenting in a class seminar to get feedback from peer groups.

Planning industry-specific certificate courses [29]

Many companies request a certificate course for their employees like CNC Machine Operation, Computer courses, or Product Testing. Most of the institutes will have up-to-date products and trained faculty members. Hence, it is beneficial to assess the needs plan development courses, and charge the companies. This is the art and science of industry-sponsored skill development courses and generates revenue. The faculty has to prepare the outcome-oriented courses, implement them, evaluate the performance of the trainees, and certify them. Faculty members can also develop sector-specific certificate courses through another institute and jointly issue a certificate. If there is a need for collaborating with more than 2 institutions, it is possible to jointly develop needed appropriate certificate courses.

Planning industry-sponsored diploma programs [30]

Most of the companies may select school levers of the state and employ them and may design industry-specific diploma courses to suit the needs. They may look for long-term collaboration and pay the development and implementation fees to the institute. They prefer part-time courses during the evenings and weekends. The faculty has to plan the program of company-specific diploma courses and offer them in the institute or at the training department of the company. The practical work will be conducted by the company trainers. In the long run, the faculty members can offer consultancy programs to the companies in the industrial hubs or corridors. They can train their regular students in these companies and look for projects for them.

Planning industry-specific and interdisciplinary postgraduate programs for sponsored engineering graduates [31-33]

Many companies may not get appropriate postgraduate engineers to join and undertake design, product development, testing, improvement, suggesting appropriate manufacturing methods, marketing, and maintenance. They chose well-developed autonomous engineering colleges and deemed universities to collaborate and plan needed postgraduate programs. Both the company executives and the senior faculty members will undertake the program planning and implementation. The newly joined faculty members need to be involved in this program. In the long run, succession planning will be easy. The trained faculty can undertake industry-sponsored research projects. Further, they can get dissertation topics for postgraduate students from these companies. Many government companies and private sector companies come forward to develop many innovative interdisciplinary postgraduate programs and they offer assistantships to the students besides paying training costs to the institutions.

Planning interdisciplinary doctoral programs [33-37]

Engineers who completed interdisciplinary doctoral programs are mostly needed by various high-tech industries to analyze, design, and develop effective products, suggest efficient and safe mass manufacturing processes, and market the products at a global level. Further, they need efficient maintenance engineers. Finally, they also need innovative products to meet the fast-changing global markets. The newly recruited faculty members need in-depth exposure to analyze the needs of various TNCs and develop multidisciplinary programs. Further, they have to develop new analytical methods to meet the challenges of disruptive technologies. Engineering institutes should focus on creating interdisciplinary postgraduate and doctoral programs to reduce gaps between the industry and education. The newly recruited faculty have to be offered many advanced programs through various global universities and bilateral agreements.

Organizing industrial training [23,24,38,39]

It is impossible to replicate the industrial production

process on the university campus. Every undergraduate and postgraduate student has to be exposed to various modern industrial processes from product analysis to maintenance. The institutions have to create sufficient linkages with the state, regional, and national companies. The faculty members have to track the development process and introduce them in the curricula. The students have to be trained in the companies. There are many apprenticeship training schemes under the Ministry of Education. The faculty members equip themselves with the latest technology innovations and are ready to master them. The graduates need complete exposure to the ongoing industrial development. They have to undertake sponsored research programs and try to solve complex programs. Dual programs can be developed and validated with MSMEs. Research-development-diffusion-adoption (RDDA) and problem-solving models (PSM) are to be studied for undertaking sponsored research programs.

Planning executive development programs [22,32,33,40]

Most of the companies modernize their production processes. This gives the need for updating the cognitive abilities of their executives. Chief learning officers (CLO) suggest changes in product planning and manufacturing. Then Chief Knowledge Officers (CKO) have to update the cognitive skills of the executives. Most of the advanced institutions can offer executive development programs using up-to-date resources and well-accomplished faculty members. These faculty members have to jointly plan executive development programs and offer them at the institute's regional training centers (RTCs) or in-house executive development centers.

