NATIONAL PRODUCTIVITY COUNCIL

Productivity

Vol. 43 July–September 2002 No. 2

Focus : Six Sigma

Guidelines for Contributors

Scope and Coverage

PRODUCTIVITY is the principal journal of the National Productivity Council of India. The Journal aims at disseminating information on concepts of and data on productivity and its growth in India and elsewhere. It also aims at disseminating knowledge on techniques and methods of productivity improvement through effective management of all types of resources. Thus, contributions from a large spectrum of disciplines are accepted for publication. Only those manuscripts that present the results of original research and analysis are acceptable to the Journal. The managerial/policy implications of the study should be highlighted separately towards the end of the paper.

Format of Manuscripts

Contributions should be of about 5,000 words length. Tables, illustrations, charts, figures, exhibits etc. should be serially numbered and typed in separate pages and should not be mixed with the main text. The text should be addressed to the Editor, **PRODUCTIVITY**, National Productivity Council, Utpadakta Bhawan, Lodi Road, New Delhi-110 003.

About the References

Only those references which are actually utilised in the text should be included in the reference list. In the text, references should be cited with the surname of the author(s) alongwith the year of publication and the page number, all in brackets. If there are more than one reference by the same author during any year, the year may be subscripted with 'a' or 'b'. For instance, reference may be given at the end of the sentence as: (Szendrovits, 1988a, p. 337). Sources of data need to be given below each table unless otherwise mentioned in the text. Reference list should be alphabetically arranged. Each reference should carry the surname of the author, followed by other names, the title of the paper in quotes, the name of the journal underlined, volume and issue numbers and the year of publication. In the event of a book, the title should be followed by the publisher's name and year of publication. In the event of a report from an organisation, the name of the organisation may be cited in the place of the author.

Accompanying Material

The manuscripts should be accompanied by:

1. An abstract of the paper not exceeding 100 words.
2. A declaration that the paper is original and has not been submitted elsewhere for publication.
3. A note about the author(s) not exceeding 50 words.

Subscription

Inland	:	Annual Rs. 1000
		Single Copy Rs. 250
Foreign	:	Annual Airmail US $ 80
		Annual Surface Mail US $ 75
		Single Copy Airmail US $ 20
SAARC Countries	:	Annual Airmail US $ 40
		Annual Surface Mail US $ 30
		Single Copy Airmail US $ 10

Productivity will be sent to all subscribers within each quarter. The Journals Division, CBS Publishers & Distributors, may be contacted in the event of non-receipt within one month from the quarter.

All business correspondence to be addressed to:

The Journals Division,
CBS Publishers & Distributors,
4819/XI, Prahlad Street
24, Ansari Road, Daryaganj,
New Delhi 110 002.

Tel. : 3289259, 3266861, 3266867
Fax : 91-11-3266838, 3276712
E-Mail : cbspubs@del3.vsnl.net.in

ISSN 0032-9924

Productivity

A QUARTERLY JOURNAL OF THE NATIONAL PRODUCTIVITY COUNCIL

Vol. 43 • July–September 2002 • No. 2

CBS PUBLISHERS & DISTRIBUTORS
NEW DELHI • BANGALORE

CBS PUBLISHERS & DISTRIBUTORS

NEW DELHI : 4819/XI, Prahlad Street, 24 Ansari Road
Daryaganj, New Delhi-110 002

BANGALORE : Seema House, 2975, 17th Cross
K.R. Road, Bansankari, IInd Stage
Bangalore-560 070

ISSN 0032-9924

Published on behalf of the National Productivity Council by S.K. Jain for CBS Publishers & Distributors, 4819/XI, Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002. Typeset by Pagitek Graphics, 7F West Guru Angad Nagar, Laxmi Nagar, Delhi and printed at Daksha Printing Pvt. Ltd., 7/11 Ansari Road, Daryaganj, New Delhi-110 002.

Printed in India.

Production Director: Vinod Jain

Contents

Six Sigma for Productivity Improvement: Korean Business Corporations

Sung H. Park

Six Sigma was introduced into Korea in 1997, and it is regarded as a fascinating management strategy in many Korean companies. First of all, the reasons why Six Sigma is fascinating are given and a smart way to introduce Six Sigma is illustrated. Seven step procedures to introduce Six Sigma are explained. Next, the differences of problem-solving processes for project team activities for R&D, manufacturing and service areas are compared. Third, a typical process for R&D Six Sigma is proposed, and major activities and scientific methods at each process step are suggested. Fourth, some differences between Six Sigma project team and quality circle team are presented. Finally, a Six Sigma model for e-business is proposed and briefly explained.

Sung H. Park is with the Department of Statistics, Seoul National University, Kwanak-ku, Korea. Paper presented at the APO-NPC Seminar on Six Sigma Management, New Delhi, 10th August, 2001.

What is Six Sigma?

Sigma is a letter in the Greek alphabet that has become the statistical symbol and metric of process variation. The sigma scale of measurement is perfectly correlated to such characteristics as defects-per-unit, parts-per-million defective, and the probability of a failure. Six is the number of sigma measured in a process, when the variation around the target is such that only 3.4 outputs out of one million are defects under the assumption that the process average may drift over the long term by as much as 1.5 standard deviations.

Six Sigma may be defined in several ways. Tomkins (1997) defines that Six Sigma is "a programme aimed at the near-elimination of defects from every product, process and transaction". Harry (1998) defines that Six Sigma is "a strategic initiative to boost profitability, increase market share and improve customer satisfaction through statistical tools that can lead to breakthrough quantum gains in quality".

Six Sigma was launched by Motorola in 1987. It was the result of a series of changes in the quality area starting in the late 1970s, with ambitious ten-fold improvement drives. The top management with CEO, Robert Galvin, developed a concept named Six Sigma. After some internal pilot implementations, Galvin, in 1987, formulated the goal of "achieving Six-Sigma capability by 1992" in a memo to all Motorola employees (Bhote, 1989). The results in terms of reduction in process variation were on-track and cost savings totalled US$ 13 billion and improvement of labor productivity increased by 204% during 1987-1997 (Losianowycz, 1999).

In the wake of successes at Motorola, some leading electronic companies such as IBM, DEC, Texas Instruments, launched Six Sigma initiatives in early 1990s. However, it was not until 1995 when GE and Allied Sigma launched Six Sigma as strategic initiatives that a

rapid dissemination took place in non-electronic industries all over the world (Hendricks and Kelbaugh, 1998). In early 1997, Samsung and LG groups in Korea began to introduce Six Sigma. The results were amazingly good. For instance, Samsung SDI, which is a company under Samsung group, reported that the cost savings by Six Sigma projects totalled US$ 150 million (Samsung SDI, 2000). At the present time, the number of big companies applying Six Sigma in Korea are exponentially growing, with a strong vertical deployment into many small and medium sized enterprises as well.

Electronic companies such as IBM, DEC, Texas Instruments, launched Six Sigma initiatives in early 1990s.

Through the consulting experiences of Six Sigma in Korea, the author believes that Six Sigma is a new strategic paradigm of management innovation for a company to survive in this 21 st century (Park et. al. 2000). Six Sigma implies three things: statistical measurement, management strategy and quality culture. It tells us how good our products, services and processes really are, through statistical measuring of quality level. It is a new management strategy under leadership of the top management to create quality innovation and total customer satisfaction. It is also a quality culture. It provides the way to do things right the first time and to work smarter by using data information. It also provides an atmosphere to solve many CTQ (critical-to-quality) problems through team efforts.

Why is Six Sigma popular?

Six Sigma is regarded as a fresh quality management strategy which can replace TQC, TQM and others. In a sense, we can view the development process of Six Sigma as shown in Fig. 1. Many companies which were not quite successful in implementing the previous management strategies such as TQC and TQM, are eager to introduce Six Sigma.

Six Sigma is viewed as a systematic and scientific approach for management innovation by the integration of four elements; customer, process, manpower and strategy as shown in Fig. 2.

Six Sigma provides a scientific and statistical basis for quality assessment for all processes through measurement of quality level. The Six Sigma method allows comparisons among all processes, and tells how good a process is. By this information, the top management knows what to do for process innovation and accordingly for customer satisfaction.

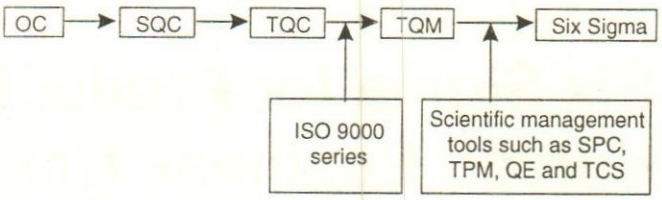


Fig. 1. Development process of Six Sigma in quality management

QC: quality control
SQC: statistical quality control
TQC: total quality control
TQM: total quality management
ISO: International Organisation for Standardisation
SPC: statistical process control
TPM: total productive maintenance
QE: quality engineering
TCS: total customer satisfaction

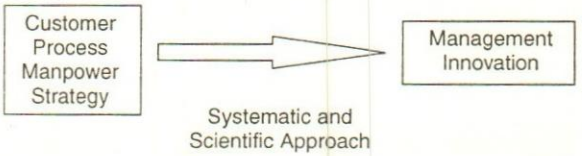


Fig. 2. Essence of Six Sigma

Six Sigma provides efficient manpower cultivation and utilisation. It has a belt system in which there are green belt, black belt, master black belt and champion. As a person in a company gets some education, he belongs to a belt. Usually, a black belt is the leader of a project team and several green belts work together for the project team.

There are many successful stories of Six Sigma in well known, world-class companies. Besides Motorola, GE, Allied Signal, IBM, DEC and Texas Instruments as mentioned above, Sony, Kodak, Nokia, Philips Electronics, Samsung Electronics, LG Electronics among others have been quite successful in Six Sigma.

To Introduce Six Sigma

When a company wants to introduce Six Sigma for its management strategy, the author would like to recommend the following seven-step procedures.

(1) Organise a Six Sigma team and set up the long-term Six Sigma management vision for the company.

(2) Start Six Sigma education for Champions first.

(3) Choose the area for which Six Sigma is introduced first.

(4) Start the education for Green belts (GB) and Black belts (BB)

(5) Deploy CTQs for all areas concerned. Appoint a

few or several BB as full-time project leaders and ask them to solve some important CTQ problems.

(6) Strengthen the infrastructure for Six Sigma such as statistical process control (SPC), knowledge management (KM), database management system and so on.

(7) Designate the Six Sigma day each month, and check the progress of Six Sigma from the top management. On this day, if necessary, presentation/reward of Six Sigma results can be implemented.

First, a few or several members should be appointed as a Six Sigma team to handle all kinds of Six Sigma jobs. And then the team should set up the long-term Six Sigma vision for the company. It is said that this is the century of 3Cs, which are Change, Customer and Competition for quality. The Six Sigma vision should match these 3Cs well. Most importantly, all employees in the company agree to and respect this vision.

Second, Six Sigma should begin from the top management and directors, so called Champions. After Champion's education, GB«BB«MBB (Master Black belts) education in sequence. However, usually MBB education is practiced in professional organisations.

Third, we can divide Six Sigma into 3 parts according to its characteristics. They are R&D Six Sigma, Six Sigma for manufacturing processes, and Six Sigma for service areas. The R&D Six Sigma is often called DFSS (Design for Six Sigma). It is not easy to introduce Six Sigma to all areas at the same time. In this case, the CEO should decide the order of introduction to those 3 areas. Usually it is easy to introduce Six Sigma to manufacturing processes first, and then service areas and R&D areas. However, the order really depends on the current circumstances of the company.

It is easy to introduce Six Sigma to manufacturing processes first, and then service areas and R&D areas.

Fourth, the GB and BB educations are the most important ingredients for Six Sigma. Usually, the GB education lasts one week, and the BB education lasts 4 months. Each month consists of one week lecture and 3 weeks practice. During the 4 months period, each BB is requested to solve a project by himself.

Fifth, deploy CTQs for all departments concerned. When the BB are born, some important CTQ problems should be given to these BB to solve. In principle, the BB should be the project leaders and work as full time workers for quality innovation.

Sixth, in order to introduce Six Sigma firmly, some basic infrastructure is necessary, such as scientific management tools of SPC, MRP (material requirement planning), KM, DBMS and so on. In particular, efficient data acquisition, data storage, data analysis and information dissemination are necessary.

Lastly, one day each month should be declared as the Six Sigma day. One this day, the top management should check the progress of Six Sigma by himself.

On this day, all types of presentation of Six Sigma results can be done, and rewards can be awarded to the persons who did some excellent jobs for Six Sigma.

Problem-solving processes for project activities

The original problem-solving process for Six Sigma developed from Motorola was MAIC which means measurement, analysis, improvement and control. Later, DMAIC instead of MAIC was advocated from GE where D stands for definition. MAIC or DMAIC is mostly used as the unique problem-solving process for manufacturing areas. However, for DFSS there are multiple proposed processes. They are as follows.

(1) DMADV (Define-Measure-Analyse-Design-Verify). MADV was suggested by Motorola for DFSS, and D was added to it for definition. DMADV is similar to DMAIC.

(2) IDOV (Identify-Design-Optimise-Validate). This was suggested by GE and has been used most frequently in practice.

(3) DIDES (Define-Initiate-Design-Execute-Sustain). This was suggested by Qualtec Consulting Company.

It seems that the above problem-solving processes for manufacturing and R&D areas are not quite suitable for service areas. The author believes that DMAR (Define-Measure-Analyse-Redesigning-Implement) is an excellent problem-solving process for non-manufactur-

Problem-solving processes for manufacturing and R&D areas are not quite suitable for service areas.

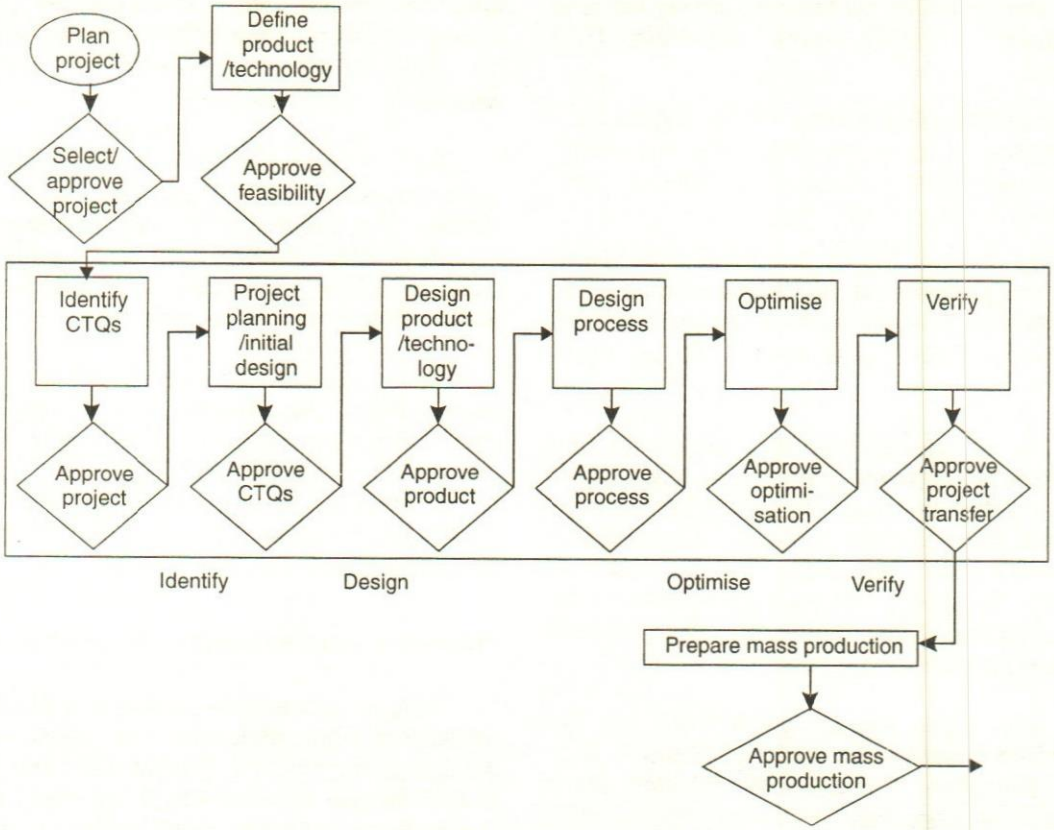


Fig. 3. A typical DFSS process

ing service areas. Here, the phase 'redesign' means that the system for service works should be redesigned in order to improve the service function.

Design for Six Sigma, DFSS

From the author's consulting experiences, it is not easy for a company to adopt DFSS. However, once it is well adopted, the effect is tremendous and the cost savings is great. Figure 3 shows a DFSS process which is quite effective in a research institute. Samsung and LG Electronics are using this process.

In Fig. 3, we saw a typical DFSS process, and the IDOV steps. The major activities and methodologies used in each step can be found in Fig. 4.

There are several problems to be tackled for DFSS implementation. These problems must be solved for smooth introduction of DFSS. They are as follows.

(1) Researchers tend to resist a new introduction of any scientific methodology into their research activities. Hence, their cooperation or approval should be sought before introducing DFSS into their works.

(2) GB or BB education/training is especially necessary, since there are many scientific tools for R&D such as QFD, DOE, simulation techniques, robust designs, regression analysis and so on. For such education/training, textbooks which contain real and practical examples should be carefully prepared in order to make researchers understand why DFSS is a very useful tool.

(3) Project team activities are not popular in R&D departments. In this case, BB should be assigned as full time project leaders. It is desirable that the company gives time, space and necessary financial supports to BB to solve the projects.

