13. NECESSITY OF TQM IN ENGINEERING EDUCATION FOR SUSTAINABLE GROWTH OF SSI SECTOR

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Abstract

Rapid globalization, impact of information technology, international transformation towards a knowledge- driven economy are the challenges of the new millennium. The strong demands for societal developments and the international and regional competitions have driven numerous education changes in different parts of the world. In this context, most of the current theoretical perspectives experimented by engineering educators are commensurate with some radical international developments in the engineering realm. These developments are aimed at getting students to think, or go beyond the information given with the integrative skill of bringing knowledge, skills, understanding and experience together in problem solving activities and environment, which provides students with the best kind of preparation for life-long independent learning. These will enable them in enhancement of their utility in the employment market. An engineer through entrepreneurship can bring a technical revolution that can meet the challenges of the emerging scenario of liberalization, privatization, and globalization with the key element of competition rather than protection.

Introduction:

The promotion of widespread entrepreneurship though setting up of small-scale units is the vital factor in economic transformation of any country in transition [1]. This sector has been well-recognized as an engine of economic growth and important source of sustainable development. Small and Medium Enterprises are the predominant type of firms and fertile ground for research [2]. The changing economic environment due to liberalization, privatization, and globalization has posed certain challenges and has provided opportunities to the Small-Scale Industrial (SSI) Sector. The challenges are in the form of increased competition, shorter life cycle of products as well as technology, reduced protection due to lower tariffs, and market determined rate of interest. On the other hand, the opportunities have come in the form of access to better technology, availability of a variety of raw materials and components, impetus to quality, efficiency, and opportunities to restructure and diversify. To face these challenges and grab the opportunities, an entrepreneur has to adopt innovative product process, productivity improvement techniques, and effective technology management for sustainability of the unit. Here the innovative approach will be the remedy for an entrepreneur for sustainability.

TOTAL QUALITY MANAGEMENT:

TQM is a total management system sets the direction of an institution, tunes its engine, and helps in realizing vision. TQM is a focused approach to increasing customer satisfaction

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and achieving business objectives. According to British Quality Association, "TQM" is a corporate business management philosophy, which recognizes that customer needs and business goals are inseparable. TQM is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization, it is the application of quantitative methods and human recourse to improve the materials and services supplied to an organization, all the processes with in an organization, and the degree to which the needs of the customers are met, now and in future. TQM integrates fundamental management techniques (3), existing improvement efforts (4), and technical tools (5) under a disciplined approach focused on continuous improvement. TQM has been defined by different researchers in different way as follows:

- It is the philosophy of total satisfaction for both internal and external customer, within the management environment that seeks continuous process improvement. (6)
- It is a combination of quality and management tools aimed at increasing business and reducing losses due to wasteful practices (7).
- It can be used universally for improving quality and productivity.(8)
- It is a structured approach for quality and productivity improvement that aims to address all aspects of a business including people methodology and technology.(9)
- It is a process oriented philosophy of enhancing customer satisfaction through the production of higher quality goods and services. (10)
- The philosophy of Total Quality Management is being embraced as the vehicle for achieving higher levels of quality through process of continuous improvement.(11)

Here engineering institution is considered as industrial concern, with engineering student as its product and industry / employment market as the customer. Large scale industry is the customer with respect to the students opting wage-employment as career option. Whereas, small-scale is customer for the students opting entrepreneurial path as career option. Role of engineering education is to enhance the employability of its product. In the changing scenario of liberalization, privatization and globalization, wherein the technology is changing at faster rate and product life time cycle is shrinking day by day, it is the engineer who can cope up with these changes for sustainable industrial growth.

Significance of Small-Scale Sector:

According to Kats et al. (12), small and medium sized-enterprises are the predominant type of firms and they provide a fertile ground for research. Not only are these firms important to industrial economies, but they also sharing traits that make them particularly interesting to researchers who want to study cause and effect. According to Ritchie et al. (13), research on areas related to SME's is under-represented in proportion to the vital role that they play.

In developing countries like India, small-scale industry is the potent way by which maximum employment can be generated with comparatively low investment. It is also helpful in removal of regional imbalance in industrial development. The performance of SSI sector in terms of critical parameters such as number of units, production, employment generation, and export is significant. This sector, in India contributes about 40 percent of national industrial production, 35 percent of total national exports and provides employment to over 18.6 million people (14). Even in developed countries, like USA, employments by small firms contributed 53 percent of total employment during the period 1976-1990. Birch (15) in his seminal research, empirically showed how these small entrepreneurial companies in the United States had created some 80 percent of the new jobs.