Implementing executive development programs [23,33,36,39-44]

Many industries develop detailed project proposals (DPAs) to get soft loans from various IDAs that provide funds for the expansion and modernization of pollution-free units. As part of the expansion project, these IDAs prescribe around 5% of the project loan for the development of executives and establish RTCs. They send Letters of Invitation (LOI) to Institutions to submit detailed technical and financial proposals. They further expect a set of project-specific curriculum vitae from the faculty members who will undertake these development programs. Hence, the institutional leaders have to mold the faculty members to prepare these *bid* documents, negotiate, and win the projects. The faculty members have to analyze the Terms of Reference (TOR) and prepare appropriate technical and financial proposals. The newly joined faculty members have to be included in the project teams and scaffolded to become efficient developers.

Developing research project reports, papers, and patents [35,43,45,46-48]

Most of the institutes may not get sufficient grants-in-aid from the government for undertaking industry-specific research projects. Hence, the outstanding faculty teams have to plan appropriate research and development projects that will create an impact on analyzing, designing, prototype development, testing, improving, choosing efficient manufacturing processes, and maintenance. This calls for advanced cognitive skills, planning process, and implementation within a specified duration. The newly joined faculty members have to be included in these research and development works. They have to undergo appropriate development programs and acquire needed professional skills. At the end of the project, the team has to prepare project completion reports and bills for reimbursement of expenditures. They have to share the project gains as per the norms. The institute has to remit its share to the corpus funds. The faculty team will become more problem solvers and technology leaders.

Presenting research papers at an international conference [49,50]

The faculty members have to develop a global vision and prepare outstanding research papers to publish in appropriate international conferences. This will provide cognitive abilities to choose appropriate topics and conduct in-depth research that leads to outstanding results and suggestions. Further, the faculty members will have an opportunity to meet other leading researchers, institutions, and ongoing research programs. They can better develop global visibility for their research.

PART-II. GET RECOGNIZED[21,36,51]

Prepare detailed portfolio

All the faculty members need to be recognized by the peer group members, professional societies, development organizations, and national funding agencies. They have to prepare an in-depth portfolio describing their accomplishments and submit them to various award-giving organizations and professional associations. In the long run, this helps them to get funds for research, and get better recognition for selecting clients for sponsored research. The leaders of the institute should recognize the reputation through the well-performing faculty members.

Become a member of national and international professional organizations [41,43-45,52,53]

In all fast-developing countries, many well-established professional organizations link institutions to industries. The faculty members should apply to get selected by these organizations. They may publish professional journals, conduct conferences, offer internships, and

provide funds for organizing executive development programs. Many government institutes reimburse the fees paid to international associations and also pay travel allowances to present papers at international conferences. Institutions can also become members of national and international professional organizations that will provide linkages with companies to get more services. The faculty should apply to become a Fellow of the Institution of Engineers (FIE), Fellow of the Indian National Association of Engineers (FINAE), Fellow of the Indian National Science Association (FINSA), and other professional associations.

Become a Fellow based on outstanding professional contributions, publications, and projects completed [43,44,53,54]

The senior faculty members could become fellows of well-established national and international organizations. The faculty members should apply to these organizations as per the prescribed formats and get selected as fellows. This will provide needed recognition for the programs and the faculty members. In the long run, the outstanding members can develop research and development programs and executive development courses under professional organizations. This will be a win-win situation.

Offer FDPs as a lead contributor [45,55,56]

The faculty members need to become lead contributors in various FDPs that are organized by various ASC, HRDI, IDAs, and corporate training units. This will improve the problem-solving capabilities of the faculties. In the long run, they can create necessary linkages between institutes and companies.

Join social media like LinkedIn, Research Gate, Academia Edu, etc. [44,45,47,56,57]

LinkedIn provides more opportunities for creating links with other faculty members and executives. They host the curriculum vitae on its website that can be included in the curriculum vitae and can be uploaded to desired websites. It also offers many development programs.

Include well-performing faculty members in your doctoral Committees [23,41]

When the faculty members offer doctoral programs, they need to constitute a doctoral committee consisting of well-recognized faculty members. These members will review the progress of research work, check the performance of the candidates in the examinations, and approve the synopsis. Hence, the faculty members have to create linkages with other faculty members.

Develop a strategic plan and prepare a tactical plan for implementation [24,42]

Every faculty member has to prepare a strategic plan for their growth and develop a tactic plan every year to implement a component. Further, he/she has to review the planned progress and achievement. This is essential. They have to plan their development programs to reach their vision.