Difference between project teams and quality circles

In Six Sigma the project teams lead by BB are the backbone of group activities. However, in TQC or TQM, quality circles are the backbone of group activities. There are some basic differences between these two teams as shown in Table 1. In the old management strategies, TQC and TQM, there are usually two types of team efforts such as task-force-team and quality circle team. The task-force-team

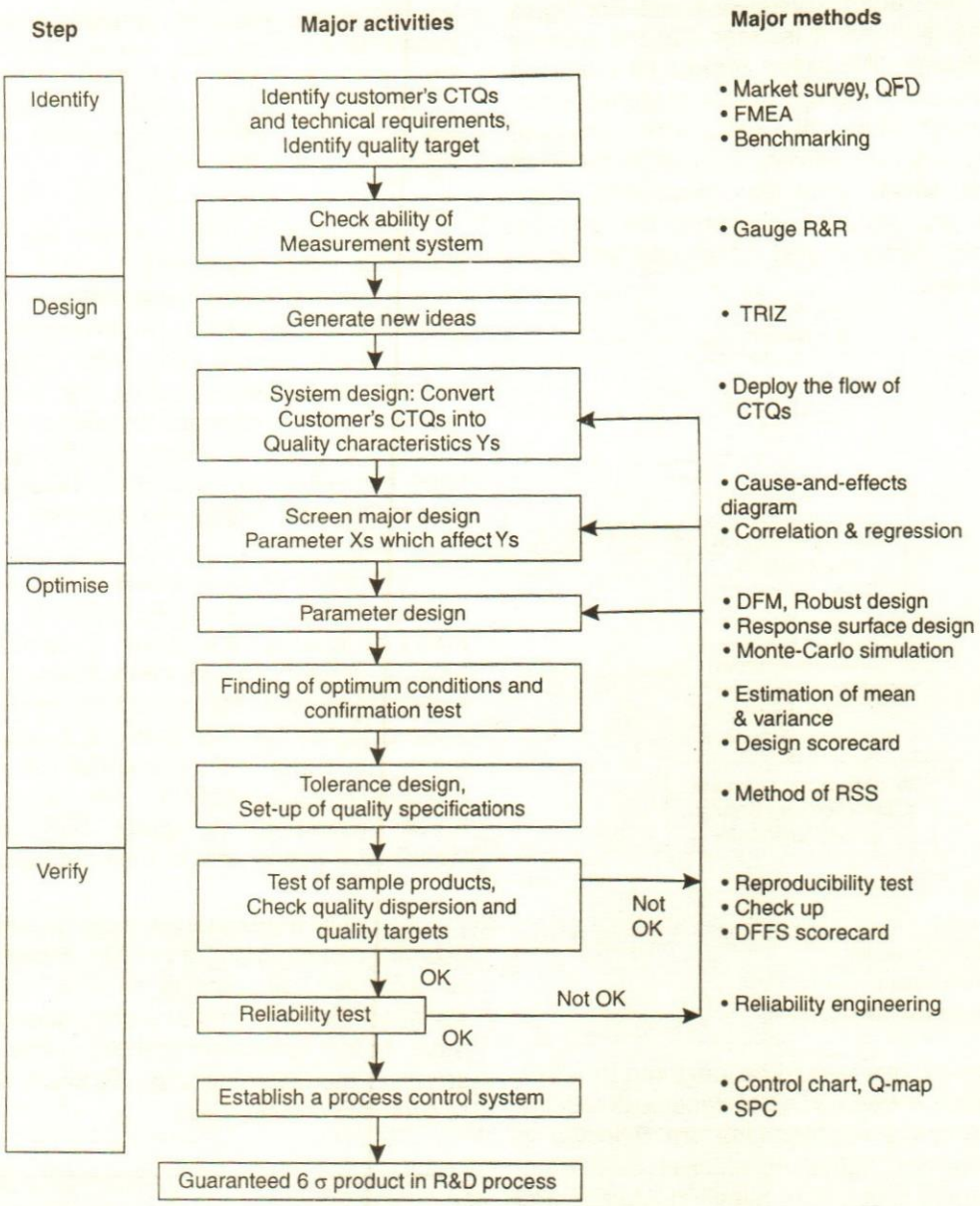


Fig. 4. Major activities and methods in each step of IDOV

mainly consists of engineers and scientists, so called white colours, and the quality circle team consists of operators, so called blue colours. However, in Six Sigma, these two teams are merged into one, whose leader is usually a BB. For the theme selection and the problem-solving flow, the differences are also listed in Table 1.

Depending on the management policy, a company may have project teams and quality circle teams at the same time under the banner of Six Sigma. However, in this case, careful control of two types of teams are necessary.

Table 1: Differences between project team and quality circle

Classification	Project team	Quality circle
Organisation	engineers (or scientists) + operators	operators
Theme selection	top-down company CTQs	bottom-up self-selection
Problem-solving flow	DMAIC, DMADV, IDOV, DMARI	PDCA

Six Sigma for e-business

Recently, it is of great interest to consider Six Sigma

for e- business. The author would like to call Six Sigma for e-business as e-Sigma. It is clear that the ultimate management concept of e-sigma should be customer satisfaction. There are 4 ingredients for customer satisfaction management. They are CQCD which are convenience, quality, cost and delivery. To have an excellent e-Sigma system which provides convenient, high-quality, low-cost and accurate & speedy delivery, the following e-Sigma model should be established in e-business companies.

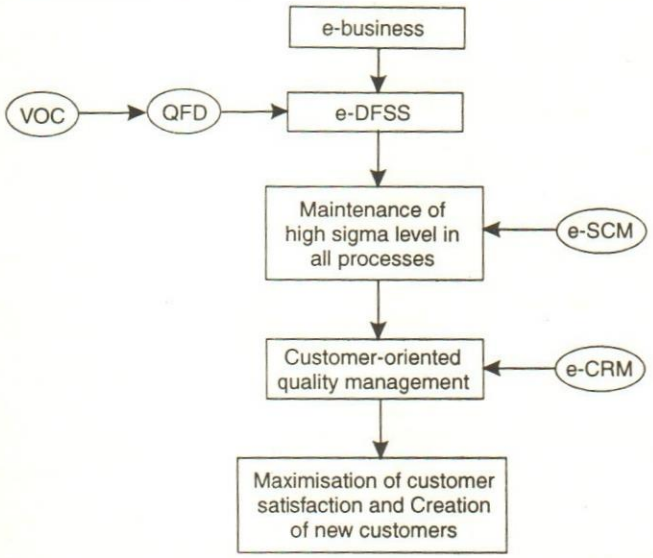


Fig. 5. e-Sigma model

VOC: voice of customer
QFD: quality function deployment
SCM: supply chain management
CRM: customer relationship management

The voice of customer should be input into DFSS by using QFD, which converts VOC to technical requirements. These technical requirements are reflected in design aspects for Six Sigma. An efficient SCM is required for systematic acquisition, handling, storage and transportation of products. In all processes of e-business, each sigma level of each process should be evaluated and improved to assure high-quality performance of each process. For customer-oriented QM, e-CRM is required in e-business. Eventually, such e-Sigma flow will guarantee high-level customer satisfaction and creation of new customers.

Quality Management in Korea Industry

Korean industries, if there were any, were completely destroyed during the Korean War between 1950 and 1953, and the effects of the war lasted for a long time. The birth of Korean QC or QM movements can be said to have begun in 1961 when the Industrial Standardization Act was announced. Over the last 40 years, the firm determination of the Korean people to develop their industry has been successful and, quite remarkably, we have achieved an average of about 8% annual growth in the gross national product. Such development is often called "Han River Miracle" in the 20th century.

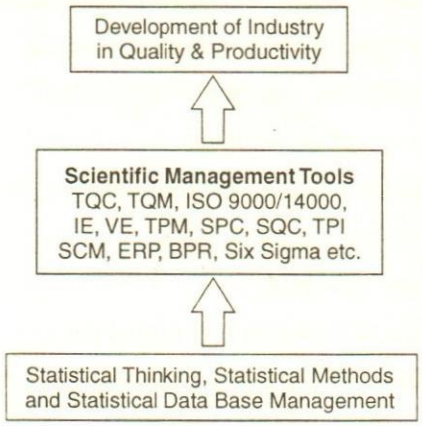
At the present time, however, due to bad effects of economic crisis controlled by IMF, due to large increases in the price of raw materials (especially in oil price), due to strict protectionism by advanced countries and due to ever-challenging competitiveness by other developing countries, the Korean economy is facing a tough challenge. To survive in the international market we have to overcome many difficulties, and need a quality and productivity revolution through the process of total quality management (TQM).

With most of its energies in the past having been largely on the quantitative development of industry, Korea is now at the point of turning its emphasis towards quality in production. Korean people feel that it has become indispensable for enterprises to introduce a higher level of scientific methods of management in order to strengthen their international competitiveness. Recently, this has propelled many Korean companies to adopt TQM, Six Sigma, ISO 9000/14000 series, etc. in their company management.

Scientific management tools should be essentially used for development of industry. However, the basis of all scientific management tools is statistical thinking, statistical methods and/or statistical data base management. In fact, statistical thinking is the beginning of all scientific management tools. Figure 6 shows the rough relationship among these.

Scientific management tools should be essentially used for development of industry.

The contribution of statistics for development of Korean industry has been more than remarkable. I believe that, without the help of statistical methods to industry, Korean industry cannot be developed to the current level of development. This paper first presents the history and the development of QM movements in Korea. Next, it presents how statistical methods are used in Korean industry. And then, some problems encountered in QM movements in Korea are disclosed, then discussed. Finally, some counter-measures to overcome these problems are suggested.



** TQC = Total Quality Control
ISO = International Organisation for Standardization
IE = Industrial Engineering
VE = Value Engineering
TPM = Total productive Maintenance
SPC = Statistical Process Control
SQC = Statistical Quality Control
TPI = Total Productivity Innovation
SCM = Supply Chain Management
ERP = Enterprise Resource Planning
BPR = Business Process Reengineering

Fig. 6. Relationship between scientific management tools, statistical methods and management science tools

History and development of QC/QM activities

The last 40 years can be divided into 3 periods, i.e. introductory, development and expansion periods.

Introductory period (1961-1972)

This period is called introductory since QC-related systems, laws and organisations were established, and standardisation and training QC were initiated. The major events are as follows.

1961. 09: Industrial Standardisation Act enacted.

1962. 03: Korean Standards Association (KSA) established.

1963. 07: Korean Industrial Standards (KS) marking system implemented.

1966. 07: Korean Society for Quality Control (KSQC) established. The name of KSQC has been changed to KSQM (Korean Society for Quality Management).

1970. 03: Quality Control Law for industrial products enacted.

1971. 03: First national qualification examination for certified QC engineers executed.

Development period (1973-1986)

QC/QM activities began to spread rapidly when the TQC concept was introduced in industries in the early part of the 1970s. At the same time, the Korean economy began to make a drastic conversion from light industry to heavy and chemical industry with emphasis on QC/QM. The foundation of the Industrial Advancement Administration (IAA) in 1973 and the first national contest of QC circles marked a turning point in QC movements in Korea.

1973. 01: The Industrial Advancement Administration (IAA) established under the Ministry of Commerce and Industry.

1975. 10: First national contest for QC circles.

1976. 04: First international convention on QC circles (ICQCC '76 - Seoul) held.

1981. 06: Factory grading system for QC introduced.

1983. 11: QC training centre in KSA established.

Expansion period (1987-present)

In this period the TQC/TQM concept spread to small and medium sized industries. TQC/TQM started to be adopted as a management tool and began to be operated as a total systems approach. Also ISO 9000/14000 series were introduced to Korean industry. In late 1990s, the concept of Six Sigma was introduced and, recently, many Korean companies are interested in this quality revolution management of Six Sigma.

1987. 11: ISO 9000 series introduced.

1992. 12: Amendment of Industrial Standardisation Act to include new industrial fields such as services and information processing.

1993. 12: Quality Management Promotion Act promulgated. The KS A/ISO 9000 series adopted as the national standards. Here KS means Korean Industrial standards, and A means a serial number in KS.

1996. 12: KS A/ISO 14000 series adopted as Korean standards.

1997. 01: Six Sigma introduced.

1997. 03: Quality Academy organised. Quality Academy is an organisation in which experts in quality from university-industry-institute study together for development of Korean industry.

Importance of statistics in the new millenium

It is said that the 21st century is the information-based knowledge society. This means that for a company to survive, it should take care of the knowledge as the most important asset, and the knowledge management should be based on information technology. This fact will be true for any organisation such as university, government, research institute, and so on.

Figure 7 shows the knowledge triangle. The fact exists by itself in our society. If we want to obtain some raw data from the fact to understand it, we need some statistical designs such as DOE (design of experiments) or sampling design. Without these statistical designs, we cannot get raw data sets efficiently. From the raw data, in order to obtain useful information, we need to use statistical methods such as data mining tools, regression analysis, multivariate analysis and so on. To obtain valuable knowledge from information, we need some kind of statistical data base to manage information in an efficient way. At this stage, the information technology such as high-speed computers, internet systems, intranet systems, etc. plays an important role.

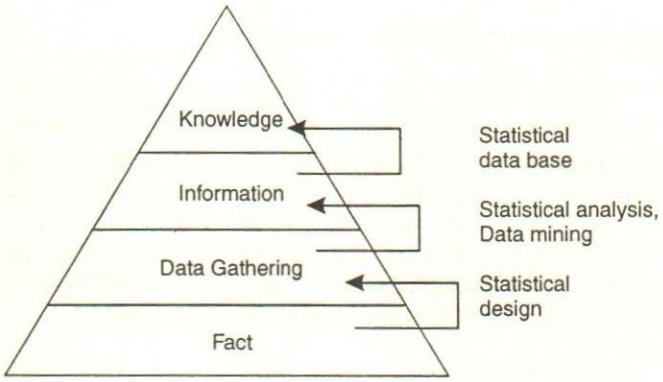


Fig. 7. Knowledge triangle

Note that in Fig. 7 some forms of statistics are involved in each stage from Fact, Data Gathering, Information and Knowledge. This means that statistics is the crucial decision-making science in the so called information-based knowledge society in the new millenium.

Use of statistical methods in Korean industry.

When we talk about the statistical methods used in industry, the following methods are the major ones.

- Seven basic tools of QC – Histogram, Scatter Diagram, Check sheet, Pareto diagram, Statistical graphs, Stratification, Cause-and-effect diagram
- Control charts and sampling inspection
- Correlation and regression analysis
- Hypothesis testing and estimation
- Design of experiments
- Multivariate analysis and reliability theory
- Process capability index
- Gage R&R test
- Taguchi methods and robust design
- SQC/SPC computer statistical system
- Data mining tools

In March 1997, the Quality Academy was organised with quality experts from university, industry and national institutes. This academy implemented a survey in November 1997 to find out the quality competitiveness of Korean companies. For the survey, total 197 manufacturing companies answered the questions which are related to statistical methods.

Use of Statistical Methods

Table 2: Status of use of statistical Methods

Statistical methods	Seven basic tools of QC	Control charts & sampling inspection	Correlation and regression analysis	Hypothesis testing and estimation
Use	189	191	93	117
No-use	6	6	97	75
No-answer	2	0	7	5
Total	197	197	197	197

Statistical methods	Design of experiments	Multivariate analysis & reliability theory	Process capability index	SQC/SPC computer system
Use	78	79	138	134
No-use	111	112	56	61
No-answer	8	6	3	2
Total	197	197	197	197

The population frame for the survey is the 2,810 companies registered at KSA (Korean standards Association) as member companies. The population consists of approximately 50%: 30%: 20% companies of "less than 300 employees": "300-1,000 employees": "more than 1,000 employees", respectively. The sample of 197 companies represents this population pretty well. Since the 2,810 companies in the population are relatively good companies in Korea, the survey results in

Table 2 may somewhat highly estimate the degree of use for statistical methods.

The seven basic tools of QC, control charts & sampling inspection, hypothesis testing and estimation, process capability index and SQC/SPC computer system are pretty well used. However, the correlation and regression analysis, design of experiments and multivariate analysis and reliability theory are not much used. Since the other statistical methods such as Taguchi methods, gage R&R test, and data mining techniques were not involved in the survey, we don't know the degree of use in Korean industry. However, we can guess that not many of these companies use these advanced statistical methods.

Education of statistical methods (SQC/SPC)

In the survey, the number of hours for statistical education in a year, related to SQC/SPC was asked. Table 3 shows the average number of education hours per person per year, which indicates that most companies use less than 20 hours for statistical education. There is no doubt that such education time is not satisfactory.

Table 3: Average hours for statistical education per year

Average hours	Number of companies
less than 10 hours	108
10 - less than 10 hours	59
20 - less than 30 hours	15
30 - less than 40 hours	6
equal to and more than 40 hours	3
Total	197

Application effect of statistical methods on SQC/SPC

However, Table 4 shows that the application effect of statistical methods on SQC/SPC is generally significant. Therefore, even though the education time is not enough, they judge that the degree of application effect of statistical methods on SQC/SPC is significant.

Table 4: Application effect of statistical methods on SQC/SPC

Degree of application effect of statistical methods	Number of companies
Very significant	24
Somewhat significant	107
Average	36
Not very significant	19
Not significant	1
No response	10
Total	197

Application area of statistical methods

In the survey the question of "where do you use the statistical methods" was asked. The results are listed in Table 5, which indicates that the most applicable area of statistical methods is the process control, and then the next area is the inspection and test. As of 1997, statistical methods are not used in the areas of quality planning and design, and market information. However, I believe that the use of statistical methods in R&D and marketing areas is increasing.

Table 5: Application area of statistical methods

Application area of statistical methods	Number of companies
Quality planning and design (R&D part)	18
Process control	80
Inspection and test	47
Market information for quality and claims	5
Total	197

Computerisation of SQC/SPC

In the survey a question was asked on the degree of computerisation of SQC/SPC. It is clear that a good computer system for SQC/SPC is necessary to implement SQC/SPC effectively. Computerised data gathering and automatic computer analysis for key factors and characteristics are essential for a good SQC/SPC system. Table 6 shows how they evaluated their computerisation of SQC/SPC system. Table 6 tells that many companies think that they are more or less at average level in terms of computerisation of SQC/SPC.

Table 6: Degree of computerisation on SCQ/SPC

Degree of computerisation on SQC/SPC	Number of companies
Very high level	15
Relatively high level	36
Average level	83
Relatively low level	43
Very low level	18
Total	197

Data gathering and automatic computer analysis for key factors and characteristics are essential for a good SQC/SPC system.

Degree of contribution of statistical methods for quality/productivity problem solving

Finally, in the survey the question "What is the degree of contribution of statistical methods for quality/productivity problem solving?" was asked. The result indicates that the companies evaluated the contribution of statistical methods for quality/productivity problem solving at a relatively high level.

Table 7: Degree of contribution of statistical methods for quality/productivity problem solving

Degree of contribution of statistical methods for quality/productivity problem solving	Number of companies
Very high level	15
High level	47
Medium level	79
Low level	31
Very low level	6
Total	197

Current problems and future desirable directions of industrial statistics

The previous sections have given a brief outline of QC/QM activities in Korea, and some survey results on the use of statistical methods in industry. Even though Korea has enjoyed, generally speaking, a fast development in economy and in the use of statistical methods in industry, we have encountered several problems and difficulties in promoting statistical methods as discussed below.

It may be noted that similar cases often exist in other countries, and we want to share our experiences and opinions with other relevant persons. When the problems are revealed, desirable future directions to solve the problems can be suggested. Below we want to first point out some problems and difficulties, and to raise possible counter measures to solve those problems.

Statistical education for engineers and scientists

In order to use the statistical methods for QC/QM activities in industry, the engineers/scientists should understand the pertinent statistical methods. However, for instance, statistical courses are only optional for engineering students, and they usually do not take the statistical courses. The companies do not educate the engineers with statistical methods, hence the engineers are not really capable of using statistical methods for quality/productivity problem solving.

Engineers are not really capable of using statistical methods for quality/productivity problem solving.

The workers/operators in industry have not had enough opportunities for education in statistics. Table 3 shows that the average hours for a worker to receive statistical education a year is less than 20 hours. This is just not enough.

I believe that two courses should be compulsory for all engineering students. One course is the introductory statistics course, and another one is the empirical model building and experimental design course. For workers in industry, I believe that at least 40 hours a year should be allocated for statistical education.

Statistical softwares in Korean language

We do not have good Korean softwares such as SAS, SPSS, Minitab, S and so on. This is the responsibility of Korean statisticians.