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liberalization, privatization, and globalization has posed certain challenges and has provided opportunities to the Small-Scale Industrial (SSI) Sector. The challenges are in the form of increased competition, shorter life cycle of products as well as technology, reduced protection due to lower tariffs, and market determined rate of interest. On the other hand, the opportunities have come in the form of access to better technology, availability of a variety of raw materials and components, impetus to quality, efficiency, and opportunities to restructure and diversify. To face these challenges and grab the opportunities, an entrepreneur has to adopt innovative product process, productivity improvement techniques, and effective technology management for sustainability of the unit. Here the innovative approach will be the remedy for an entrepreneur for sustainability.

Necessity of Engineer as Entrepreneur:

Small business particularly in dynamic high technology markets, are spreading and expanding in the international markets at much faster rate than previously (16, 17, 18). According to studies conducted by Bryson, Kirby and Jones-Evans, and Miles et al. (19, 20, 21), entrepreneurs in small service firms are typically highly qualified individuals with previous managerial experience who are 'pulled' into entrepreneurship by positive motivations such as spotting a market opportunity.

It is a fact that with proper education and training provided to the person with entrepreneurial zeal, sustainable entrepreneurship could be developed. Bhat Khursheed (22) supports this when he carried out experiment in the two towns of Andhra Pradesh in collaboration with Small Industries Extension Training Institute (SIET) Hyderabad.

In the fast changing technological environment, the role of technical entrepreneurship has assumed a central place. Moreover as per Baburao G (23), the favorable factors of the technical person who can be an effective entrepreneur, after proper education and training, can be as follows:

i) Ability to grasp opportunities which offers economic advantage;

ii) Ability to analyze and diagnose the problems of production and service of an enterprise and device remedial measures at the right time;

iii) Ability to workout economics of production and service outputs and evolve competitive and cost effective strategies;

iv) Ability to give fillip to ancillarization, helpful in better linkage between large and small enterprises;

v) Technical and analytical capability helpful in preventing accidental breakdown problems, thus reducing expenditure on trouble shooting;

vi) Ability to forecast the changes in technology and adopt to the changing environment more easily;

vii) Ability to contribute to self propelled performance rather than push propelled developments;

viii) Ability to effectively transfer technology from laboratories to industries.

Engineers as entrepreneurs can meet the challenges of emerging scenario of liberalization, privatization, and globalization with key elements of competition rather than protection.

Sanghi (24) rightly described the role of technical entrepreneurship, which is pivotal in the process of liberalization. It can make a contribution to industrial development through innovations, new product / process development / improvement in productivity etc. Technicians and technocrats can play the role of innovators with comparatively ease because they have characteristics such as propensity to adapt to

new knowledge more rapidly. Technologists and technicians who learn sufficient science and engineering acquire capabilities to know why and how of various theories and can design products and services based on their knowledge and skill competencies.

Entrepreneurship Education

In recent years, entrepreneurship education has been developing steadily but unevenly in most nations world-wide (25). The entrepreneurship education has been developed by professionals of different areas of knowledge; however, the predominance is in management programs, followed by computer science programs and engineering. There is still an on-going debate in the entrepreneurship academy about whether we can actually teach students to be entrepreneurs (26). A ten year (1985-1994) literature review of enterprise entrepreneurship and small business management education reported "most of the empirical studies surveyed indicated that entrepreneurship can be taught or at least encouraged by entrepreneurship education" (27).

Elizabeth Muir et. al. (28) has question the entrepreneurship education on two fronts. Firstly it implies as education limited to an aim to the creation and development of enterprise rather than on the wider development of entrepreneurial people. Secondly, that focusing upon the economic phenomenon of enterprise limits the understanding of entrepreneurship as a personal activity, and excludes disciplines of economic history, sociology, psychology and anthropology, as suggested by Swedberg (29). Levie (30) distinguishes between teaching 'for' and 'about' entrepreneurship. We concur with this distinction and add the notion that entrepreneurship is not just limited to economic development, but is also inclusive of personal development of the entrepreneurial individual. Thus we perceive entrepreneurship as a whole person activity that involves and aspires to both cognitive (knowing) and co-native (doing) excellence (31). This belief and understanding then has implications for course content and delivery.