Overcoming vulnerability, uncertainty, complexity, and ambiguity [25,48,58]

All the faculty members have to safeguard themselves from all vulnerabilities in their planned projects, consultancy projects, publications, and development activities. There may be many uncertainties in their progress. Many projects will have many complexities. They have to equip themselves well in advance. Ambiguities will also obstruct their planned growth.

PART-III-MIDDLE-LEVEL FACULTY DEVELOPMENT COURSES

These courses can be offered up to ten years of entry and choice can be given to choose the desired courses. These courses will add more skills to contribute to regional competitiveness and better leadership development. The following courses center around planning *bid* documents and negotiation for consultancy projects under various IDAs.

Preparing a technical proposal for bidding [40,43,54,47,59]

Every client prepares very stringent terms of conditions for technical proposals and financial proposals. The best faculty teams alone can prepare needed technical proposals. It should be based on the field needs, available human resources, equipment, and proven safety. No ethical issue can be neglected. Environmental pollution is to be controlled. The faculty should visit the site or a factory and discuss the needs and the problems faced by the client. If there is a need, the institute has to employ adjunct faculty or field experts who have completed similar projects. At the time of the presentation, the client's project engineers will ask many questions and get to know the successful completion. The technical team will be responsible for a thorough analysis of the problem. The faculty should have expertise in analysis, design, development of prototype, testing it, improving it, and suggesting the safe operation, The operators should be trained. The client may prescribe a reasonable period of supervision and provide a guarantee. The faculty members should also take health insurance for their faculty team. Many conflicts may arise but they should be resolved. There should be more cooperation among the team members. The project should be completed well before the deadline. The bills are to be presented periodically as per the TOC. Project management is very essential. Stakeholder cooperation is essential. The clients will

rank the technical proposals first, and they may plan to negotiate with the faculty members who stand first. If the technical proposal is not accepted, they will not open the financial proposal.

Preparing a financial proposal for bidding [48,59]

The project team should prepare an appropriate financial proposal and should not believe competitors who may spread rumors about the cost. If taxes are to be paid, they should be included in the financial proposal. In projects, the client may demand a bank guarantee and this is similar to debt and the institute has to pay the interest. No additional work should be accepted without an additional contract. Financial management is essential. Further, value engineering has to be adopted to check the excess expenditure. In most of the situations, the client may request to reduce the cost of the project. Hence, include 20% excess cost and then reduce 10% during negotiation. Maintain careful accounting procedures.

Negotiation and winning research and development projects [42,44,57,60]

Negotiation is an art and every faculty team member has to master it. First, they have to present the success stories of the institute and the department. Next, they have to present the success stories of the project team and innovations in the technical proposal. Then they have to answer the questions raised by the client's manager. Most of the time, they demand additional work without any additional payments. The team has to check the possibilities and add extra work without incurring additional expenditure. They can introduce project-specific games, posters, and models.

Implementing the project [24,47,57]

Most companies prescribe deadlines and if the project is not completed within the specified time, they will impose a penalty. Hence, the project team has to complete the project well in advance and should not implement any additional work that is not included in the original contract. Once the project is completed, the project leader has to prepare a completion report. If the project suffered due to any civil unrest or natural calamities like floods or earthquakes, the project leader has to claim an extension of time under the class force majorize.

Planning continuing education programs for MSMEs [40,43,57,59]

The faculty members have to assess the needs of the employees, engineers, and managers of MSMEs. They need more input on technology, modern machines, safety, optimization of energy, productivity, financial management, marketing, and maintenance. If they are not trained, they will incur heavy losses. Hence, the faculty members have to be trained in conducting needs analysis, and development of company-specific courses.

Delivering invited lectures for an international conference [26,37,46-48,50]

As a professional faculty with well-accomplishments, they should be ready to deliver advanced lectures at various national and international conferences. This has to be considered in planning interdisciplinary postgraduate and doctoral programs. They have to reach the highest level of professional leadership

Reviewing the articles as a peer reviewer for journal publication

When the faculty members publish their excellent articles through reputed journals, they will get many invitations to review the articles for publication by various journals, Hence, the faculty members should continue to undertake research and development projects and publish outstanding articles. In the long run, their leadership will be rewarded.