For quality/productivity problem solving, a small-sized software for personal computers can be used. A few groups of Korean statisticians have been interested in developing statistical softwares, but it may take a long time to develop as good a statistical software as SAS or SPSS. Fortunately, there are some small-sized statistical softwares emerging recently such as ISP (Information Statistical Processor), Spectrum, Sigma Prism and so on which are written in Korean.

Use of scientific QC/QM methods

Many managers and engineers in industry are not well aware of the power and usefulness of scientific QC/QM methods such as SPC (Statistical Process Control), DOE (Design of Experiments), reliability analysis, TPM (Total Productive Maintenance), IE (Industrial Engineering) and so on. Even though there are many certified QC engineers in Korean industries, it seems that they are not very active in using some of the scientific QC/QM tools. Since they do not use scientific tools much, consequently they do not use industrial statistics much.

In order to advance the current status of industrial statistics to a further level, more scientific QC/QM tools should be actively used, and some related statistical softwares should be provided. Perhaps the best way to activate the use of industrial statistics is to organise project teams, and let them use the statistical tools for their problem solving.

The best way to activate the use of industrial statistics is to organise project teams, and let them use the statistical tools for their problem solving.

Fortunately, as Six Sigma is introduced in Korea, many companies which adopt Six Sigma start to form many project teams and use statistical methods. We are in fact quite encouraged by Six Sigma management in Korean industry.

Reliable data gathering, and use of information technology

Since the industrial situation becomes more complex and a lot of variables are involved, we need to obtain large data sets for the complex industrial systems. However, modern technology is still not capable of handling large data sets. Moreover, most top managers of the old generation do not understand the current changing society with fast information technology.

We need to prepare and quickly go ahead to cope with complex industrial systems by using modern information technology and good statistical tools such as data mining and large-scale data analysis tools.

Statistical academic circles

At the end of 1999, the number of universities which have the statistical education programme is over 70, which is about half of all universities in Korea. And, every year more than 2000 college graduates majoring in statistics come out into society. However, they do not satisfactorily play their roles in society including industry. One major reason for this problem is that many statistical professors are theoretically interested in statistics, but they do not know how to teach statistical application to their students.

I believe that statistical academic circles should be more interested in applied statistics, including industrial statistics. Then students could get more application oriented education in statistics.

Statistical academic circles should be more interested in applied statistics, including industrial statistics.

Concluding remarks

This paper dealt with Six Sigma and its role in quality management. Since many aspects are based on Korean experiences, some of them are not quite true for other countries. However, the author believes that the general trend is right. The author believes that Six Sigma is the best strategy for quality management so far in this new millennium. Since the concept of e- business is changing, the concept of e-Sigma may soon change. The concept of Six Sigma for e-business will emerge more as e-business steadily prospers.

Now is the right time in industrial and academic circles in Korea to reflect upon whether industrial statistics has been playing the right role for development of Korean industry.

Several problems and difficulties we have in using statistical methods in industry have been disclosed and possible counter-measures suggested. We hope that eventually industrial statistics can be strengthened in Korea, and keep contributing to the development of Korea economy.

References

Bhote K.R. (1989), "Motorola's long march to the Malcolm Baldrige National Quality Award, National Productivity Review, 8(4), pp. 365-376.

Harry M.J. (1998), "Six Sigma: A Breakthrough Strategy for Profitability", Quality progress, May, pp. 60-64.

Korean Standard Association, (2000), "Industrial standardization and quality management promotion", unpublished paper.

Korean National Institute for Technology and Quality (1998), "Handbook for Quality Competitiveness in Manufacturing Companies in Korea".

Losianowycz G. (1999), "Six Sigma Quality: A Driver to Cultural Change & Improvement, an invited lecture by Korean Standards Association at Seoul".

Park, Sung H. (1992), "Quality control movement in Korea: past, present and future", Total Quality Management, Vol. 3, No. 1.

Park, Sung H. (1999), "Reliability management and education in manufacturing industries", European Journal of Engineering Education, Vol. 24, No. 3.

Park, S.H. and Kim, K.H. (2000), "A study of Six Sigma for R&D part", Quality Revolution, 1(1), Korean Society for Quality Management, pp. 51-65.

Park, S.H., Lee, M.J. and Chung, M.Y. (1999), "Theory and Practice of Six Sigma", Publishing Division of Korean Standards Association, Seoul.

Park S.H., Lee, M.J. and Lee K.K. (2001), "Design for Six Sigma", Publishing Division of Korean Standards Association, Seoul.

Park, Sung H. and Sun Ju D. (1993), "Quality control activities and statistical computing in Korea", Proceedings of the 49th Session of International Statistical Institute, Firenze, Italy.

Tomkins R. (1997, October 10), "GE beats expected 13% rise", Financial Times, pp.22. □

Six Sigma: Singapore's Response to the DMAIC Challenge

John Man

This article provides a detailed discussion of the use of six sigma by singaporean companies. It traces the history and development of six sigma methodology, with references to actual facts and data about the use of six sigma in Singapore.

John Man is from Smart Process International, Singapore. Excerpted from APO-NPC Seminar on Six Sigma Management, New Delhi, 10th August 2001.

The Six Sigma ideology was promoted in Singapore by leading American multinational companies. In the 1980s, Motorola Championed the idea in their manufacturing foundry. As in most cases, ideas about quality improvement and total quality were diffused through such channels. Interestingly, a Sigma college was created by an informal arrangement when some leading electronics multi nationals decided that they should network and share experiences in using the methodology. The network included Motorola, Advance Micro Devices, Texas Instruments, and Western Digital.

The Changing fortunes that forced many multinationals to restructure took place in 1995. We know this as the Asian economic crisis. The members of Sigma College went their separate ways. Motorola remained faithful. There were also new entrants such as Seagate, 3M, Singapore Technologies group and Chartered Semiconductors.

The Climate for new ideas

The early experiments did not augment well for the practice and use of the Six Sigma methodology. In more recent times, the concept is gaining new support.

The Singapore Productivity and Standards Board (PSB) now acknowledges its efficacy in the promotion and application of Six Sigma methods by teams. This is in support of the national drive for creativity and innovation.

Managers in Singapore are quickly impressed with new approaches and ideas. We are guilty of what is often termed as Excessive Activity Syndrome (EAS). A quick 'walk through' the businesses, enterprises and government departments will reveal that management and employees are gripped with the concern to increase productivity and improve the quality of work methods and processes. The government plays an

active role in sponsoring, promoting and developing many of the initiatives that focus on creating a thinking and innovative work climate. People are a vital resource and the work attitudes and skill performance is constantly upgraded through numerous programmes.

The Quality Control Circles and Work Improvement Teams movement that became a national movement in 1981 is constantly rejuvenated. Today close to 40 per cent of the work force is involved in such activities and programmes. The search for the inception of foreign talent plays a vital role in exposing organisations to new approaches and methods.

The search for a 'game plan'

Six Sigma methodology in most parts is one such programme amongst many. The search remains for an integrated model that can offer a comprehensive 'game plan' that organisations can use to focus on improvement, innovation and productivity.

The Singapore Quality Award and Singapore Quality Class awards were introduced in 1996. Based on creating a 'balance scorecard', these awards have succeeded in creating the much-awaited model for excellence. But, like most certification schemes, many of these schemes are often seen as 'ends' rather than the 'means' that sustain the organisation's survival and competitiveness.

When Dr. Joseph Juran visited Singapore in 1987, people asked if there was a 'short cut', a simpler approach, an easier model that could be adopted for quality management and improvements.

Those who asked this of Dr. Juran had little patience for developing measurements and data collection and sharing systems. They were asking for painless approaches to realising success.

Since then we have received and heard many prominent thinkers and practitioners on the subject of quality improvement and innovation. The list of distinguished visitors included P. Crosby, K. Ishikawa, Lester Thurow, Bill Gates, and others. The message presented was clear. Quality improvement and innovation comes from thinking minds that are willing to experiment and measure performance. There were no quick fixes.

Quality improvement and innovation comes from thinking minds that are willing to experiment.

Unfortunately, these leading 'gurus' and their messages are not well internalised. The Six Sigma methodology alongside many other 'remedies' are seen as popular methods and the use is dependent on the 'flavour of the month' approach in most organisations.

News about General Electric's application of Six Sigma methods soon made inroads in the minds of management. Jack Welch's belief and testimony was enough for most people to stand up and take a closer look at the methodology. To some extent the assessors of the Excellence awards suggested that organisations should have a 'closed loop system' to bring into focus the 'voice of the customer' issues.

The Six Sigma approach could provide the 'apparatus' for developing a scheme that would assess the organisation's capability and approach to eliminate 'loss to the customer'. The floodgates were now opened. Major conferences and speakers expounded the issues and dimensions of the Six Sigma approach.

Assessing the response – phenomenological study

A phenomenological study of the response of organisations illustrates the lack luster enthusiasm to this new wave and awakening.

A leading semiconductor foundry proclaims the ideology 'Six Sigma in everything that we do'; that the basic work value is to achieve the Six Sigma standard. The proclamations are grand and well documented in the organisation's corporate vision and mission statements and corporate business plan. The organisation brings in consultants and trains managers and senior engineers to take the roles of Six Sigma Champions. Master Black Belts are developed and the Six Sigma deployment is completed at the cost of US$ 1.2m. The infrastructure is in place. The moment of truth comes when measurements are required on the key performance indicators, defects per opportunities and sigma levels.

At this point the same organisation explains that Six Sigma is used to get people to adopt the mindset and that it is not yet ready to use the measurements and rigour of data to define sigma levels and standards. The contradiction is obvious indeed.

Data and measurements

Another semiconductor organisation announces

that Six Sigma is much too technical and encompasses the need for tracking data that is much too time consuming. This organisation decides to use the 8D model for problem solving; a method that is suited more for dealing with routine problems instead of designing processes that seek to eliminate variability and implement new standards of performance.

Key business performance indicators

In a large government organisation, a senior manager asks, 'what is needed to start a Six Sigma programme?' After listening to the expectations of the Define, Measure, Improve and Control (DMAIC) requirements, he concludes that the organisation is not yet ready to work with the concept. He says, 'we still have some way to go to develop measurements that would indicate our baseline performance standards'. The manager suggests that perhaps we should first appreciate the concept before we embark on any serious action.

A director from a creative multinational corporation proudly announces that the organisation is already at Six Sigma. The organisation identifies modest levels of defectives and defects per unit and opportunities per defect. With precise use of statistics, it shows that it has already arrived. Even GE still believes that they are not yet at five sigma. Yet here is an organisation here that is nowhere near the fortunes of GE that proclaims that Six Sigma is complete.

Sigma levels

A study of Six Sigma will show that at 2-3 sigma levels, the organisation is still using the basic statistical methods and techniques to eliminate problems. A company at 2-3 sigma is wrestling with routine 'fires'. A 4-5 sigma level organisation is designing new processes. The aim is to obtain 3.4 million parts per million-defect rate through process design. This is the concept, which works with Design for Six Sigma (DFSS). The type of tools that are in use here would include Design of Experiments (DOE). Clearly there is little scope for experiments when the organisation is averse to risk and seeks to control quality levels rather than shift 'mindsets' on the delivery of products and services that achieve 'zero loss to the customer' at the lowest possible cost to the organisation.

Evidence and actual practice

A study of the organisations who are recognized annually for their productivity and quality achievements in Singapore show that in 87 per cent of cases the projects are based on low levels of analysis of equipment and performance tracking.

In most cases the projects are an evaluation of known solutions. The learning dimension is clouded by assumptions and judgments rather than clear measurements and facts. The project selection is based on directions from upper management who prefer to explore their intuitions rather than use an intelligent questioning process to identify critical design and process issues.

The learning dimension is clouded by assumptions and judgments rather than clear measurements and facts.

In many cases the data collected is biased for areas that are suspected as the 'root causes'. The solutions produced soon fade away with the departure of the incumbents that start the project. Finally, the projects are largely a one-time effort based on the wisdom and talents of a few rather than a discovery of innovations through a process of participation with the stakeholders.

Today, the quality movement in Singapore boasts of impressive numbers. A senior government official once asked, 'what lies behind the numbers'? The evidence of significant 'turn a rounds' and impressive changes arising from the projects completed by teams using various methods of analysis is weak. Even the organisations that profess using Six Sigma methods admit that much of the savings derived from these projects are not verified.

There is clearly a gap in what remains as the form and substance of the quality efforts. Each year, at the launch of the national productivity campaign, impressive gains are publicised arising from the participation of the work force in quality improvement programmes. In 2000 alone, the savings reported exceeded tens of millions of dollars. The numbers impress but soon get drowned in the daily routine of organisational life. The sustenance, tracking and future improvements to these efforts do not surface.

Taking up the challenge – imperatives

The Six Sigma challenge is a formidable one. We need to recognise the imperatives.

- Firstly, senior management's transparency is

critical. In a learning organisation, information on vital business directions is shared.

- Secondly, the management's actions to facilitate the breakthrough process are visible and concrete.
- Thirdly, management invests time and resources in deploying a Six Sigma structure that is directly linked to the operational and business policies.
- Fourthly, the Six Sigma breakthrough methodology is used daily and describes what people in the organisation do. New value is created constantly through the process of questioning, learning, analysing and acting on 'real time' data that tracks the organisation's performance.
- Finally, decisions are derived from the use and application of the methods and techniques that act as the 'lubricant' of the thinking process in Six Sigma.

We are now realising that the Six Sigma methodology forms the basis for matching organisational goals with performance. The methodology requires an investment that is visible. Management and employees are organised in Matrix relationships to identify, diagnose, and find remedies and changes that are aligned to the expectations of the 'stakeholders'.

Action Learning mode

The Six Sigma methodology uses an action-learning mode in practice. Formal training sessions best serve to raise awareness. Clear action items and deliverables are designed to measure and track the implementation of the practice. The Matrix arrangement forms the basis for learning the methods and techniques and applying them directly on 'real time' projects. The themes and projects are tracked for their impact on the key outcomes and measurements of the organisational goals. This is the level of preparedness required for any organisation that ventures into the Six Sigma breakthrough methodology. It is this experience that makes Singapore's response to the DMAIC challenge an instructive one.

The Matrix arrangement forms the basis for learning the methods and techniques.

□

The step-by-step process itself is easy to understand. But process alone is not at issue. ...Managing any kind of change has far-reaching implications. It requires inspired, in-touch leadership.

– Peg Fisher

Statistical Techniques in Six Sigma

P. R. Lakshmikanthan

Six Sigma concept has become a global trend setter in developing Quality management strategy. The success is primarily due to its data based approach, which eliminates personal bias. Statistical techniques are a pack of tools in the repertoire of any decision maker, to arrive at rational decisions. This paper deals with some of the most often used statistical techniques.

P. R. Lakshmikanthan is with the Statistical Quality Control & Operations Research Unit of the Indian Statistical Institute.

Six Sigma developed by Motorola was perfected by General Electric Company as a strategic management tool. The stress on six sigma approach is based on objective decision making. The approach guarantees a man independent and situation independent decision, under given operating conditions called control conditions. The six sigma approach gives a clear cut directive on situation—when to act or when not to act, with stated guarantee.

Since six sigma concepts are based on data, the quality of the data assumes paramount importance. Statistical law of regularity says, if the data comes from a set of controlled conditions the data will exhibit a predictable pattern called statistical models. This paper deals with a set of *statistical models* herein called techniques.

Generic Techniques

Interestingly, the conventional SPC and other techniques like TPM, 5S, TQM etc. also play an important role in the six sigma approach. Cause and effect diagram, checksheet and pareto are techniques for diagnosing the problem. The major distinction for the approach is the identification of the problem. The problem is defined as the hardship faced by a customer (external as well as internal) and the emergence of the problem is due to increased variation. All the techniques are orienting towards identifying source of variation, and controling the variation.

Another generic technique is called the process map or flow diagram. The technique is highly useful in administrative process like sale, finance etc. For example, a bank wants to attract the customer by giving faster service on making drafts. The draft making process is detailed out through unit activities. This approach gives a scope to eliminate non value addition activities and also helps to plan parallel processing for reduction of cycletime.

Process map or flow diagram. Is highly useful in administrative process like sale, finance

When the data collection becomes difficult and time consuming a generic technique called FMEA – *Failure Mode effect analysis* (sometimes success mode also) is used to prioritise the area of action. This technique is based on brain storming approach. A team of 4 to 5 experts participate in the deliberation. Failure is defined as any non compliance of customer requirement – explicit or implicit. Modes are possible reasons responsible for failure. Effect is the impact analysis on the failure. The analysis is based on three important components (a) occurrence (b) impact or effect (c) detectability or able to detect occurrence. A scale of 1-10 is decided and each expert is asked to give his opinion on a 1-10 scale. Any major disparity is resolved through *consensus and not by voting or averaging.* The product of the three numbers is called risk priority or probability number (RPN). Actions are initiated to reduce the occurrence or improve detectability.

Stratification and disaggregation analysis are used to find the internal bench mark of a process. It is known that there are some good performances in a system which can be bench marked. For example, when there are several identical power presses working, one can find some of them will have less breakdowns compared to the rest. The reasons for less breakdown lead to an over all improvement in other presses also. In cycle time reduction problems some processes may be taking more time. Actions on this sub process will improve over all performance.

Data oriented statistical techniques

As mentioned earlier, the approach of six sigma is to identify the variation and its sources. Variation is split into two parts (a) common cause variation (b) special cause variation. Common cause variation is due to the influence of random occurrences of various factors. For example, a heart beat of a normal man 72 ±2. ±2 gives the concept of common cause variation. Special cause variation is influenced by a known ascribable set of factors disturbing the pattern of common cause variation. The understanding of common cause variation and the limits becomes the fulcrum of data based statistical techniques.

The understanding of common cause variation, becomes the fulcrum of data based statistical techniques.

When a system operates under a set of standard operating conditions, the variation from the system is termed as common cause variation. When the system misbehaves or malfunctions the situation indicates the presence of special cause variation – thus indicating changes in one or many of the control conditions. The technology and process knowledge will help in pinpointing the action plans.

Some Statistical Models : BINOMIAL

The control conditions are –

(a) the out come must be Yes / no type

(b) out come has to be integer between zero and n - no. of items tested

employees, attrition rates, defective letter of credits, defective items etc. follow this pattern. The model is described by (a) no. of sample (b) proportion of defectives expected. Model is $\binom{n}{r} (p)^r (1-p)^{n-r}$

The two key indices are avg = np and standard-deviation - a measure of common cause variation $V\ np\ (1-p)$

How to use?

Suppose there are 100 employees in a company and 10 out of 100 is the average absenteeism rate under common cause variation; this could be as large as $10 \pm \sqrt{(10)\ (0.9)} = 19$ or as low as $10 - 3\sqrt{10 \times 0.9} = 1$, where 3 is a confidence factor of 99.73%. It means the system is stable as long as the absenteeism rate fluctuates between 1 and 19. This model is used when the critical to Quality parameter (CTQ) is defective.