Challenges before Engineering Education

American Society for Engineering Education (1994) asserted (32) that engineering education should be relevant, attractive and connected, relevant to the lives and careers of students. Engineering education has clearly the most important contribution to the economic viability of any nation. Bhaskaran (33) sees the technological dominance of the United States largely has been possible because of its educational system, which has supplied an abundance of scientists and engineers, besides business strategists, managers, skilled technicians, and skilled workers.

As per Natarajan R (34), engineering practice today has changed dramatically and irreversibly due to:

- Growing global competition and the subsequent restructuring of industry;
- Shift from defence work to private enterprise as major source of engineering employment;
- Explosion of information;
- Development of information and technology.

Webster John (35) has emphasized engineering education should equip graduates to demonstrate the attributes which are similar to entrepreneurial characteristics. In technical education, emphasis has to be given on nurturing entrepreneurship to enable the engineering students to be the champions of the product and process, market system practices and help in professionalizing the small-scale sector.

The present system of engineering education has very little practical application, as graduates are ignorant of field practices (36). As a result there is a lack of vision, creativity, innovative ideas, and diagnostic skill among the students. Therefore, the technical graduate coming out of the technical institution, in spite of lack of wage employment, prefers job hunting rather than going for self-employment as a career option.

In engineering education efforts are to be made to develop entrepreneurship in the students. The necessity of developing a creative design, methodology, or several of them to suit individual idiosyncracy is unquestionable. Its usefulness for developing creativity in students has been verified by many teachers. But the fact remains that the methodology of creative thinking alone cannot turn an engineer into an entrepreneur, unless he has the required amount of insight. To develop necessary insight, Karune (37) has emphasized on only one method, and that is presenting the principles from known to unknown, from old concepts to new ones, from simple problems to complex problems involving several laws. This will give the students, the right insight and develop his confidence in meeting new situations with initiative and originality.

Strategy in Developing Engineer as Entrepreneur

The economic development of any country depends on its industrial growth and productivity, which is directly related to the quality of engineers coming out of the technical institution (38). The quality of engineers in turn has a direct bearing upon the quality of technical education imparted to them. Technology and entrepreneurship cannot be viewed in isolation. Technological development is a prime mover in the course of economic development. It is evident that, invention and innovations have invariably led to growth in advanced countries. With this philosophy, there is a wide scope for engineers in entrepreneurial field to meet the requirements, face the challenges, and sustain the small-scale sector in the global market.

The entrepreneurial awareness in curriculum will be helpful and facilitate the students (interested in self-employment as career option) to have awareness and broad outline in the area. The entrepreneurial development program should not be only theoretical i.e. lectures and theory paper. But in fact, it should be theoretical at first instant then practical oriented. Thus the complete curriculum of the entrepreneurship development programme should be adopted in different steps as follows:

Table No.: 1- Steps and Process in Entrepreneurship Development Programme

STEP	PROCESS
Pre-operational drill	-Identification of Entrepreneur -Individuals decision to choose self-employment as career.
Operational drill	-Opportunity recognition. -Product identification. -Self-confidence building. -Techno-commercial aspects of unit.
Post-operational drill	-Vetting of techno-economical viability of proposed unit. -Vetting of project report from the financial institutions. -Technical sustainability of the unit.
Functional and structural parameters	-Land/ Shed allotment for the unit. -Resource generation for the unit. -Technical know-how for the unit. -Rules, Regulations of the land.
Competence building for decision making	Development of: -Leadership qualities, -Decision making ability, -Labor management skill, -Finance management skill, -Sales, marketing and purchase management skill, -Shop-floor management skill.

Among these, the first 3 stages will be for technical competence building and remaining two for managerial competence building of the participant of the programme (39).

This process will make students aware about the steps in technical entrepreneurship as follows:

1) To be well versed with product line, just knowing manufacturing/service process/ method is not sufficient. Process/ method know-how and know-how to operate the machine/ equipment is must.

2) Sufficient shop floor experience to guide operational staff at different level.

3) Familiar with raw material requirement alternatives, their specifications, availability, quality, source of supply price etc.

4) Quality requirements of product, measures for improving quality.

5) Marketing channels, distribution networks, agency practices, transport intricacies, and economies of packaging and presentation.

6) Well versed with taxation and other regulatory rules.

7) Maintain accounts, stores inventors in efficient way.

8) Willingness to put with bureaucratic regulations, external environmental turbulence, and ability to move with wind.

9) Ability to identify the opportunity and avail opportunity benefits.

10) Quality expertise, shrewdness, resourcefulness, perseverance.

11) Follow five 'P' principles i.e. Planning, Preparation, Persuasion, Patience, and Perfection for running industrial venture successfully.