PART IV STUDENT PERSONNEL ADMINISTRATION

Counselling before registering for courses

Most students will have tough problems in selecting courses that are counted for a degree. If the wrong counseling is selected, they may lose the fees paid and they have to register for the needed or prescribed courses. An advisor has to check the rules and regulations before advising to safeguard the student's interests and valuable time. The students also need effective counseling to choose topics for project works and dissertations.

Mentoring

Students will have a lot of distress during the study. Financial problems, managing filed works, preparing project reports, presenting the results in class seminars and they can rely on the mentor. A mentor should offer suitable guidelines to overcome fears, bottlenecks, and constraints. Many international students will face many problems in registering for the courses, joining the designated dormitories, getting transport facilities, and extending visas. There may be student service officers who can help. Mentors have to guide the students in distress. Students are dependent on trusted mentors to resolve many academic and personal problems.

Student services

They include guidance in planning to get assistantships, internships, campus interviews, applying for postgraduate programs, and joining as research assistants in sponsored projects, teaching assistants, *etc.* Advisors, mentors, and counselors have very important roles in

developing the students so that they can become graduates with problem-solving skills, critical skills, and ready to enter the companies with needed attributes. Even though there are many professional units to shape them, mentors and advisors have very important roles to play. The faculty members have to develop a broad mind with sufficient empathy and emotional intelligence. All the faculty members could become excellent scaffolders for the students in distress.

PART V- SENIOR-LEVEL FACULTY DEVELOPMENT COURSES

Higher educational administration [40,44,50,57,58]

The faculty members should plan to become growth-oriented faculty and should develop skills in planning and administering the institutes. They have to know the process of planning capacity development, quality improvement, efficiency improvement, generating internal revenue, and offering services to the society and state. They have to focus on human capital and knowledge capital development. They have to decentralize administration and empower the faculty to develop innovative postgraduate and research programs. Further, they have to create sustainable linkages with other institutions, national laboratories, and multinational development organizations.

Leadership development [37]

Institutional development depends on leadership. Hence, to facilitate the flawless development of engineering institutions, every senior faculty member has to be trained as goal-oriented super leaders who focus on creating and encouraging more leaders in engineering institutions. They should empower the faculty members to bring creativity and innovation. He/she has to facilitate self-leadership behavioral strategies to influence the faculty teams. Institutional leaders have to encourage every faculty member to achieve the goals of the institution. All these are to be linked to a continuous process. When such initiatives are undertaken, the graduates will become more employable in any complex company.

Engineering educational institutional management [54,59]

Engineering educational institutes are facing more complex problems due to the fast growth of disruptive technologies, fast change of analysis-design-prototype development, efficient manufacturing-marketing, and maintenance. The institutions have to narrow down the gap between the industry and curriculum. More funds are required to acquire modern equipment, pay salaries to the faculty and technical support staff, maintain advanced systems, and meet the cost of consumables. They need to adopt a project-specific financial management system. They should earn more through internal revenue generation, royalty on publication, and fees for conducting executive development programs. They have to adapt to using value engineering.

Entrepreneurship development [40,46,61]

The graduates have to be trained to become successful entrepreneurs. In every product analysis-design-prototype development-manufacturing-marketing, and maintenance, they have to estimate the cost of the raw materials. The raw material cost increases due to labor costs, taxes, transportation, manufacturing costs, marketing costs, and maintenance costs. Most of the courses do not introduce costing, estimation, and value analysis. The students may not have any chance to prepare detailed analysis, cost analysis, unit rates, and profit margins. Without introducing these fundamentals, it is impossible to develop entrepreneurs. Hence, all the programs are to be revised to include costing, estimation, value analysis, and cost per unit so that they can become entrepreneurs.

Intrapreneurship development [61]

Well-performing faculty members should be approved to *bid* for global projects under TNCs and IDAs. They can bring substantial revenue for the growth of programs based on the current technologies and develop graduates with adequate attributes who can get high-end jobs in modern companies. The students can be employed as project assistants. Intrapreneurs will become a standing example for the graduates to become entrepreneurs. The departments can become modern consultancy centers and developers of technology-driven innovation. The outstanding faculty members can build effective linkages with companies and undertake continuous product development.

Annual tracer studies [47,50]

Well-designed tracer studies [4] will meet the needs of recently graduated employees, forthcoming new technology-based products, the possibility of undertaking company research studies, product innovations, and creating new interdisciplinary training programs. The leaders have to fund the tracer studies every year. The employers have to be involved in the tracer studies that can supplement the needs of their companies.