Poison Models

In real life application defective will not lead to correct problem diagnosis as there are many types of defects possible for a defective product. For example, a defective picture tube may be because of electronic faults, electrical faults, visual faults etc. Their occurrences and remedial actions are totally different. Hence defects per million opportunities (DPMO) concepts are used. DPMO follows the Poisson model. The model is

$$\frac{e^{-\lambda}\lambda^{x}}{x!} x = 0,1,2,\ldots\infty$$

For example, an average DMPMO of 9 will have a band of $9 \pm 3\sqrt{9}$ is 0 to 18 under common cause variation.

Normal Model

When the data becomes measurable in nature this model is invariably used. It is characterised by Average and Std. deviation. The Std. deviation is the measure of common cause variation. For example, outside diameter of a shaft has Avg. 1.5 and Std. deviation 0.001 implies the outside diameter can vary from 1.497 to 1.503 (±3 Std. from Average) under common cause variation. These limits can be used to detect the presence of special cause variation.

Negative Exponential Model

When the data is measurable in nature and by and large one sided specification is given, this model is used. For example, concept of delay in systems, concept of overdrawn accounts in bank etc. follows this model. The model is $\theta e^{-\theta x} x \geq 0\ \theta > 0$ where θ is the parameter of the model. For the model Avg. and Std. deviation are same.

Process Capability

Process capability is defined as the extent of natural or common cause variation under a given set of operating conditions. Under assumption of Normality it is defined as 6 Std. deviation. When compared with the customer's requirements this concept evaluates the Customer dissatisfaction level. C_p Index, defined as Width provided by customer (upper spec. limit-lower spec. limit) divided by process width (6 Std. deviation) is a key indicator. $C_p = \perp$ will mean 2700 ppm will be rejection C_p = 1.33 will mean 80 ppm rejection $C_p = 2.0$ will mean .0018 ppm rejection.

Another indicator called C_{pk} index defined as

$$Min\left[\frac{USL-\bar{X}}{3Std.\ deviation}, \frac{\bar{X}-LSL}{3Std.\ deviation}\right]$$

is also extremely useful. This index indicates where the process is centred. Ideally speaking, $C_p \geq C_{pk} \geq 2.0$ will give practically defect free performance.

Inferential Statistical Techniques

Basically the application of statistical techniques can be equated to search theory. At every juncture a conjecture is made and acceptance or rejection of the conjecture is made through *Statistical tests of Significance.* Tests of Significance are the key techniques to differentiate common cause variation from special cause variation - hence reflecting on the status quo laid down, control conditions or change in control conditions. These tests require small samples only and give a guaranteed differentiation. Some of the tests which are used in Six Sigma application are–

(a) *t* tests for averages

(b) x^2, *F* tests for variances

(c) Non parametric tests like Mann-Whitney, Kruscal Wallis etc.

Application of statistical techniques can be equated to search theory.

Improve Phase Techniques

The maxim of Six Sigma is 'To days' common cause variation is tomorrows' special cause variation. There is always a customer squeeze on the CTQ. Hence optimisation techniques are required. Design of Experiments with special emphasis on Taguchi's methods are extensively used.

Control Phase Techniques

Results achieved through Six Sigma methodology will have to be monitored. Control charts are used to monitor the systems performance. Some of the frequently used charts are $\bar{X} - R$, moving range charts, *p* or *np* charts, *c* charts and *u* charts. The conditions under which these charts are used, are given below:

Chart type	Conditions	Examples
$\bar{X} - R$	1. Measurable data production	Control of outside diameter of shafts
	2. Normal distribution	
	3. Fast production	
Moving range	1. Measurable data production	Transaction time of opening of letter of credit
	2. Normal distribution	
	3. Fast production	

p or *np* charts	Data Attribute Binomial Distribution	Defective control absenteeism control
c or *u* charts	Data Attribute Poisson Distribution	Defects control (DPMO) Errors in L.C. making

Conclusion

These techniques are so powerful that rationality of decision is ensured. There are no restrictions that control phase techniques should be used only in control phase and not in any other phase. Depending on the need of the problem and availability of data, techniques are used. In short statistical techniques do not require volume of data but requires good quality data of a smaller set. Understanding the Control Conditions are very important in the application of Six Sigma Statistical techniques.

□

Elegance of language may not be in the power of all of us; but simplicity and straight forwardness are. Write much as you would speak; speak as you think. If with your inferior, speak no coarser than usual; if with your superiors, no finer. Be what you say; and, within the rules of prudence, say what you are.

– Alford

Six Sigma in Bulb Manufacturing

Jugal Prasad

This article outlines the six sigma initiatives taken by a company to reduce shell crack during the manufacturing of bulbs. By means of several diagrams the significant improvements in the processes have been shown.

Jugal Prasad is a Six Sigma Consultant with the Institute of Quality Limited, New Delhi.

This work was delineated in a company based in Noida. The Company set-up fully automatic facility for manufacturing of Halogen Automotive Lamps and Compact Fluorescent Lamps (CFL).

Recently the company has started Six Sigma in order to achieve breakthrough improvements in their process. Most of the company's processes were operating at 3 to 4 sigma level. They were handicapped with the basic quality improvement tools in further enhancing its quality.

The company started the initiative with training for Champions and Black Belts. Tooled up with Six Sigma tools they started solving the chronic problems at their end.

Problem

Shell crack during the manufacturing process was one of the chronic problems and was to the order of 2.32 per cent.

Objective: Reducing the Shell Crack was taken up for study using Six Sigma methodology.

Tools Used

Define

- Walking through the process (PFD)
- Pareto Analysis

Measure

- Sigma Level
- Use of Measurement System Analysis

Analyse

- Brainstorming to identify potential causes
- Identifying the potential factors and their level

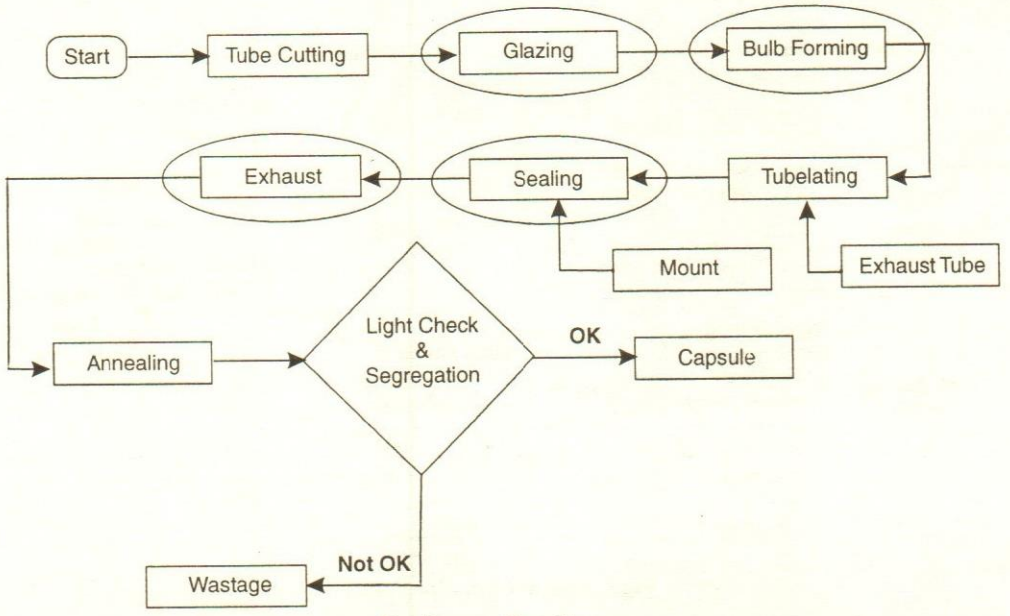


Fig. Process Flow Diagram

Improve

- Design of Experiment
  - Conducting 2 level design of experiment for optimising the factors and their levels
  - Verifying those factors (Switching on and off)
  - 3 level experiments for further optimisation

Control

- Developing the control plans
- Poka Yoke
- Control Charts

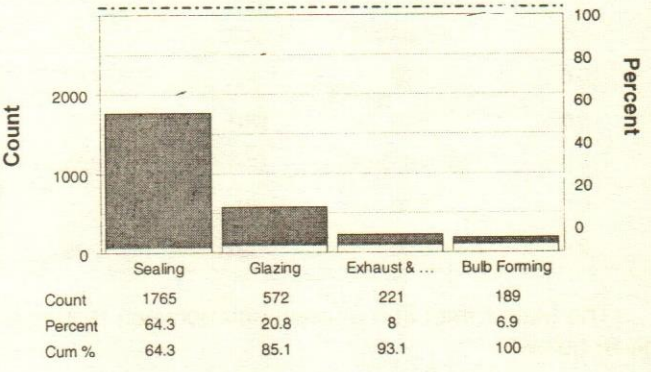
Walking through process diagram

- Depicting the origin of cracks at four different locations
  - Glazing
  - Bulb forming
  - Sealing and Exhaust

From Pareto analysis it is clear that 85 per cent of the problem is during sealing and glazing operations.

Diagram showing the probable causes and factors which can be controlled to optimise the result.

Pareto Analysis of Shell Crack



Count	1765	572	221	189
Percent	64.3	20.8	8	6.9
Cum %	64.3	85.1	93.1	100

Data Collection and Pareto Analysis

Design of Experiments

Parameter optimisation using Design of Experiments:

Identified factors for experimentation

- LPG/O2 pressure
- Air pressure
- Burner location

Here burner location is a discrete factor and the levels are 'In' and 'Out' position. A full factorial design is planned to run the experiment. The experimental plan and the result is given below:

Probable causes of the problem

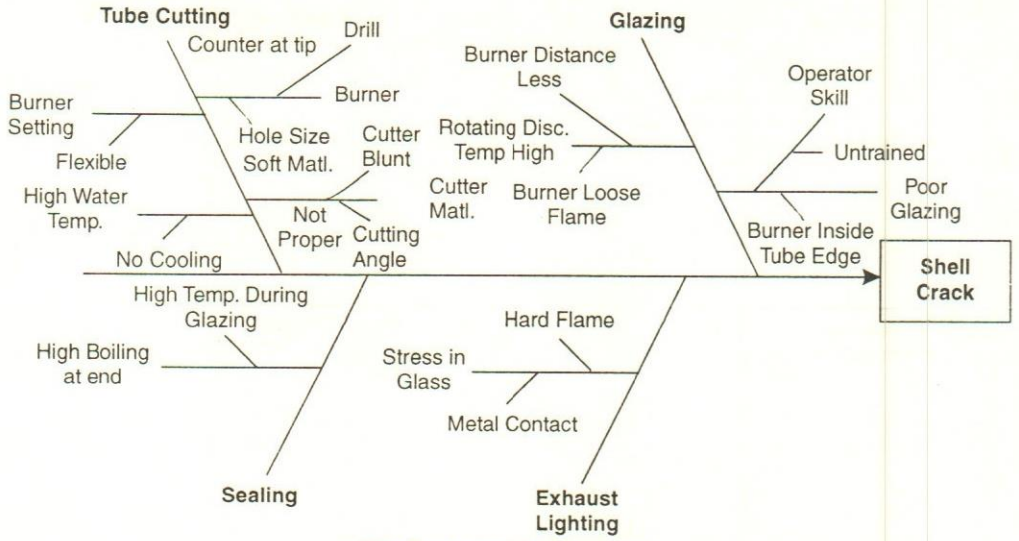
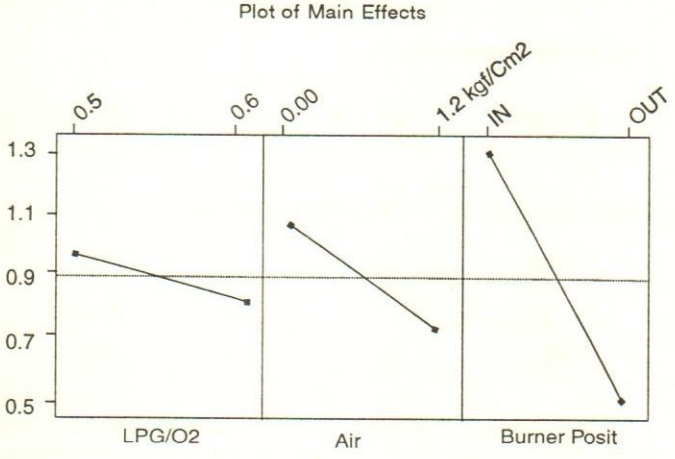


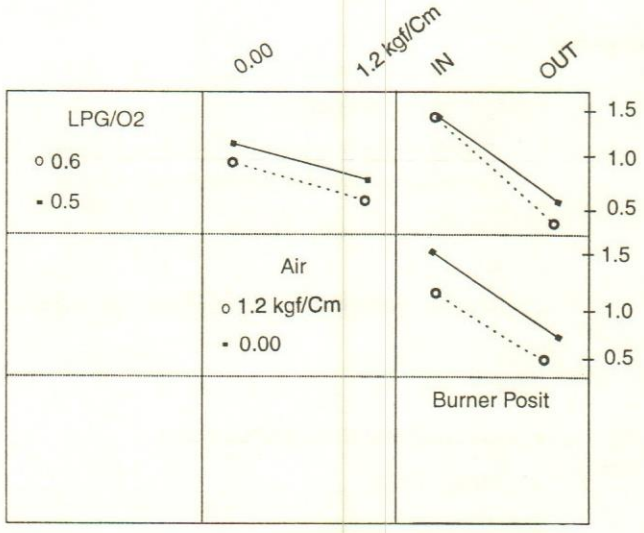
Fig. Cause and Effect Analysis

LPG/O2	Air	Burner Position	%Crack
0.5	1.2 Kgf/Cm2	IN	1.35
0.6	1.2 Kgf/Cm2	IN	0.84
0.5	1.2 Kgf/Cm2	OUT	0.24
0.6	0.00	IN	1.67
0.5	0.00	OUT	0.96
0.6	1.2 Kgf/Cm2	OUT	0.51
0.5	0.00	IN	1.25
0.6	0.00	OUT	0.29

The Main Effect and Interactions between factors is given below:



It is clear from the main effect plot, that air pressure and burner positions significantly effect shell crack.



Interaction Plot (data means) for % Crack

3-Level Full factorial design

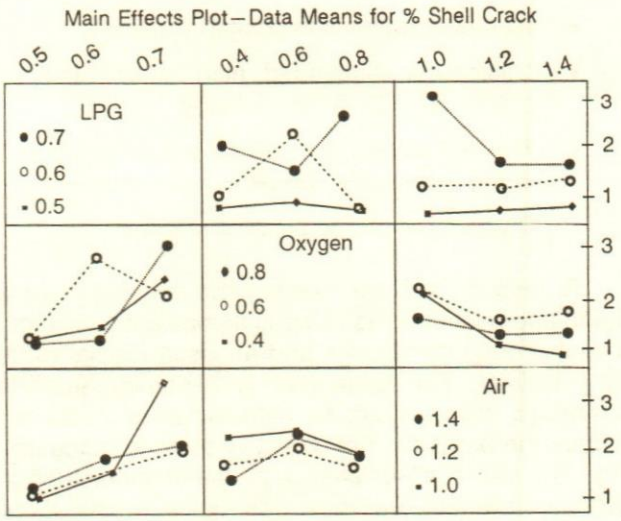
Exp. No.	LPG	Oxygen	Air	% Shell Crack
1	0.5	0.4	1.0	0.33
2	0.5	0.4	1.2	0.56
3	0.5	0.4	1.4	0.57
4	0.5	0.6	1.0	0.23
5	0.5	0.6	1.2	0.60
6	0.5	0.6	1.4	0.93
7	0.5	0.8	1.0	0.56
8	0.5	0.8	1.2	0.28
9	0.5	0.8	1.4	0.42
10	0.6	0.4	1.0	1.05

11	0.6	0.4	1.2	1.00
12	0.6	0.4	1.4	0.45
13	0.6	0.6	1.0	2.00
14	0.6	0.6	1.2	2.16
15	0.6	0.6	1.4	3.00
16	0.6	0.8	1.0	0.41
17	0.6	0.8	1.2	0.20
18	0.6	0.8	1.4	0.80
19	0.7	0.4	1.0	3.60
20	0.7	0.4	1.2	1.10
21	0.7	0.4	1.4	1.20
22	0.7	0.6	1.0	3.00
23	0.7	0.6	1.2	0.95
24	0.7	0.6	1.4	0.94
25	0.7	0.8	1.0	3.00
26	0.7	0.8	1.2	2.80
27	0.7	0.8	1.4	2.70

17th experiment gives the best result, which is 0.20% rejection.

From the interaction plot it is clear that there is no significant interaction between the factors. The 6th experiment in the standard order gives the best result, that is 0.29 per cent on the sealing machine. The crack earlier was 1.49% on the same machine. It was further tried to reduce the shell crack by fixing the burner location at the 'out' position and splitting the LPG/O2 into two independent factors and also by changing the levels of the factors. A three level full factorial design was conducted.

The main effect plot and interaction plots are given below:



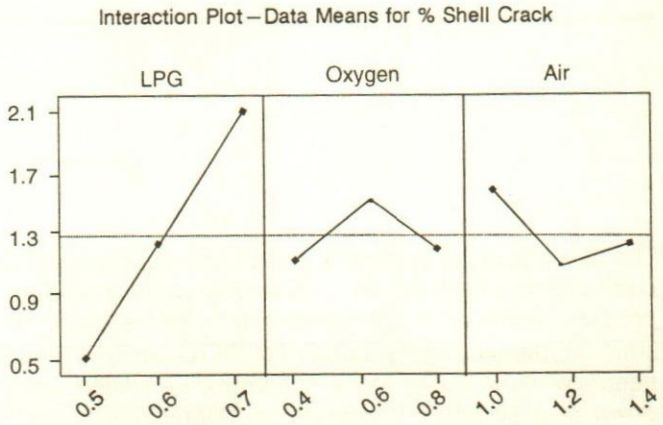
From main effect plot it is clear that LPG is a significant factor. However, seeing the interaction and keeping LPG at low level the shell crack increased.

The final setting has been decided as:

LPG at 0.6

Oxygen at 0.8

Air at 1.2 AND Burner position 'out'.



Till date the rejection on the sealing machine is maintained at 0.20 per cent. It is necessary to hold the gain using Poka Yoke on burner location.

Verification

The experimental results have been verified by switching on and off, leading to the result authenticity.

Control

Control chart (p chart) has been deployed to control the process.

Benefit

The whole process is operating at 4.5 Sigma level, which was earlier 3.2-sigma level, resulting in significant improvement in the bottom line. □

Focus

Six Sigma in Manufacturing

Pradeep Kumar

The fast changing economic conditions such as global competition, customer demand for high quality product, product variety and reduced lead-time had a major impact on manufacturing industries. To respond to these needs while keeping manufacturing and related costs down is a constant challenge to manufacturing companies. The issue that is becoming important nowadays is to reduce the production of defective parts in manufacturing. This issue can well be addressed by implementing Six sigma, the latest and most powerful methodology, in the manufacturing industries. In the present paper a framework for the implementation of six-sigma in manufacturing industries has been presented.

Pradeep Kumar is Associate Professor, Department of Mechanical and Industrial Engineering, Indian Institute of Technology, Roorkee.