12) Should be physically and mentally tough to withstand neck-to-neck competition from the similar units and business rivals.

Diagrammatic representation of an industrial venture can be represented as follows:

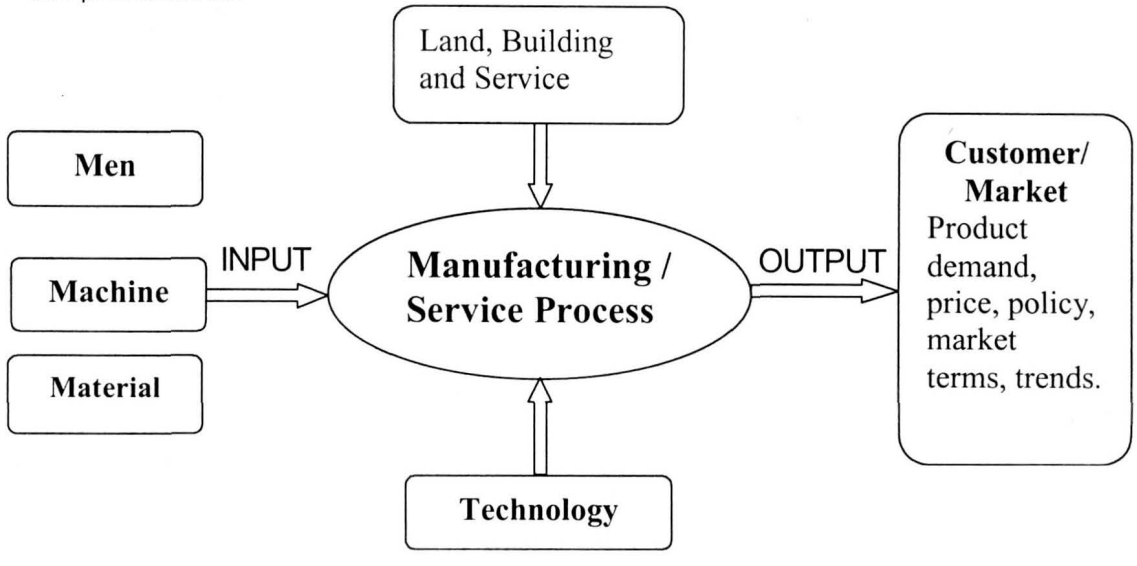

Figure No. 1. : Basis for Entrepreneurship Development Model

The inputs for an industrial venture are men, machine, material, land, building, and technology. It is carried out in the land and building of the unit, where services are also input and are responsible for running of unit. The manufacturing or service operation is carried out at the unit location. The product / service to be produced / provided should meet the market requirements. So the prospective entrepreneur, who will be responsible for running the unit should be well aware of these inputs, services required, and manufacturing / service process, technology involved market / end user i.e. customer requirements, market trends etc. The entrepreneurship development programme to be conducted should incorporate these factors. With these, the proposed entrepreneurship development programme to be run at technical institutions can be categorized in five phases as follows:

Table No. 2: Proposed Entrepreneurship Development Programme

Phases of the Programme	Focus to be made on	Input / Action Programme.
Selection of the right prospective entrepreneur	The Entrepreneur	Entrepreneurial characteristics & capability test of student then input.
Motivation of an individual to become an entrepreneur.	The Entrepreneur	Awareness about incentives, avenues, & schemes in the field, interaction with entrepreneurs followed by visit to their unit. Achievement motivation programme.
To start the unit	Venturing process: steps in marshalling the resources i.e. men, m/c's, material, money, land, services & technology etc. and product / market assessment.	Industrial potential survey, market survey for assessment of product demand, market terms & conditions. Preparation, presentation of the techno economic feasibility project report followed by the group discussion.
To run the unit.	Running a business/ venture; awareness of internal & external factors affecting unit's performance.	In plant study, interactions with the successful/unsuccessful entrepreneurs. Giving open-end problem in industrial training as exercise. Report preparation involving the techno-commercial aspects and presentation.
To expand the unit	Unit, market, customer.	Case study, written report, formal presentation, and discussion.

The said entrepreneurship development programme will be useful for:

- Building entrepreneurial vision among engineers;
- Effective industry institute interaction;
- Industrial exposure to the faculty;
- Entrepreneurial awareness to the faculty;
- Effective utilization of infrastructure available at engineering institutes.

In nutshell, it will be helpful in developing the effective engineer as per the requirements of the industry either in **self-employment** or in **wage-employment** career of an engineering student.

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