Impact studies [58]

Impact studies [5] will provide information on the overall success of programs, and their contribution to communities, companies, government, and entrepreneurs. It will supplement further information on industry-institute-national labs- and government partnerships. The outcome of diverse global faculty development, poverty alleviation, and engineering

education beyond borders can be assessed.

Planning MOOCs

In the last five years, MOOCs have become a well-established learner development model. They are very cost-effective and the largest number of learners can be accommodated in each program. Best programs are developed by well-established world-class universities. Hence, every engineering institute has to develop MOOCs based on the expertise of the faculty members. The institute can offer MOOCs to many global learners and executives of companies.

PART-VI- ADVANCED-LEVEL PROGRAMS

The following advanced-level programs become essential for the continued development of the institution through continuously auditing and planning faculty development courses, and curricula, adding new courses and interdisciplinary programs, undertaking challenging consultancy projects under many IDAs, and leading innovations.

Generating smart goals of engineering education [44,54,59,62]

Every higher education institution is facing many critical issues in meeting global challenges due to the globalization of the economy (Table 1). Hence, engineering institutions have to continuously audit and upgrade their programs to reach excellence. Smart goals center around capacity-building improvements, quality enhancements in all human resources, and efficiency improvements which are linked to radical developments in human and knowledge capital. Based on the ever-increasing challenges, engineering institutions have to develop strategic goals that are required to improve the competencies of the students through the faculty members, modern resources, outcome-based programs, and scaffolding of the faculty. There is a need to meet the disruptive technologies through multidisciplinary and advanced programs in cutting-edge technologies. Further, the institutions have to finetune all smart goals continuously. Such a process would bring credit and unwavering recognition and support for growth of the human resources.

Creating leadership with Equity, Integrity, ethics, Humility, and outstanding culture [29,30,45]

All higher education institutions have to develop faculty leadership with equity, integrity, ethics, humility, and outstanding culture which will facilitate fast growth of industry-specific programs. Simultaneously the administrators have to resolve toxic leaders' actions which impede outstanding faculty teams' performance and radical innovations in developing graduates with desired attributes. Over some time, the reputation of the institute's relentless efforts will be rewarded.

Creating a sustainable and outstanding culture to develop high-performing education [28,30,40,44,50,54]

All the engineering institutions have to upgrade their culture which will facilitate the academic environment for developing interdisciplinary programs, multidisciplinary research, and outcome-based courses for the development of human and knowledge capital. The culture should reflect in recruiting, awarding salaries, allowances, in-house training of the faculty, promotion, and supporting all outstanding programs. The growth of toxic teams has to be checked and controlled. The art of rewarding outstanding faculty teams should be visible and this will motivate the rest of the faculty teams to contribute to the growth of human capital.

Developing and supporting high-performing faculty teams [40,43,44,47,50,54,55,58]

Every institute should focus on high-potential faculty members who have outstanding performance, contribute to knowledge capital, have unlimited achievement motivation, and are eager to undertake complex consultancy projects under various IDAs. Further, they need to be continuously supported and scaffolded to bring the best innovations. They need funds to start their bidding for projects which can be returned soon from the project. They need sufficient leave at their credit and they have to be permitted to avail as and when they need. The institute should celebrate their contributions to internal revenue and the institute should share the gains as per the norms, standards, and rules.

Creation of servant leaders [20,63]

Servant leadership is a leadership style that prioritizes the growth, well-being, and empowerment of faculty members. It aims to foster an inclusive enrichment that enables faculty members in the institution to arrive at their authentic selves. The theory of servant leadership was created by Robert K. Greenleaf, who popularized the term in 1970. The seven pillars of servant leadership are: (1) Person of character: A servant leader maintains integrity, makes decisions based on ethics and principles, displays humility, and serves to vision the institution. (2) Puts faculty first: A servant leader demonstrates care and concern for faculty and helps faculty members meet their goals and grow within the institution. (3) Skilled communicator: Communication skills are integral to servant leadership, and you will need to ensure you can effectively listen to and speak with your faculty members, while you are inviting feedback. (4) Compassionate collaborator: To be a strong servant leader, you will need to consistently work with faculty members and