Manufacturing is converting raw materials into usable products. A further refinement of this fundamental definition is that these products may be reproduced in quantity, at a quality, which makes them functional, and at a cost, which makes them competitive. This act of replication requires the organisation of product design, materials, special tools and equipments, skilled people, the use of effective manufacturing and control techniques, and the organisation of a management team into a productive system.

Manufacturing is the backbone of any industrialised nation. In 1991, the National Academy of Engineering/Science in Washington, D.C. rated "Manufacturing" as one of three important subjects necessary for America's economic growth and national security, the others being "Science" and "Technology". In Japan the importance of these three subjects were pointed out as early as 1935. In the present scenario and fast changing economic conditions world wide, the following factors had a major impact on manufacturing:

- Global competition increased rapidly, and the markets become multinational and dynamic.
- Market conditions fluctuated widely.
- Customers demanded high quality, low cost products and on-time delivery.
- Product variety increased substantially and became technically complex.
- Product life cycles became shorter.

To respond to these needs while keeping manufacturing and related costs down is a constant challenge to manufacturing companies and an issue crucial to their very survival. The issue that is becoming important nowadays with respect to manufacturing costs is to reduce the production of defective parts in manufacturing. The costs associated with the manufacturing of defective product are known as Quality costs. Quality costs have been categorised as costs of control and costs of failure.

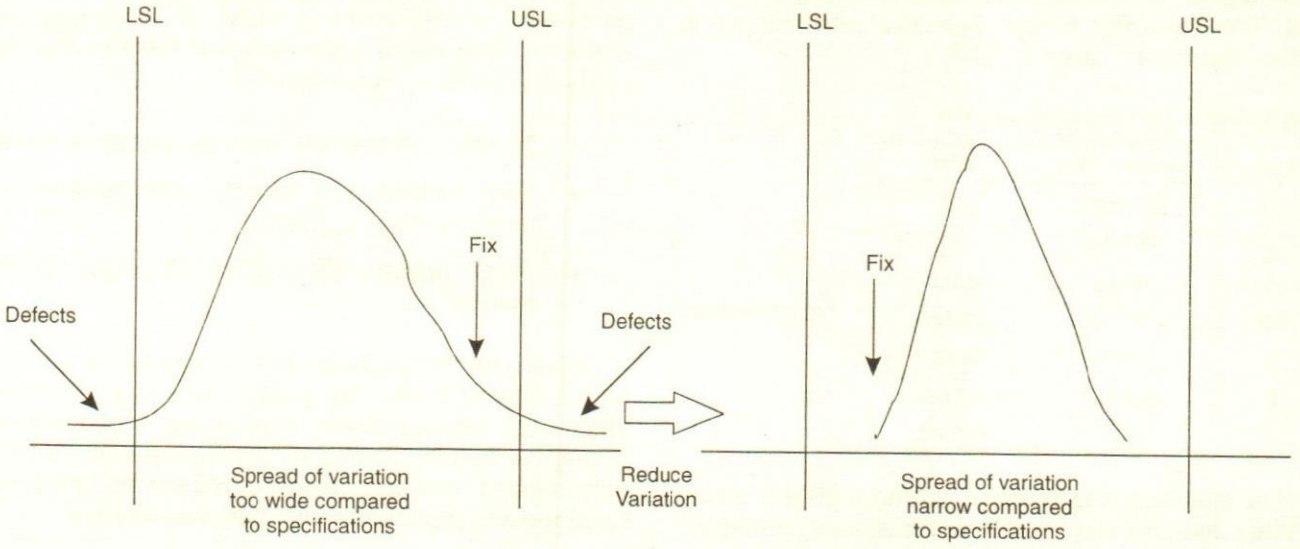


Fig. 1. Importance of Reducing Variation

The process of quality improvement plays a dominant role in reducing the above costs. Activities to integrate quality in manufacturing have two objectives: to prevent defects and to minimize variability in processes. To be more competitive in the market there should be continuous improvement, waste elimination, customer focus etc. There are different tools available to control and improve the quality while keeping the cost low, with minimum lead-time. Some of these tools are Quality Function Deployment (QFD), Concurrent Engineering, and Statistical Process Control.

Some philosophies were evolved to use these tools to reach the goals of an organisation as well as customer satisfaction. Quality Circles, JIT, TQM, and Six Sigma are some of these philosophies. Six Sigma is the latest and most powerful methodology in reducing defective parts so that quality is improved and cost is reduced.

Concept of Six Sigma

Six sigma is an approach to continually improve and reduce variations is the processes that contribute to waste and poor quality. It is a measure of how well a process is performing. Six sigma is a well structured, data driven methodology for eliminating defects, waste, or quality control problems of all kinds in manufacturing, service delivery, management and other business activities (Pyzdek, T. 1999). It focuses on not making mistakes and reducing the variability in the processes. Six Sigma properly implemented will improve customer satisfaction, significantly improve quality, improve the way we launch new products, and create a continuous improvement mindset. Six Sigma is all about improving the bottom line. It costs less to do it right the first time.

Sigma, σ, is a letter in the Greek alphabet used by statisticians to measure the variability in any process. In business and manufacturing organisations, variations in a process almost always results in defects, rework and scrap. If one can reduce the variation in a process, one can reduce the defects in the process (Reliability Analysis Center, 1999; Harry, Mikel J., 1998).

Six Sigma focuses all functions on "process". Every process/procedure has an expected outcome/measurement called a "mean". Every outcome/measurement has some variability. The measure of that variability is called sigma (σ). Thus, the focus of six sigma methodology in manufacturing/business is to reduce variability and defects of processes.

A company's performance level is measured by the sigma level of their business processes. To increase the performance, the variation has to decrease. The concept of reduction in defects while reducing the variation is depicted in Fig. 1 (Mazur, 2001).

The objective of six sigma is reducing defects less than 3.4 Parts Per Million (PPM), also known as Defects Per Million Opportunities (DPMO), reducing cycle time, and reducing costs dramatically which impact the bottom line. Reducing variability and defects is the essence

Most industries work on 3.5-sigma concept.

of six sigma. Most industries work on 3.5-sigma concept. The Parts Per Million Defective with respect to various sigmas are given in Table 1.

Table 1: Sigma and Corresponding PPM

Sigma	per cent Yield	PPM	
6	99.9997%	3.4	
5	99.98%	233	
4	99.4%	6,210	
3.5	**97.7%**	**22,700**	← Industry Average
3	93.3%	66,807	
2	69.1%	308,537	
1	30.9%	691,462	

The statistical and problem solving tools are similar to other modern day quality improvement strategies. However, six sigma stresses the application of these tools in a methodical and systematic fashion to gain knowledge that leads to breakthrough improvements with dramatic, measurable impact on the bottom line. The secret ingredient that really makes six sigma work is the infrastructure within the organisation. As the process sigma value increases from zero to six, the variation of the process around the mean value decreases. With a high enough value of process sigma, the process approaches zero variation and is known as 'zero defects'.

Why Six Sigma

For Motorola, the originator of six sigma, to the question "why six sigma?" the answer was simple: survival in the competitive marketplace. Today, Motorola is known worldwide as a quality leader. To accomplish its quality and total customer satisfaction goals, Motorola concentrates on several key operational initiatives. At the top of the list is "Six Sigma Quality". At the manufacturing end, the six sigma quality requires "robust designs" that accommodate reasonable variation in component parts while providing consistently uniform final products. Motorola employees record the defects found in every function of the business, and statistical technologies are made a part of each and every employee's job. (Hoerl, 1998; Pyzdek, 1999)

Reducing the "total cycle time"—the time from when a Motorola customer places an order until it is delivered—is another vital part of the company's quality initiatives. In fact, in the case of new products, Motorola's cycle-time reduction is even more ambitious; the clock starts ticking the moment the product is conceived. This calls for an examination of the total system, including design, manufacturing, marketing, and administration.

Many companies struggled to engage the entire organisation in implementing TQM. To overcome this problem, Jack Welch (chairman and CEO of GE) has made the following statements:

- To get promoted you must be six-sigma trained
- Forty percent top management bonuses are tied to six sigma goals
- Stock options are tied to six sigma performance.

Six-sigma methodology has proven to be successful not only at improving quality but also at producing large cost savings along with those improvements. Some spectacular six sigma "success stories" at large corporations have been widely publicised and they captured the imagination of many business leaders.

Over the ten years from the establishment of six sigma, Motorola achieved:

- Five-fold increase in sales
- Profits increased at nearly 20 per cent per year
- Cumulative savings based on six sigma at over $ 14 billion.

History of Six Sigma

The word six sigma was coined by Motorola in 1986, which began seeing benefits just two years later. Six-sigma was developed by Mikel Harry. The programme gained publicity when Motorola won the Malcolm Baldrige Quality Award. Further development took place in the turn of the decade in ABB. Some of the pioneering companies which use six sigma are Motorola, General Electric (GE), Allied Signal, Texas Instruments.

General Electric spent $ 500 million on six sigma in 1995 and gained more than $ 2 billion from that investment in 1995/96. Many companies are aware of six sigma and are planning to introduce it in their business; some have already adopted it to great effect. The most advanced companies are three years or more into their programmes with the culture well and truly in place. They have absorbed the six sigma philosophy completely into their operations and are already reaping the

General Electric spent $ 500 million on six sigma in 1995.

rewards. Others have successfully established the structure whilst an even greater number are still in the process of establishing the basic structure.

Implementation of Six Sigma in Manufacturing

Implementation of six sigma programme requires close cooperation between the product design effort and the design of the manufacturing process. One of the goals of product design is to increase the allowable tolerance to the maximum that will still permit successful functioning of the product. On the other hand, process design has the goal of minimising the variation of the process that reproduces the characteristics required for successful functioning of the product, and centering the process on the target (nominal) value of the desired characteristic. Typically, there are three primary sources of product variation and all of these need to be addressed if optimum process capability is to be reached. The primary sources of product variation in manufacturing are:

There are three primary sources of product variation and all of these need to be addressed.

- Insufficient design margin: A Design of Experiments (DOE) approach, Taguchi Methodology or Robust Design approach should help to assure that the specification limits are optimally selected. Other import design reliability tools that should also be considered at this point in the design effort due to their potential impact upon design margins would include Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Worst Case Circuit Analysis (WCCA) and Accelerated Testing. The basic premise is that it is much easier, and more cost effective, to eliminate bias from the design target characteristics than it is to reduce the variation itself.
- Use of less than optimal parts or materials: One goal of a six sigma programme is to completely eliminate incoming inspection, whenever possible. Suppliers should be expected to incorporate the necessary process controls to detect and correct manufacturing defects well before the completion of their finished product. The total cost to acquire materials from a supplier and the cycle time required to produce these materials is influenced by the suppliers' manufacturing yield and any non-productive steps added to the manufacturing process in an attempt to "inspect" quality of the supplied materials. Key contributors to process variation comes from the differences in the incoming material quality, particularly if there are multiple suppliers.
- Inadequate Process Control: Total process characterisation is the key to adequate process control. This involves establishing specific values of C_p and C_{pk} for each of the critical parameters and then optimising the manufacturing process. An intimate knowledge of the manufacturing process and its physical basis is thus required to identify and eliminate these causes of variability.

The various tools and methods used in six sigma implementation are given in Fig. 2.

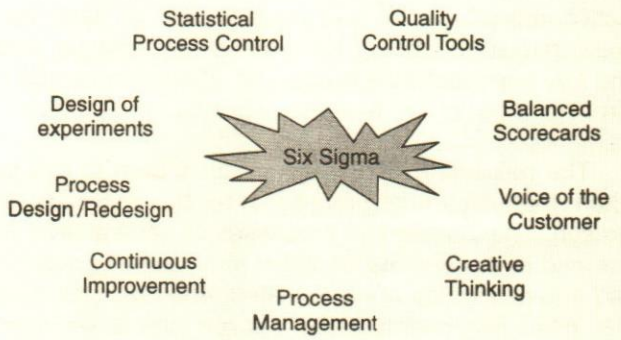


Fig. 2. The Six Sigma Tools & Methods

It is reasonable to carry out the six sigma implementation as a six-phase process (Fig. 3). Phases from one to four establish six sigma, and phases from five to six are for realisation of six sigma.

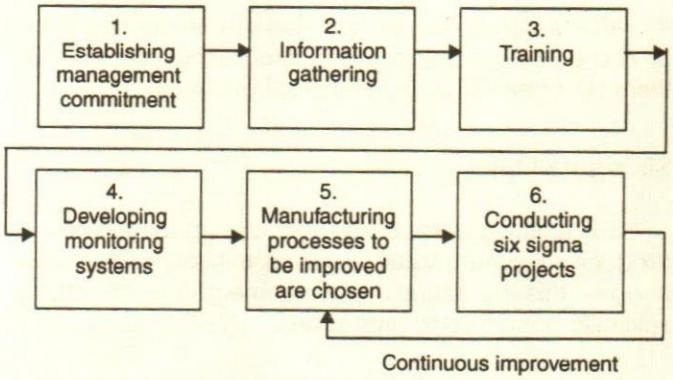


Fig. 3. Six sigma Implementation Model

First phase is to establish commitment of supreme command. This means training the principles and tools to senior management. This should be followed by

development of a management infrastructure to support the six sigma.

Second phase is information gathering. This translates into intensive communication with customers, suppliers, and employees. Information is required about the conditions of the processes, which need to be improved to attain the requisite PPM opportunities. Analysis of the information helps to identify the obstacles standing in the way of success.

Training the whole staff in the organisation is the third phase on the way to six sigma. The training needs are assessed, and the training is conducted from top to bottom. Training levels can be, for example, Champions, Master Black Belts, Black Belts and Green Belts.

Fourth phase of the six sigma implementation process is to develop a monitoring and measurement system. Equipment used in measurement must have effective reproducibility and repeatability of data. Adequate measures should be created for strategic goals and key manufacturing processes. Measures can be internal/or external, for example, customer satisfaction.

The realisation of six sigma starts from phase five when manufacturing processes to be improved are chosen. The current key processes in general level are mapped and problems identified and valueless activities and sub-processes are terminated. Then the processes that need improvement are chosen and a six sigma project is defined. One project concept is DMAIC (Define, Measure, Analyze, Improve, Control) where the problems of the process that need improving are defined and then the goals that should be achieved during the project are determined. The existing system needs to be measured. Establish valid and reliable measures and carry out research. Analyse the findings.

After analysis, the system starts to create new ways of doing things. Improve the processes and validate them by simulations and statistical methods.

Six sigma Steps

Six sigma's role is to help the management to produce maximum value by using minimum resources. It does this by rational management (i.e., it applies scientific principles to processes).

If there is an existing process that is not meeting customer specifications, using six sigma five phase methodology (DMAIC), that process can be improved and made more effective, more efficient, or both. If no process exists, or if existing processes are deemed beyond repair, then "Design For Six Sigma" (DFSS) methods are used to create effective and efficient processes. Some DFSS design tools are Critical to Quality (CTQ), Capability flow up, Simulation. The five-phase approach DMADV (Design, Measure, Analyse, Design, Verify) approach is used in DFSS.

Some DFSS design tools are Critical to Quality (CTQ), Capability flow up, Simulation.

A specially trained Black Belt or Green Belt leads the team to help identify root causes of defects and/or variation in an existing process (or product) and then to improve and control that process.

DMAIC Methodology

Define:

- The goals of improvement activity
- Top levels goals may be higher ROI
- Operation Level goals may be increased throughput

Measure:

- Identify CTQ (Critical to Quality) Variables
- Map the Process
- Develop and Validate Measurement Systems

Analyse:

- Benchmark and Baseline Processes
- Calculate Yield and Sigma
- Target Opportunities and Establish Improvement Goals
- Use of Pareto Chart & Fishbone Diagrams

Improve:

- Use Design of Experiments
- Isolate the "Vital Few" from the "Trivial Many" Sources of Variation
- Test for Improvement in Centering
- Use of Brainstorming and Action Workouts

Control:

- Set up Control Mechanisms
- Monitor Process Variation
- Maintain "In Control" Processes
- Use of Control Charts and Procedures

DMADV Methodology

Define:

- Project goals
- Customer (internal and external) deliverables

Measure:

- Customer needs and specifications

Analyse:

- Process options to meet the customer needs

Design:

- The process to meet the customer needs

Verify:

- The design performance and
- Ability to meet the customer needs

Leadership in Six Sigma

Six sigma involves changing major business value streams that cut across organisational barriers. It is the means by which the organisation's strategic goals are to be achieved. This effort cannot be lead by anyone other than the CEO, who is responsible for the performance of the organisation as a whole. Six sigma must be implemented from the top-down (Harry, 1998; Pyzdek, 1999)

Champion: A business leader who provides overall strategic direction for a Six Sigma project team. This individual serves as a liaison between the management and the project team; facilitates the acquisition of resources and support for the project. In all organisations, champions also include informal leaders who use six sigma in their day-to-day work and communicate the six sigma message at very opportunity. These Champions learn the six sigma philosophy, deployment strategies that include proper project selection, choosing and managing the right people to become Master Black Belts, and how to effectively review projects. Normally in manufacturing organisations the CEO acts as the champion.

Master Black Belts: Quality leaders responsible for strategy, training, mentoring and deployment of Six Sigma. Black Belts are the all day problem solvers who also operate as team leaders in six sigma projects. This is the highest level of technical and organisational proficiency. Master Black Belts provide technical leadership to the six sigma programme. Thus, they must know every thing the Black Belts know, as well as understand the mathematical theory on which the statistical methods are based. Master Black Belts must be able to assist black belts in applying the methods correctly in unusual situations. Master Black Belts are typically assigned to a specific area or function of an organisation. It may be a process specific area such as an assembly unit. Normally in manufacturing organisations the Managers act as master black belts.

Master Black Belts are the all day problem solvers who also operate as team leaders.

Black Belts: Six Sigma experts who work projects across the business. Black Belts are the heart and soul of six sigma quality initiative. Candidates for Black Belts status are technically oriented individuals held in high regard by their peers. They should be actively involved in the process of organisational change and development. Black Belts are expected to master a wide variety of technical tools in a relatively short period of time. Normally in manufacturing organisations the Foremen act as black belts.

Green Belts: Fully trained individuals who work on projects. Green belts are the team members in six sigma projects. Normally in manufacturing organisations the shift foremen act as green belts.

Six Sigma Organisational Structure in Manufacturing

A typical six sigma organisational structure in a manufacturing organisation is shown in Figure 4.

Quality Leader/Manager (QL/OM): The quality leader's responsibility is to represent the needs of the customer and to improve the operational effectiveness of the organisation.

Master Black Belt (MBB): Master Black Belts are typically assigned to a specific area or function of a business or an organisation.

Process Owners (PO) or sponsor: Process Owners are the individuals responsible for a specific process.

Black Belt (BB): Black Belts lead quality projects and work full time until they are complete.

Green Belt (GB): Green Belts are employees trained in six sigma who spend a portion of their time in completing projects, but maintain their regular work role and responsibilities.

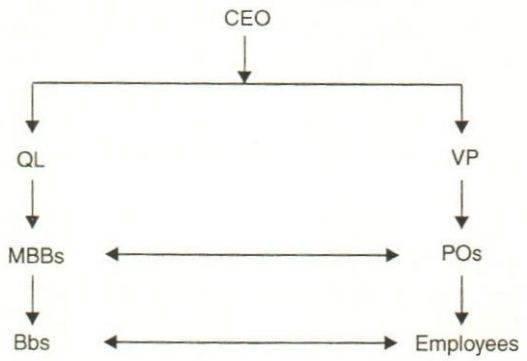


Fig. 4. Typical Six Sigma Organisational Structure in Manufacturing

Benefits of Six Sigma Projects in Manufacturing

The following are some of the benefits of six sigma in manufacturing:

- Improved overall customer satisfaction.
- Reduced cycle time.
- Increased productivity and added value.
- Improved capacity and output.
- Reduced total defects.
- Increased product reliability.
- Decreased work in progress.
- Improved process flow.
- Faster return on investment.

References

Harry, Mikel J. (1998), "Six Sigma: A Breakthrough Strategy for Profitability", Quality Progress, May, 60-64.

Hoerl, R.W. (1998), "Six Sigma and the Future of the Quality Profession", Quality Progress, June, 35-42.

Hoerl, R.W. (2001), "Six Sigma Black Belts: What Do they Need to Know?" Journal of Quality Technology, Vol. 33, No. 4, October, 391-406.

Mazur, G.H. (2001), "QFD and Design for Six Sigma: Customer Driven DFSS", 45th EOQ Congress, Istanbul, Turkey.

Pyzdek, T. (1999), "The Complete Guide to Six Sigma", Quality Publishing, Tucson, AZ.

Reliability Analysis Center, (1999), "Six Sigma Program", Selected topics in Assurance Related Topics, Vol. 6, No. 5.

Web sites:

http://www.qpronline.com

http://www.qualitydigest.com

http:///www.isixsigma.com

□

Kind worlds can be short and easy to speak, but their echoes are truly endless.

– Mother Theresa

Process Variation & Six Sigma

B. Majumdar

This article deals with the problem of variation in industry and how it can be reduced. In this context, the role of statistics for controlling variation is discussed at length.

B. Majumdar is with the Indian Statistical Institute, New Delhi.

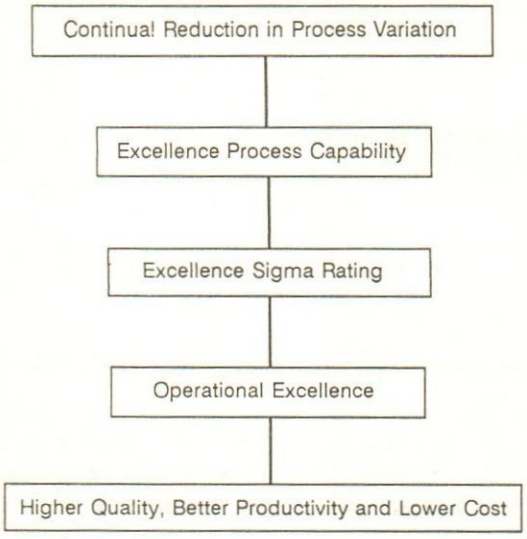
Variation is the single greatest enemy of any industry. Most of the quality and management problems are due to the existence of variation. All defects and non-conformities would have vanished if variation could have been eliminated. However, we cannot eliminate variation altogether. Variation is inevitable in nature. The higher the variation, the bigger is the dimension of the quality problem. Statistics may be regarded as a science of studying the variation. Statisticians have developed methodology and tools for estimating, apportioning, comparing, controlling and reducing variation. The commonly used measure for variation is the standard deviation, σ, given by the standard formula:

$$\sigma = \frac{\sqrt{\Sigma (x_i - \bar{x})^2}}{(n-1)} \qquad (1)$$

For a stable process about 99.7% of the observations are expected to be contained within $\pm 3\sigma$ around the mean.

By reducing or cutting down the variation we mean that some breakthrough exercises are carried out and actions are taken accordingly such that the computed from a set of data from the process after the actions were taken has been reduced as compared to that before the actions were taken.

Six Sigma is basically a disciplined and coordinated methodology for quality maintenance and improvements in an organisation through systematically reducing variation in key processes and in characteristics critical to quality (CTQ). Here the term quality is used in a broader sense and includes quality of product, services, process and any activity whose end result needs to be within desired norms. The following diagram shows how continual reduction of process variation can lead to improved quality, higher productivity and reduced cost:



The Six Sigma Philosophy

Six sigma's goal is to eliminate defects in any process, product or service to a negligible level of 3.4 parts per million opportunities (DPMO) or defects per unit (DPU) as the case may be. This is achieved through cutting down variation in the process or in the language of six sigma by increasing the sigma rating or simply "sigma". But in statistical sense this implies that the process variation measured in terms of the standard deviation (σ) has to be reduced to achieve a higher sigma rating. By increasing sigma, product and service quality is improved and the cost of poor quality (COPQ) is also reduced significantly. Six sigma is a project by project approach. To implement six sigma in an organisation first the key processes and CTQs are selected and then a project is identified in that area. This in the language of six sigma is to define (D), a problem in the first instance. Next we try to develop a measure (M) for the characteristic – either an attribute type of measure (DPU or DPMO) or a variable measurement. Such an quantitative measurement is essential since "unless we measure we can not control or improve". The measurements will lead to creation of data. Next this data needs to be analysed (A) using various tools and techniques. After the analysis comes the improvement stage (I). The current status or the existing sigma of the process is found out on the basis of either the estimated process variation (standard deviation) or the defect rate (DPU or DPMO as the case may be). If the sigma of the process is low or the defects level is much higher than 3.4 ppm then efforts are made to improve the sigma using various tools and techniques of six sigma. Once the improvements are achieved, control (C) is instituted to sustain the gains. This is the DMAIC cycle of six sigma.

Types of variation

A process is defined as an entity which transforms inputs into outputs. The ingredients of a process are man, machine, material, methods and environment. Any activity or part of an activity can be regarded as a process. It need not be just a manufacturing process. Every process has an intrinsic or inherent variation. This gives the minimum achievable variation in the process and this cannot be reduced further without special efforts in the form of breakthrough exercises. The minimum achievable variation was termed as the Chance Cause variation by Shewhart. Deming used the term Common Cause variation for the same. Taguchi often referred to this as Noise variation.

The minimum achievable variation was termed as the Chance Cause variation.

The observed variation in any process may be equal to the Chance cause variation or higher than this (never less than this). The additional variation is due to some specific cause or causes and is known as the assignable cause (Shewhart) or special cause (Deming) of variation. When the process is working under the influence of chance cause of variation alone, then the process is known as "Stable" or under statistical control and it follows a pattern known as the Normal Distribution.

In industry, we often consider short term and long term variation. The short term variation is equivalent to the chance cause variation and the long term variation consists of both the chance cause and the assignable causes of variation.

Schewhart control chart limits are based on the chance cause variation and is meant for detecting any changes in the process due to assignable causes. In six sigma we try to estimate the chance cause variation (standard deviation) and then find out short term sigma, as how many times is half of the tolerance width in terms of the standard deviation. To find out the long term sigma or simply the sigma, an allowance of 1.5 σ is added to the short term sigma, to absorb unavoidable long term disturbances in the process.

Short and long term variation

As short term variation should include only the chance cause variation, care has to be taken to avoid inclusion of any variation due to assignable causes.

Since in a short period it is expected that there may not be any change in the process level, we can estimate short term variation by either of the following two methods:

(i) Take 25 to 30 consecutive observations spread over a short duration, say, half-an-hour or one hour. Based on this data calculate standard deviation by the standard formula given at (1). However, to justify use of this method, it is recommended that the stability of the process during the period of data collection must be ascertained either by Normal Probability Plot (NPP) or by drawing the Histogram. It may be noted that for drawing the histogram one needs to take more data, say, 50-100

(ii) Take 25-30 rational subgroups, each subgroup consisting of 2-6 consecutive observations, at regular interval, say, every half-an-hour or one hour. Compute the range for each subgroup, and then compute the average range ($\bar{R}$). The standard deviation is computed by,

$$\sigma = \frac{\bar{R}}{d_2} \qquad (2)$$

where d_2 is a constant available from the statistical table for control chart constants. In this case there is no need to ascertain the stability of the process.

For estimating long term variation, we can take 200-300 observations. The observations may be either consecutive or one in every 2-6 consecutive observations, depending on the rate of production. We can even take the observations in the rational sub-group form and treat them as individual readings, ignoring the sub-groupings, and use them for calculating the long term variation. The observations are then used to compute the standard deviation using the standard formula (1). This estimated variation is often termed as the overall variation since this is the combined variation due to short term as well as long term disturbances.

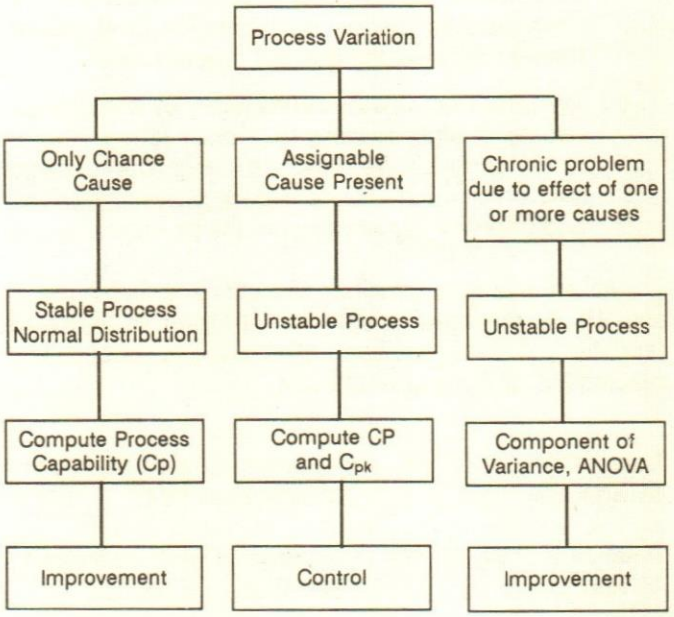
If the data is taken in sub-group form for estimating the long term variation, then the same data can be used to estimate the long term or overall variation (σ) the standard formula and the short term variation (σ_0) by $\frac{\bar{R}}{d_2}$. An estimate of the component of the overall variation due to long term disturbances alone (σ_1) can be obtained as:

$$\sigma_1 = \sqrt{\sigma^2 - \sigma_0^2} \qquad (3)$$

Often there may be more than one long term component. In such cases, the Analysis of Variance (ANOVA) is a handy statistical tool for estimating the contribution of different long term as well as the short term component of variation. Once this information is available we can plan for reduction in process variation for improvement in the sigma level.

Analysis of Variance (ANOVA) is a handy statistical tool for estimating the contribution of different long term as well as the short term component of variation.

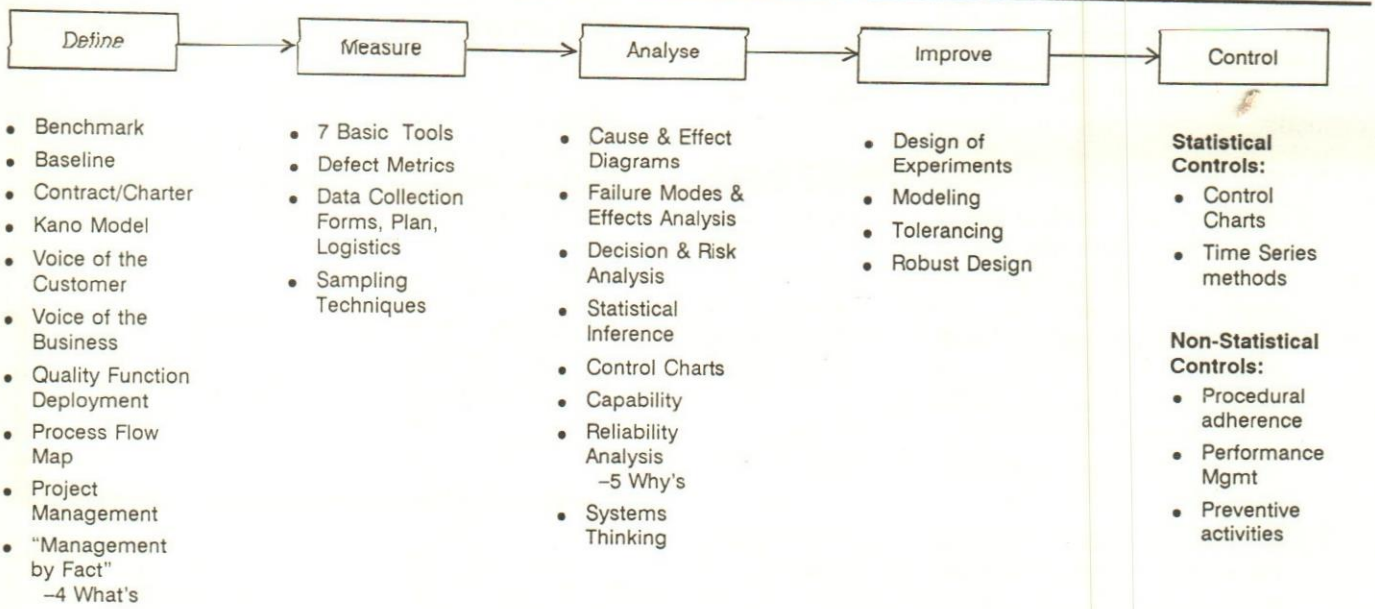
A schematic diagram of the process variation under various situations and the suggested actions in each situation is shown in the following diagram:



Target value (Mean) and variation

Changes in the mean level is caused due to assignable causes and leads to higher process variation. Hence to maintain the process within achievable variation we have to remove all assignable causes. This is a control problem and must be looked into before we launch a programme for process improvement for six sigma. Once the process variation is maintained within the chance causes, we may have two kinds of problem:

(i) The process mean is different from the desired level. We can always find a techno-managerial solution to this. We have to find one or more



parameters which have a linear effect on the characteristic under consideration and adjust them to achieve the desired process level.

(ii) The process variation (measured by the chance cause) is high, leading to a poor rating. This is more serious. We have to carry out detailed breakthrough studies to reduce process variation and improve sigma rating of the process.

As an example, consider two chemical balances, A and B. A standard weight of 50 gms is weighed repeatedly 5 times on each of the two balances. The readings in gms are given below:

Balance A: 55, 52, 54, 51 and 52	Average = 52.8, Standard deviation = 1.64
Balance B : 54, 47, 53, 46 and 51	Average = 50.2, Standard deviation = 3.56

Though balance A gives a much higher average (52.8) than balance B (50.2) as compared to the actual weight of the standard, we prefer balance A because it is more accurate, having a much smaller standard deviation. The higher average value can be corrected by calibrating the balance. But the higher variation is an intrinsic property of the balance and is difficult to correct easily.

Process Capability and Six Sigma

As mentioned earlier, for any stable process 99.7% of the observations are expected to remain within the spread of or (6 times the standard deviation). This total spread of the process is referred to as the process capability of the process. To have a measure of process capability, independent of the unit of measure and comparable with other processes, process capability indices have been developed. C_p and C_{pk} are two such indices. C_p is defined as the ratio of total tolerance width and 6σ. This is also known as potential capability. C_{pk} is defined as:

$$C_{pk} = \text{Minimum of } \left[\frac{USL - Mean}{3\sigma}, \frac{Mean - USL}{3\sigma}\right]$$

C_{pk} is also known as achieved process capability.

Traditionally, it was recommended that C_p should be at least 1.33 and C_{pk} should be as close to C_p as possible. If C_p is maintained at 1.33 and it is ensured that C_{pk} is almost equal to C_p through rigid process control, then the sigma rating of the process is 4 and with this, the defects per million would be 32. That was supposed to be an excellent performance, a decade back when most companies used to measure defective level in percentage, may be, 2-5% (equivalent to 2000-5000 ppm). With the changing scenario, customers becoming more and more demanding, a need has come to achieve a higher level of perfomance. For a six sigma process the C_p value works out to be 2 and C_{pk} works out to be 1.5. This implies that six sigma has a more stringent requirement than what was required earlier. In terms of process variation, six sigma requires the process to have a much smaller process varition.

Role of Statistics in Six Sigma

From the foregoing discussion it is evident that

Statistics is a key ingredient in successful implementation of a six sigma programme.

statistics is a key ingredient in successful implementation of a six sigma programme in any organisation. Tools and techniques of statistics are useful in all stages of the DMAIC cycle. The earlier diagram illustrates a partial list of tools and techniques useful in different stages of the DMAIC.

Thus, statistics has a key role in six sigma, especially in the treatment and reduction of process variation. However, we should not be carried away and overemphasize the statistical component of six sigma. Six sigma is a much broader concept. It is a philosophy, a way of life and an organised approach to achieve all-round excellence in any organisation.

□

Great minds discuss ideas;

Average minds discuss events;

Small minds discuss people

– Eleanor Roosevelt

* * *

Truth must necessarily be stranger than fiction, for fiction is the creation of the human mind and therefore congenial to it.

– G.K. Chesterton

Six Sigma in Indian Automobile Sector

V.K. Khanna, Prem Vrat, B.S. Sahay & Ravi Shankar

The paper presents the survey result and analysis of TQM status and quality tools being followed by Indian automobile sector. The survey focused on twenty-three key Quality Tools. This paper reveals that Indian automobile sector is still not responding fast, even after liberalisation, to the changing needs of the market scenario and concludes that implementation of most of these Quality Tools are not effective. The weakest among these tools is Six Sigma and its supporting tools. Indian automobile sector is loosing an opportunity to make 2941-fold improvement in quality when compared to product built under the constraint of 99 per cent capability. This paper discusses at length the weakest tool Six Sigma and its implementation strategy in the Indian automobile sector.

V.K. Khanna is with the Department of Mechanical Engineering, Indian Institute of Technology, New Delhi. Prem Vrat is Director, Indian Institute of Technology Roorkee. B.S. Sahay is with the Management Development Institute, Gurgaon. Ravi Shankar is with the Department of Management Studies, Indian Institute of Technology, Delhi.

Total quality management (TQM) is a management philosophy that builds customer driven learning organisations dedicated to total customer satisfaction with continuous improvement in the effectiveness and efficiency of the organisation and its processes (Corrigan, 1995). Today TQM is not an option but rather a reality for organisations doing business in a liberalised economy. The discipline of competition, arising from the free market, requires the elements found in TQM: customer-driven quality, strong quality leadership, continuous improvement, full employee participation, management by fact, company-wide application, quality and operational results, and systematic quality strategies, methods, and practices. TQM is the only mechanism to either sustain competitive advantage or survive competitive disadvantage (Spitzer, 1995).

The success stories of TQM are well known. Japan's automobile industry started out several decades behind the USA's but in 1980 it over took the USA's and became the biggest in the world using this philosophy (Ulrich et al, 2000). Though there has been a steady growth of Indian automobile sector, but India's contribution in car production as per cent of market share in world-wide production is negligible, at around 0.9 per cent (Itasaka, 1989). It is astonishing to note that the competitiveness of India has been ranked very low (41 out of 49 counties) as per world competitiveness yearbook report 2001 (Anonymous, 2002a). Since TQM philosophy has proved its success world-wide and Indian automobile organisations are also taking the same route, one of the major reasons for dismal performance of Indian automobile sector in the world market may be attributed to the poor understanding and implementation of various TQM quality tools.