Table 1: Comparative analysis of various models of faculty development

No.	Model	Feedback from the Alumni	Feedback from the Directors
1	Short-term courses in one particular area	Met that purpose but left more gaps in the total development of the faculty	Useful to improve classroom teaching only
2	Summer Schools	Limited opportunity for the faculty but lags continuity for total cognitive ability	Adhoc, but different caders need more focused areas.
3	In-house Faculty Development Programs	All faculty members from all branches were included. Focuste on the instructional design only	One course alone can be implemented per year. Only one area of specialization has been developed
4	AICTE-sponsored faculty development programs	Adhoc courses. No continuity. Leaves more gap in leadership development	Seats are limited; Difficult to get training programs for senior faculty
5.	Faculty development from recruitment to retirement	Covers all areas, faculty can get excellent development to meet all challenges	Excellent opportunity for sending appropriate cadre

work to strengthen relationships, support diversity, equity, and inclusion, and navigate conflict in the workplace. (5) Has foresight: As a servant leader, you will need to keep an on the future and anticipate anything that might impact the institution. You'll also need to have a strong vision for your institution and be the type of person who can take decisive action when needed. (6) System thinker: Servant leaders need to be comfortable navigating complex environments and able to adapt to change. This type of leadership requires strategic thinking and the ability to effectively lead change in the institution. (7) Leads with moral authority: As a servant leader, it's important to establish trust and confidence in your faculty members by establishing quality standards, accepting, and delegating responsibility, and fostering a culture that allows for accountability. In higher education institutions, servant leadership is most often seen in an agile development environment.

Planning effective and efficient ways of executive development [58,63]

The institute has to establish a center for offering executive development programs for companies. The faculty members have to collaborate with the company-sponsored training centers in the industrial corridors and hubs. Further, they can jointly establish industry-specific and interdisciplinary postgraduate programs for the executives. It will be beneficial to offer interdisciplinary doctoral programs for executives to create innovative products. Companies can also sponsor research and development programs to solve and innovate in analysis, design, prototype development, testing, improvement, mass production, marketing, and maintenance.

Art and science of safeguarding the outstanding faculty members from institutional hazards and planned destructions [29-36,38,47,49,54,60]

In many institutions, a set of toxic leaders grows and they are unethically supported by some leaders. They destroy the culture and many outstanding faculty teams leave the institutions. There should an appropriate grievance and redressal councils to resolve the problems. Sometimes more court cases are filed to get justice. All these things are to be watched and controlled.

Comparative studies in global engineering education

This is a proven method to update the curriculum and instructional planning and delivering methods without losing global development. A study project has to be established and focus on the growth of innovations in world-class universities and corporate centers. Such a study will reveal the additional courses to be added. Faculty exchange could be included.

Globalization and global networking of engineering institutions

After studying the growth of cutting-edge programs, the next step is the globalization of engineering education. The duration, courses per semester, credits for various courses, and credits for on-the-job training in an industry should be comparable. Accreditation of all programs is essential which will enable the graduates to join overseas universities and get assistantships. The outstanding faculty members will be invited to offer many topics to foreign universities through online modes. They have to be permitted. Sometimes, a foreign university may offer research and development courses under its funding. The qualified faculty members are to be approved.

Planning diverse global FDPs

Many IDAs may seek well-designed diverse FDPs with needed funding. The authorities have to approve and provide needed resources. Similarly, they may invite local faculty members to undergo internships at their universities. These programs have to be included in the strategic plan and be approved for early implementation. This brings a win-win situation.

Creating a Center for Excellence

The leaders have to create a center of excellence in their engineering institution. This will attract the best faculty

members, enable them to undertake many complex consultancy projects for MNCs, IDAs, and MEMEs, create needed knowledge capital, and undertake interdisciplinary research projects. Offer more industry-relevant postgraduate programs and diverse global FDPs. The graduates can join well-performing companies.

Research-Park

In this 21st Century, many multinationals have established their product development centers in India. These companies started developing new products in the research parks of many institutes of national importance. Based on the success of research parks could be established in well-performing state universities and deemed universities. Hence, the administrators have to plan innovative research parks by utilizing high-performing faculty members and modern resources. The beneficiaries will be graduates of the institute.