India's contribution in car production as per cent of market share is negligible.

Research Methodology

A comprehensive questionnaire was designed to survey TQM Quality tools applicability in Indian automobile sector. The survey questionnaire is primarily based on twenty-three key TQM tools {Histogram, Failure Mode and Effect Analysis (FMEA), Quality Function Deployment (QFD), Fish Bone Diagram, Brainstorming, Run Chart, Suggestion Scheme, Six Sigma, Business Process Re-engineering (BPR), PDCA, PERT/CPM, Statistical Process Control (SPC), Scatter Plot, Kaizen Activities, Control Chart, Why-Why Analysis, Design of Experiment (DOE), TPM, Benchmarking, Pareto Diagram, 5S Activities, Process Mapping and Measurement System Analysis (MSA)}. The respondents were asked to give the status regarding various quality tools being used in their company (Caravatta, 1997; Sunil, 1997; Agrawal, 1999).

The survey questionnaire was validated based on sample data from automobile manufacturers, suppliers (first tier) and sub-contractors (second tier and above). In addition to survey, personal visits to companies were made to get first hand information.

The survey questionnaire was mailed to 350 automobile companies and the analysis is based on the responses received from 48 companies. The 48 responses were collected after making more than one personal visit and holding a series of detailed discussions with the practicing TQM managers of the companies.

Survey Result and Analysis

TQM: A Guiding Philosophy

It is very interesting to note that 62 per cent of automobile sector claim to follow TQM as a guiding philosophy whereas 38 per cent of automobile sector has still not taken up TQM as a guiding philosophy. Majority of automobile sector are convinced that TQM can bring the desired results.

Further, it was analysed that before liberalisation 15 per cent of the automobile sector were following TQM philosophy and after liberalisation it improved to 47 per cent. 38 per cent of the organisations have still not started TQM as a guiding philosophy even after liberalisation. The effect of the same can be seen on rejection and cost of quality status.

Before liberalisation 15 per cent of the automobile sector were following TQM philosophy.

World-class organisations are monitoring their rejections in ppm (parts per million) whereas 83 per cent of automobile sector claim to be having rejection more that 4 per cent which is very high. This shows that automobile sector has to go a long way in achieving that kind of performance and much more serious efforts are required for process control in order to achieve ppm rejection levels.

Harrington (1987a; 1987b; 1994; 1997) observed that the complexity of today's business environment has made it necessary for organisations to evaluate all the alternatives before committing resources to an improvement process. He proposed the use of quality cost concepts (cost of poor quality) to avoid ambiguity and improve understanding of quality improvement. But unfortunately only 10-15 per cent Indian automobile organisations are using quality cost as measure of their quality performance thus loosing an opportunity to identify critical areas for improvement and reduction of cost.

It is evident from the analysis that 79 per cent of the respondent organisations of the automobile sector claim to have achieved either of ISO 9000/QS-9000/ISO 14001 certification. This establishes the fact that all out efforts are being made to nurture continuous improvement though the desired results have not been achieved which is evident through high rejections.

Desired results have not been achieved which is evident through high rejections.

Application of TQM Tools

In automobile sector Fish Bone Diagram, Brainstorming, Run Chart and Pareto Diagram are very popular and are being used for solving quality related problems where as the area of concerns are Histogram, QFD, Suggestion Scheme, Six Sigma, FMEA, BPR, PDCA, PERT/CPM, SPC. Scatter Plot, Kaizen activities, Control Chart, Why-Why Analysis (Root Cause Analysis), DOE, TPM, Benchmarking, Process Mapping, MSA and 5S activities, which are also very essential for continuous improvement and for improving housekeeping, as shown in Figure 1.

The applicability of various quality tools by the respondent organisations have been analysed and shown in Table 1.

Table I: Applicability of Quality Tools in Indian Automobile Sector

Respondent Organi-sations	Applicability of Quality Tools	No. of Quality Tools used out of 21 tools
60% - 70%	Run Chart and Pareto Diagram	2
50% - 60%	Fish Bone Diagram, Brainstorming, Run Chart, Suggestion Scheme, PCDA, SPC, Control Chart and Pareto Diagram	8
40% - 50%	Histogram, Fish Bone Diagram, Brainstorming, Run Chart Suggestion Scheme, PDCA, SPC, Kaizen Activities, Control Chart, Why-Why Analysis, Pareto Diagram and 5S Activities	12
30% - 40%	Histogram, Fish Bone Diagram, Brainstorming, Run Chart Suggestion Scheme, PDCA, SPC, Kaizen Activities, Control Chart, Why-Why Analysis, Benchmarking, Pareto Diagram and 5S activities	13
20% - 30%	Histogram, QFD, Fish Bone Diagram, Brainstorming, Run Chart, Suggestion Scheme, PDCA, SPC, Scatter Plot, Kaizen Activities, Control Chart, Why-Why Analysis, DOE, TPM, Bench marking, Pareto Diagram and 5S activities	17
10% - 20%	Histogram, FMEA, QFD, Fish Bone Diagram, Brainstorming, Run Chart, Suggestion Scheme, BPR, PDCA, SPC, Scatter Plot, Kaizen Activities, Control Chart, Why-Why Analysis, DOE, TPM, Benchmarking, Pareto Diagram and 5S Activities	19
10%	Histogram, FMEA, QFD, Fish Bone Diagram, Brainstorming, Run Chart, Suggestion Scheme, Six Sigma BPR, PDCA, PERT/CPM, SPC, Scatter Plot, Kaizen Activities, Control Chart, Why-Why Analysis, DOE, TPM, Benchmarking, Pareto Diagram and 5S Activities, Process Mapping and MSA	23

It is very interesting to note that the most popular quality tools among the Indian automobile sector are Run Chart and Pareto Diagram and 60-70 per cent of the respondent organisations are using only these two tools to solve quality related problems. 50- 60 per cent, 40-50 per cent, 30-40 per cent, 20-30 per cent, 10-20 per cent and less than 10 per cent of the respondent organisations are using 8, 12, 13, 17, 19 and 23 quality tools respectively. However, the least understood tool is Six Sigma, which is being used by less than 10 per cent of the organisations, which is evident through Table I. The literature reveals that Six Sigma quality represents a 2941-fold improvement in quality when compared to product built under the constraint of 99 per cent capability. The success story of organisations using Six Sigma tool as a part of TQM are well known. They include such organisations as Motorola, General Electric, Ford, General Motors,

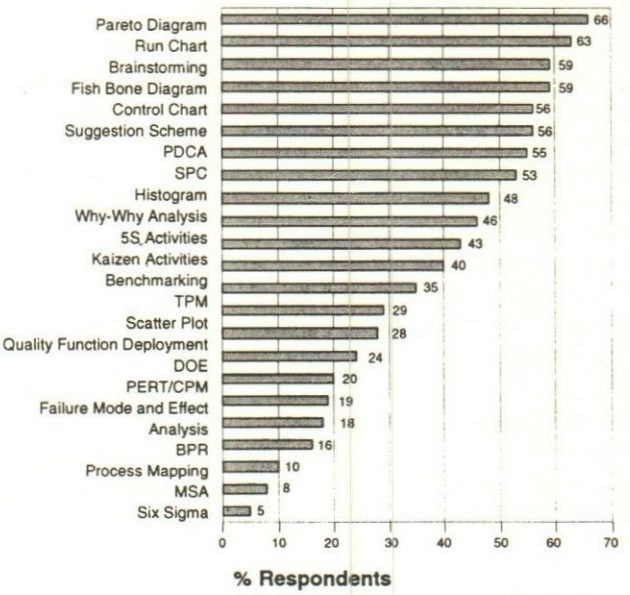


Fig. 1. Category wise Tools Applicability by Respondent Organisation

Chrysler, Toyota, Xerox, Whirlpool, Honda Motors and Mazda. Using this vital tool the Japanese clearly outwitted, outsmarted and outsold the Americans in the car industry (Grant et al, 1995). World-class organisations are implementing Six Sigma tool along with other quality tools, it is ironic to note that Six Sigma tool is the weakest among all tools in Indian automobile sector.

Six Sigma is being used by less than 10 per cent of the organisations.

To be globally competitive it is very important that Indian automobile sector must focus on the implementation of Six Sigma tool along with other quality tools.

What is Six Sigma

The basic idea behind the Six Sigma philosophy is to reduce product and process variation continuously. Seemingly small variations in environmental conditions, operator performance, raw material and machinery can cause accumulative quality problems.

The basic idea behind Six Sigma is to reduce product and process variation.

A crucial part of Six Sigma is to define and measure variation with the intent of discovering its causes and to develop efficient operational means to control and reduce the variation. The expected outcomes of Six Sigma efforts are faster and more robust product development, more efficient and capable manufacturing processes, and more confident overall business performance (Sanders and Hild, 2000).

In order to reduce the variation to a very low level, the first step is to "design for productibility". This means that designers configure a product in such a manner that its performance is "shielded" against variation. By doing this, the organisation can be sure that its specified levels, i.e. all the product, will be on target with minimum difference between units of product (Harry, 1988).

The next step is to find out, control and eventually eliminate all root causes of variation in the manufacturing processes involved in both the supplied parts and the final assembly. This is done using SPC and other tools including computer simulation, participative management practices, process mapping, DOE, MSA and FMEA.

Six Sigma Status in Indian Automobile Sector

Only 5 per cent of respondents in Indian automobile organisations claim to follow "6-Sigma" tool. That is one of the reasons why Indian automobile sector has not been able to achieve consistent level of quality based on ± 3 sigma limits around the specified target value. In spite of 62 per cent automobile sector claiming to follow TQM philosophy, actual rejections are more than 4 per cent, that is, 40,000 ppm against 2700 ppm at 3-Sigma level, which is quite alarming. Motorola Corporation received Malcolm Baldrige National Quality Award in 1988 based on much of its efforts on "6-Sigma" (Pande et al, 1997). When Indian automobile sector rejection is compared with sigma conversion table (Terziovski, 2002) as shown in Table 2, it gives a pathetic picture with respect to world-class organisations.

In spite of 62 per cent automobile sector claiming to follow TQM rejections are more than 4 per cent.

Motorola, Inc. invented Six Sigma in 1986. Six sigma methodology has yielded powerful bottom-line results, in fact the organisation has documented more than $16 billion in savings as a result of Six Sigma efforts (Anonymous, 2002b).

Table 2: Sigma Conversion Table

Quality Level (Yield)	Defects per Million Opportunities (DPMO)	Sigma	Cost of Poor Quality (Percentage of Sales)	Types of Companies
30.9	690,000	1.0	>40	Non-Competitive
69.2	308,000	2.0	30-40	Industry Average
93.3	66.800	3.0	20-30	
99.4	6,210	4.0	15-20	
99.98	320	5.0	10-15	World Class
99.9997	3.4	6.0	10	

Six Sigma Methodology is a proven tool set for driving and achieving transformational change. Six Sigma is a continuous improvement process focusing on: Customer Requirements, Process Alignment, Analytical Rigor and Timely Execution (Anonymous, 2002c). A comparative performance at "99 per cent capability", "3-Sigma quality level" and "6-Sigma quality level" has been shown in Table 3.

Therefore to be globally competitive, it is essential for Indian automobile sector to follow "6-Sigma" tool to deploy TQM philosophy. This tool will help Indian automobile sector to track their performance overtime and to take requisite countermeasures.

Why Six Sigma tool could not take off in Indian automobile sector

The foremost reason for low implementation of Six Sigma tool in Indian automobile sector has been identified as lack of top management commitment. 70 per cent of the top management teams have not shown interest in implementation of this tool because of high cost involved in training the people for green belt, black belt and master black belt (Ingle and Roe, 2001). Blakeslee (1999) has articulated seven principles that need to be considered when implementing Six Sigma quality tool and a survey reveals that automobile sector lacks in implementing these principles.

Principle 1: Six Sigma implementation efforts are driven by committed leaders with edge. Leaders must take personal responsibility for driving Six Sigma efforts, participating in improvement teams, leading their own Six Sigma projects and teaching other leaders.

Principle 2: Six Sigma efforts must be integrated with existing initiatives, business strategy, and key performance measures. The integration process must be spearheaded by the senior management team to drive home its importance to all employees.

Table 3: Comparative performance between 99 per cent Capability, 3-Sigma and 6-Sigma quality level (Harry, 1988)

99 per cent Capability level	3-Sigma Quality level	6-Sigma Quality level
200,000 wrong drug prescriptions each year	At least 54,000 wrong drug prescriptions each year	One wrong drug prescription in 25 years
	More than 40,500 newborn babies dropped by doctors/ nurses each year	Three newborn babies dropped by doctors/nurses in 100 years
Unsafe drinking water almost 15 minutes each day	Unsafe drinking water about two hours each month	Unsafe drinking water one second every 16 years
No electricity for almost 7 hours each month	No telephone service or television transmission for nearly 27 minutes each week	No telephone service or television transmission for nearly six seconds in 100 years
2 short or long landings at most major airports each day	Five short or long landings at O' Hare Airport each day	One short or long landing in 10 years in all the airports in the U.S.
5,000 incorrect surgical operations per week	Nearly 1,350 incorrect surgical operations per week	One incorrect surgical operation in 20 years
20,000 lost articles of mail per hour	54,000 lost articles of mail per hour	35 lost articles of mail per year

Principle 3: Six Sigma efforts are supported with a framework of process thinking and a rigorous mapping of existing processes. Being able to examine (and close) the gap between what a business produces and what customers demand is the essence of Six Sigma.

Principle 4: Six Sigma requires disciplined customer and market intelligence gathering. But current customer data and data gathered from competitors' customers should be used as the basis for analysing what the market is doing.

Principle 5: Six Sigma projects must produce real savings or revenues. Over the years, improvement initiatives have promised a lot, but often have delivered little. Consequently, any Six Sigma programme a company implements should be designed to pay its way, at least from the second year of implementation onward.

70 per cent of the top management teams have not shown interest in implementation of this tool.

Principle 6: Six Sigma efforts are led in the trenches by a thoroughly trained core of fulltime team leaders. Six Sigma is an intense approach to quality improvement; it requires the disciplined training and commitment of dedicated practitioner.

Principle 7: Six Sigma is sustained by continuous reinforcement and reward of leaders who support initiatives and improvement teams that carry them out. Employees who want to be considered for promotion of Six Sigma must be Six Sigma trained.

Six Sigma Implementation Strategies

According to Sanders and Hild (2000) there are three general strategies of six sigma development.

1. Six Sigma organisation;
2. Six Sigma engineering organisation; and
3. Strategically selected projects and individuals.

In Table 4 the main aspects of each of these strategies are outlined, and comparisons made in the areas of kind of personnel trained, typical course content as well as strengths and weaknesses of each strategy.

The first strategy, "Six Sigma organisation" uses a methodology of training all individuals, in all areas, in the fundamental concepts and tools involved in the application of Six Sigma.

Using this method, a high level of awareness can be created throughout an organisation, and a common language and problem-solving approach adopted. The "Six-Sigma engineering organisation" strategy in contrast, however, focuses on training and development within the design and manufacturing engineering departments of the firm. In this case, resources are more focused and there is an emphasis on project applications. The third category, "Strategic selection" as it implies, refers to the development of strategically-selected employees. "These individuals are assigned complex projects identified by needs and objectives critical to the site or organisation" (Sanders and Hild, 2000). Here there is a great amount of flexibility in training in comparison to the previous two approaches. Training is provided as required by the very strong project focus.

Emerging Issues

The analysis given above implies that Indian automobile sector is aware of the need for improving

Table 4: Main aspects of typical six sigma implementation strategies (Sanders and Hild, 2000)

Aspects	Six sigma organisation	Six sigma engineering organisation	Strategically selected projects and individuals
Personnel trained	All employees - Senior and area managers from all areas of firm - Engineers - Operators	A larger percentage of the engineering staff - Design/product - Manufacturing/ process	Strategically selected individuals - Project driven - Informal leaders
Typical course content	Overview Philosophy and basic concepts Fundamental tools and methods Project work	Overview Philosophy and basic concepts Fundamental tools and methods Advanced – fundamental tools Project work	Overview Philosophy and basic concepts Fundamental and advanced tools and methods Specific methods and tools as needed for individual projects Project work
Strengths	High level of awareness Common language Common tool set and problem-solving approach	Focused resources Larger set of tools for engineers Similar backgrounds among individuals in training More attention given to project application	Projects aligned with organisational objectives Less initial dollars required for training High amount of flexibility in training content (as needed) Strongest project focus
Common Weaknesses	Tendency for cynicism to develop A focus on "buzzwords" and slogans Large amounts of resources required for mass training An inflexible road map for process improvement or problem-solving	Lack of common language across all areas of organisation Difficulty in deployment outside of operations and engineering Managers not provided training to effectively integrate skill learned into everybody's engineering responsibilities	Isolation of those trained Lack of common language Difficulty in integrating beyond "Six Sigma projects" Tendency for attitude of elitism to develop

quality, however systematic approaches are not yet in place and efforts for improvement are not yielding sufficient results, though many organisations claim to be TQM organisations and many more are taking ISO 9000/QS-9000 certification as a route to implement TQM philosophy. Many executives actually believe that the mere accreditation of the organisation to ISO 9000 and QS 9000 quality standards will bring about an overall improvement in its quality levels. The result of the survey does not corroborate it. It seems many Indian organisations become complacent after receiving the certification.

Many Indian organisations become complacent after receiving the certification.

The overall processes are unstable and corrective and preventive actions are not effective thus leading to very high rejections. The importance of "6-Sigma" and "the cost of quality" have not been understood as a very important analytical tool to drive continuous improvement in a prioritised manner and thus there is no systematic tool to assess TQM endeavours.

The supporting tools of Six Sigma like SPC, Process Mapping, DOE, MSA and FMEA are not effectively used leading to unstable processes resulting in higher rejection.

Organisations have to develop better methods for identifying poor quality and eliminate the associated cost of poor quality. In fact, organisations will more than double their profits without capital investment. Cycle-time reduction, zero rejection, zero breakdown, zero accident should be an obsession. Here Six Sigma, it's supporting tool and other quality tools can be very effective.

The limitation of this study has been the low response rate of 13.71 per cent, i.e. analysis and interpretation of findings are based on the response received from 48 automobile organisations out of 350. Statistically, it may appear to be just about adequate as 10 per cent response rate is all right. However to overcome low response limitation, the sample size was randomly selected to represent the automobile sector fairly well and was followed up by a series of detailed discussions with the practicing managers and chief executives to understand the status more objectively and to avoid contradictions in the findings.

Concluding Remarks

India is still a player of little consequence in the world auto market production. Though there is greater system emphasis, more market orientation/customer

focus, continuous improvement culture, analysis shows there is no significant progress in effective implementation of quality tools. Since growth of automobile industry in any country is an indication of overall economy, a lot has to be done by the automobile sector in implementing quality tools, particularly 5S, Kaizen, TPM, BPR, PERT/CPM, QFD and Six Sigma. The weakest among all quality tools is Six Sigma and its supporting tools like SPC, FMEA, DOE, Process Mapping and MSA. The implication of not using Six Sigma quality tool is that Indian automobile sector is loosing an opportunity to make 2941-fold improvement in quality when compared to product built under the constraint of 99 per cent capability. To achieve the benefits of TQM philosophy and to be globally competitive, Indian automobile sector must focus on effective implementation of TQM quality tools, particularly Six Sigma and its supporting tools.