PART-VII. RADICAL INNOVATIONS

Radical innovation [1,15,57] is a type of innovation that combines technology in a new business model. It is a concept that changes the relationship between customers and suppliers by displacing current products and services or by producing new products. Most of the researchers can develop innovative articles, equipment, software, and hardware. The faculty members have to guide students in developing radical innovations in designing, assembling, manufacturing, and maintenance.

DISCUSSION

The continued faculty development is a long-term change process and all the stack holders need to be convinced and take action step by step. In addition, the national commissions and councils should be supported. The newly recruited faculty members need more exposure to the art of planning new curricula, developing innovative instructional methods, developing the attributes of the graduate, and improving their cognitive abilities, motor skills, and attitudes toward the challenging engineering profession. They need continuous faculty development, exposure to fast-changing technologies, planning continuing education programs for the employees of companies, developing executives in designing and creating prototypes and adopting efficient manufacturing methods, Hence, FDPs are to be planned from their entry to exit. The administrators have to focus on outstanding performance in planning and delivering innovative intellectual products to companies. The high-performing faculty members have to be innovative in planning interdisciplinary postgraduate programs. The institutes have to focus on centers of excellence, radical innovation, and establishing research parks. They have to establish diverse global FDPs. The faculty members need scaffolding and decentralized administration followed by delegation. All the above FDPs were planned and implemented over 50 years. There is no end to this type of development.

Comparative analysis

These comprehensive FDPs are compared with the previous models as follows: From this, it is concluded that training from recruitment to retirement is welcomed both by the faculty members and the directors of the engineering institutes. It has built-in flexibility. Suits the needs of all cadres.

Implementation challenges

The following are the implementation challenges: There is a need for a strategic plan for faculty development in every engineering college; Every faculty member has to plan their needs every year and apply for needed program; The courses are to be linked to the institutional needs; Needed funds have to be allocated for faculty development; Every department should have a sufficient number of faculty members; The impact on the graduates' attributes has to be measured; Feedback from the faculty will enhance the planning; Impacts made so far; Highest rate of employment of the graduates; More research publications from the faculty members; Rise in revenue generation through consultancy projects and sponsored research programs; Reduced turnover of faculty members; Every seat was filled by the students.

CONCLUSION

The outstanding faculty members when they complete their engineering degree programs may not be able to undertake various tasks in higher engineering education. They need to be trained from entry to exit so that they can substantially contribute to knowledge and human capital. Most of the institutes don't systematically plan the development of the faculty members. Hence, this research study focused on the lifelong faculty development process. The training needs are based on the feedback of 396 entry-level faculty members. Seven-stage planning consists of: Entry-level courses to develop their basic competencies in planning and delivering instructions. In the second stage, they are to be facilitated to get recognized by the employees, clients, and students. By this time, they will reach the middle stage. Various programs that are needed for further growth have to be planned and offered. In the fourth stage, they need to know various planned assistance to the students so that they can become successful graduates. In the fifth stage, the experienced faculty members have to be trained to become outstanding chairpersons to develop the institution and create an impact on the community. In the sixth stage, they need

to become outstanding leaders to create an excellent academic ecosystem to meet global challenges. When global growth depends on many radical innovations, the faculty members need to explore radical innovations and train the students to confidently enter the world of work. All the stages have been validated through a set of five educational leaders who have agreed to implement step by step since they have to bring a change in their policies and create the needed academic environment, resources, and acceptance of the Board of Governors.

Limitations in this research

Most of the training courses were offered under various funding from the World Bank, United Nations Development Project, AICTE, ISTE, and colleges under in-house FDPs. Most faculty members accepted to undergo these courses over their service. This study was restricted to the southern region. The culture varies from state to state. The growth opportunities also vary from state to state. Many outstanding faculty members leave their institutions and continue their profession in many foreign countries.

Suggestions for further research

It is suggested to replicate this study at the national level and the Ministry of Education can fund it. The results will help to standardize the FDPs. It is hoped that the outcome will enhance to performance of the graduates and their effective and efficient contributions to knowledge and human development.

DECLARATION

Author contributions

Vedhathiri T: Conceptualization, Data curation, Choosing a Research Methodology, Data Analysis, Creating an Original Draft, Writing, Reviewing and Editing.

Ethics approval

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Conflict of interest

The authors declare no competing interest.

Data availability statement

Not applicable.

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