References

Agrawal, S.K. (1999), "Business Excellence Model in Indian Context: A Selected Study", Unpublished Ph.D. Thesis, IIT Delhi.

Anonymous, (2002a), http://www.imd.ch/wcy/ranking/pastresults.html.

Anonymous, (2002b), http://mu.motorola.com/sigmasplash.htm

Anonymous, (2002c), http://mu.motorola.com/sigma.html

Blakeslee, J.A. (1999), "Implementing the Six Sigma Solution", Quality Progress, July, pp. 77-85.

Caravatta, M. (1997), "Conducting an Organisational Self-Assessment using the 1997 Baldrige Award Criteria", Quality Progress, Milwaukee, WI., pp. 87-91.

Corrigan, J.P. (1995), "Is ISO 9000 the Path to TQM?", in The Quality Yearbook.

Cortada, J.W. and Woods, J.A., McGraw-Hill Inc., pp. 589-596.

Grant, R.M., Sahni, R. and Krishnan, R. (1995), "TQM's Challenge to Management Theory and Practice", in Cortada, J.W. and Woods, J.A. (Eds.), The Quality Yearbook, McGraw-Hill Inc., pp. 49-65.

Harrington J.H. (1987a), "Poor Quality Cost', ASQC Quality Press, New York.

Harrington, J.H. (1987b), "The Improvement Process—How American's Leading Companies Improve Quality", Mc-Graw Hill, Singapore.

Harrington, J.H. (1991), "Business Process Improvement", McGraw Hill, New York.

Harrington, J.H. (1994), "Total Improvement Management", ASQC Quality Press, Milwaukee, WI.

Harrington, J.H. (1997), "The Fallacy of Universal Best Practices", TQM Magazines, 9(1), pp. 61-75.

Harry, M.J. (1988), "The Nature of Six Sigma Quality", Discussion Document, Motorola.

Ingle, S. and Roe, W. (2001), "Six Sigma black belt implementation", The TQM Magazine, Nov. 4, Vol. 13, No. 4, pp. 273-280.

Itasaka, G. (1989), "Gates to Japan: Its People and Society", Translated by Loftus, J.H., Second Printing, 3A Corporation, Tokyo, Japan.

Pande P.S., Nueman, R.P. and Cavanagh, R.R. (1997), "The Six Sigma Way", McGraw-Hill, New York.

Parth S. (1996), "Towards Implementing Total Quality Management".

Sanders, D. and Hild, C. (2000), "A discussion of strategies for six sigma implementation", Quality Engineering, Vol. 12, No. 3, pp. 303-9.

Spitzer, R.D. (1995), "TQM: The Only Source of Sustainable Competitive Advantage", in Cortada, J.W. and Woods, J.A., (Eds.) The Quality Yearbook, McGraw-Hill Inc., pp. 47-48.

Sunil, S. (1997), "TQM in Indian Engineering Industries", Business Relations Inc.

Terziovski M. (2002), "Beyond the Fads: What Can we Learn From Deming's Profound Knowledge and Our Research Over the Past Ten Years", Change Management: Proceedings of the 7th International Conference on ISO 9000 and TQM, Eds. Ho, S.K.M. and Dalrymple, J., Melbourne, pp. 206.

Ulrich, K., Choudhry, R.S. and Rana, K.S. (2000), "Managing Corporate Culture: Leveraging Diversity to Give India a Global Competitive Edge", Macmillan, India.

Weaver, C.N. (1995), "How to Use Process Improvement Teams", Cortada, J.W. and Woods, J.A., (Eds.) The Quality Yearbook, McGraw-Hill Inc., pp. 398-405.

□

Feature

JIT/TQM in Indian Industries

Vikas Kumar, Dixit Garg & N.P. Mehta

Both Just-in-Time (JIT) and Total Quality Management (TQM) have great importance in the Indian context due to their wide range of benefits. Although, the success stories of these management philosophies are limited in India, several Indian industries are implementing basic principles of Just-in-Time (JIT) in fragmentary framework of Total Quality Management (TQM) with the belief that it would be helpful in facing global competition. This paper signifies the present status of 'JIT/TQM Quality Techniques' in India through a survey of 46 Indian industries.

Vikas Kumar is Assistant Professor, Mechanical Engineering Department, Regional Engineering College, Kurukshetra (Haryana).

Recent years have witnessed a large number of organisations, both from developing and developed nations, aspiring for and working towards quality improvement techniques. 'JIT/TQM Quality Techniques' are likely to gain great importance in this respect as their main objectives include improved quality, building quality culture, reduction of quality cost and increased customer satisfaction. Some researchers (Garg and Deshmukh 1999) have presented a wide range of benefits of 'JIT/TQM Quality Techniques' in the area of quality, cost and flexibility. These benefits are an economic necessity of Indian industries that are facing problems of inferior quality, low productivity, underutilisation of capacity, unreliable delivery of raw material etc.

In the 1990s, several success stories of Japanese and American manufacturing sectors motivated Indian industries to implement 'JIT/TQM Quality Techniques' in India. Attempts are being made in several Indian industries for implementation of their basic principles. High inventory is responsible for inferior quality. On this issue, Chong and Rundus (2000) stated that 'inventory is an evil because of its non value added nature'. Due to absence of inventory from the factory floor, processes can be moved closer, which allow better communication resulting in better control on product quality. Product quality can also be increased by effective implementation of 'Quality Circles'. 'Quality Circles' identify, analyse and solve the problems of their choice and present their solutions to the management for implementation authorisation. Here, management commitment and its direct involvement is essential for successful implementation of 'JIT/TQM Quality Techniques' (Forza 1996). In JIT/TQM environment, management allow the workers to try and, if they fail, to learn from these failures.

Management allow the workers to try and, if they fail, to learn from these failures.

'JIT/TQM Quality Techniques' not only assess and appreciate quality concepts but also existing culture, habit, norms and values of employees. The employees work best and produce qualitative products only when they are valued and encouraged to contribute their own thoughts (Bonito 1990). Therefore, employee evolvement, commitments and promotion of open decision-making are a necessity of 'JIT/TQM Quality Techniques'.

In short, make quality every body's responsibility, high level of visibility on quality control, strict product quality compliance, match worker responsibility with authority, self correction of worker generated defects, 100 per cent quality inspection of products, routine maintenance, continual quality improvement, long term commitment to quality control efforts. These are some basic fundamentals of 'JIT/TQM Quality Techniques', which offer a sense of ownership to workers and emphasise on making quality efforts a habit for the employee. Once the use of quality techniques becomes a part of the manufacturing routine, continuous quality improvement and waste elimination becomes everyone's objective.

Some Relevant Past Studies

JIT/TQM practices have provided significant paradigm shift in management philosophy to improve product quality and organisational effectiveness in today's competitive and ever changing world market. Though there are many critical issues that should be examined for successful implementation of JIT/TQM practices, two main issues are considered in this literature review due to their great significance in the Indian context. These are:

JIT/TQM practices have provided significant paradigm shift in management philosophy.

Work force practice in Indian context

The research on Indian work force under JIT/TQM is limited. Research available on Indian workers made it clear that success of western models is limited, when applied in India. Vrat et al (1993) conducted a Delphi study on implementation of Just-in-Time (JIT) in India, which revealed that chances for success of Just-in-Time (JIT) practices in India are mixed and depends upon conduciveness of work culture. 'Indian work culture' is differed from Japanese. Cooperation, dedication, harmony, group decision process, pride of belonging to company, high level of motivation, high literacy level, multifunctional workers, enterprise union are core uniqueness of Japanese workmen while 'Indian workforce' have a comparatively low level of literacy, low motivation, specialised workers and low interaction between people at various levels. Chakrobarti (1997) acknowledged that some other factors such as lack of understanding about quality, insufficient mechanism to solve quality problems, lack of shared vision and poor commitment across various levels are also key obstacles in implementation of quality improvement techniques. On this issue, Agarwal et al (1996) suggested that some human aspects relevant to Indian workforce such as historical background, attitude, beliefs, values, interpersonal behaviour pattern and their impact on organisational effectiveness should be studied to conquer the evils in execution of quality techniques. In a different study, Singh and Bhandarkar (1996) stressed on the need for tolerances of ambiguity among Indian managers. Their study revealed that over one-third of population of Indian managers are highly intolerant to ambiguity while current business environment demands high tolerance to ambiguity. Their findings closely corroborate with the observation made by Hofstede (1982) in his culture study of 40 nations, wherein India had figured in the zone of 'weak uncertainty avoidance'. This study affirmed that Indians are inflexible, low risk takers and weak in uncertainty avoidance.

Indians are inflexible, low risk takers and weak in uncertainty avoidance.

Benefits of JIT/TQM practices

The purpose of this segment of literature review is to highlight the benefits of 'JIT/TQM Quality Techniques'. Ebrahimpour and Schonberger (1984) have presented potential benefits of JIT/TQC in developing countries and addressed the question "What about Just-in-Time (JIT) production with Total Quality Control (TQC)?" by considering some typical problems that stand in the way of industrial development. This documented that implementation of JIT/TQC not only improve quality and productivity but also reduce the cost. This view is supported by Dutton (1990), who presented the benefits of 'TQC quality culture' in the JIT production in Bytex Corporation, Massachusetts, in the from of reduced inventory, reduced total cycle time, improvement in quality, reduced floor space and increased sales. In another study, Priestman (1985) highlighted that JIT and SQC work well together to share the four common principles: simplicity, waste elimination, exposing problems, and

continuous improvement. JIT exposes the problems quickly because of its hand to mouth mode of operation. The combined efforts of JIT and SQC uncover the pattern and location of problems in the processes and provide tools to control these problems. But, effective implementation of JIT with SQC requires management commitment and direct involvement of operators. Finally, the study reported that less scrap and rework, less cost per unit, high productivity and high quality products, are key benefit of JIT practices.

Hohner (1988) affirmed that any significant improvement always takes time. 'Making quality a habit' requires behavioural changes, and changing behaviours also take an extended period of time. The research has also shown that over a longer term, both countable defects and their costs decreased after adoption of 'JIT/TQM Quality Techniques'.

'Making quality a habit' requires behavioural changes.

Oliver and Wilkinson (1992) surveyed 1000 manufacturing firms and found that over half of British and American firms were implementing JIT/TQM techniques in the work place and there had been a measurable decrease in traditional management. In another similar study, John et al (2000) surveyed the impact of JIT/TQM in 103 manufacturing firms and reported that implementation of JIT/TQM practices leads to lower inventory values for materials and parts, works in process, and finished goods. The percentage of inventory to total assets is much smaller than the traditional ratio of 29 per cent. The significant decrease in inventory lowers the overhead cost involved in handling and tracking inventory.

Flynn et al (1995) studied the relationship between Just-in-Time (JIT) and Total Quality Management (TQM). Their study revealed that use of Total Quality Management (TQM) practices improves overall organisational efficiency through remarkable reduction in rework time and process variance. In the same way, Just-in-Time (JIT) techniques improve quality performance through problem exposures and improved process feedback. In a different study, Chong and Rundus (2000) stated that quality differences can give a competitive edge to a company in the world market, therefore, high quality is the driving force of new manufacturing practices. The firms that have adopted now JIT/TQM practices are enjoying tremendous cost saving, improved product quality, reduced waste rate and optimal utilisation of capacity.

Criticism on JIT/TQM practices

Some researchers criticised JIT/TQM practices as having considerable negative implications at various levels. These are:

- JIT/TQM practices demand appropriate 'fit' between new techniques and organisational design, structure and processes. Therefore, firms cannot expect favourable results just by their implementation. Furthermore, its success depends critically on executive (management) commitment, employee empowerment and an open organisational culture (Flynn et al 1995; Powell 1995; Selto et al 1995).

Success depends on executive (management) commitment, employee empowerment and an open organisational culture.

- JIT/TQM practices require unrealistic employee commitment levels. Additionally, these practices have need of excessive re-training costs and multifunctional workers. (Sewell and Wilkinson 1992, Balakrishnan et al 1996).
- Implementation of JIT/TQM practices does not automatically increase profit because benefits from their adoption may be offset by its many direct and indirect costs (Priestman 1985; Selto et al 1995).
- Kanban requires longer time to transmit any new information through the manufacturing system as compared to centralised information processing systems (Ackroyd et al 1988; Powell 1995).
- Smaller lot sizes require increased efficiency and reliability of production process because multiple sourcing becomes difficult under JIT (Garg 1997, Garg and Deshmukh 1999).
- JIT/TQM practices require continuous assessment to achieve a sustained improvement in quality. They also require idealistic continuous close cooperation and communication at various levels of industries (Voss 1990).
- JIT/TQM practices also have negative implications for workers. Workers are, in fact, subject to highly visible forms of managerial power, control and processes of constant surveillance and monitoring of output & performance (Delbridge 1995; Sewell and Wilkinson 1992).

Success and failure of JIT/TQM practices

JIT/TQM practices are spreading throughout the world. Some reputed companies such as Lucas Electrical, South Wales; Rank Xerox, Netherland; New United Motor Manufacturing, USA; Repco Clutch Company, Australia; Hewlett-Packard, USA; Computervision corp. Manchester, are some examples of successful implementation of JIT/TQM practices. But in some companies, such practices did not help in improving quality. Florida Power and Light, USA, for example, launched a quality improvement drive with the ambitious objective of becoming the first U.S. Company to win the Japanese Deming Prize. The company gave its employees only six months to become experts on the Deming method before making it 'the mandatory approach in all problem-solving situations'. To fulfill Deming Prize requirements, some functional review teams were shaped to document and analyse 800 different procedures. As a result, 1,700 teams were presented with 'a confused problem-solving process'. Thus, the employees were trapped in the rigid procedures required by the Deming method. Reluctant employees were forced to use rigid analytical techniques. However, in November 1989, Florida Power & Light became the first American Company to capture the Japanese Deming prize. Right after that, the company's business started to deteriorate and their position in the market grew worse (Weisendanger, 1993). FP&L's experience with the Deming method is an instructive lesson about the dangers of blind implementation of JIT/TQM practices and ignoring the impact of work culture on organisational effectiveness.

JIT/TQM practices in industries: A survey

Chong and Rundus (2000) affirmed that it is extremely difficult to define and categorise various techniques of both Just-in-Time (JIT) and Total Quality Management (TQM) due to their broad philosophical nature and strong relationship. Similar views were presented by a number of quality managers of reputed Indian firms. They reported that a numbers of Indian industries are implementing basic principles of Just-in-Time (JIT) in fragmentary framework of Total Quality Management (TQM). This situation makes it difficult to classify Indian industries on basis of JIT or TQM implementations. In this study, all possible practicable quality improvement techniques of JIT/TQM practices are listed and classified on the basis of their utility. The main objectives of this paper are:

- *To identify present status of 'JIT/TQM Quality* Techniques' in Indian industries.
- *To identify those quality techniques, which are easy/difficult to implement.*
- To identify importance of each quality technique in Indian context.

Difficult to classify Indian industries on basis of JIT or TQM implementations.

Methodology

A questionnaire was prepared on the basis of identified quality techniques. The survey was completed in two phases. In the first phase, eighty-two questionnaires were mailed to different Indian firms that were located around Delhi, Faridabad, Gurgoan, Chandigarh and Ludhiana. As a result, nineteen questionnaires were received. In the second phase, twenty-seven managers were personally interviewed. In all, forty-six responses were completed for the study. The general profile of companies is given in Table 1.

Table 1: General Profile of Companies

• Type of Company	Automobile: 9, Heavy Machine: 12, Electronics: 7, Others: 18
• Annual Turn over (In crores)	Maximum (2200), Minimum (6), Average (306)
• Number of employee	Maximum (6750) Minimum (27) Average (1656)
• Number of employee (In quality control department)	Maximum (212) Minimum (3) Average (38)
• Percentage of scrap	Maximum (7.0) Minimum (0.5) Average (2.6)
• Percentage of reworks	Maximum (8.5) Minimum (1.4) Average (2.2)
• Awareness about JIT/TQM quality techniques: Yes: 35; No: 4; No Response: 7	

Analysis

Data collected was analysed with help of factor analysis on scale (0-100). The results obtained are presented in Table 2 and 3. Table 2 represents 'degree of difficulty' in implementation of quality techniques as perceived by respondents. In the same way, Table 3 indicates the state of importance being given by surveyed companies to quality techniques of JIT/TQM practices. The mean scores of Tables 2 and 3 were put in XY scatter chart, which indicates present status of quality techniques in Indian context (Fig. 1). X-axis and Y-axis of XY scatter chart represent 'degree of difficulty in implementation' and 'degree of importance', respectively. The plot area of XY scatter chart is divided into four zones. The quality techniques like acceptance quality level, flexible workforce, gantt chart, stand-

Table 2: 'Degree of difficulty' in implementation of JIT/TQM Quality Techniques

1. Management techniques							
Quality Techniques	Highly difficult	Difficult	Average difficult	Little difficult	Easy	No Response	Mean Score (0- 100)
Acceptance quality level	3	6	23	9	2	3	46.19
Affinity diagram	12	15	8	8	3	–	63.58
Arrow diagram	4	6	21	13	1	1	55.97
Automation & autonomation	21	8	11	6	–	–	73.91
Benchmarking	6	14	20	5	1	–	60.32
Cellular manufacturing	13	12	17	4	–	–	68.47
Contingency planning	8	10	15	7	2	4	53.80
Cost-benefit analysis	6	6	15	13	3	3	46.19
Customer contingency table	7	9	19	8	3	–	54.89
Deming Wheel (PDCA)	16	7	10	8	5	–	61.41
Departmental purpose analysis	3	6	12	16	4	5	38.04
Error proofing (poke yoke)	13	15	10	6	2	–	66.84
Flexible workforce	2	3	16	18	5	2	36.41
Gantt chart	2	7	21	11	5	–	44.56
ISO-9000	6	14	21	5	–	–	61.41
JIT purchasing	6	21	13	6	–	–	61.67
Kanban	14	12	9	5	2	4	74.40
Kaizen	21	10	8	7	–	–	62.05
Long term contract	8	11	16	7	2	2	56.52
Potential Problem analysis	5	18	13	7	3	–	58.15
Process decision programme chart	2	7	24	8	2	3	46.19
Program evaluation & review	6	16	16	5	1	2	59.23
Quality circles	7	14	16	7	2	–	64.13
Quality function deployment	7	17	12	6	1	3	59.23
Relation diagram	1	3	16	18	3	5	34.23
Set up time reduction	8	23	12	3	–	–	69.56
Small lot size	9	15	15	4	1	2	62.50
Standardisation	1	7	18	16	4	–	41.84
Team work	–	11	16	13	2	4	42.39
Total prod. maintenance	8	15	17	6	–	–	63.58
W.I.P. reduction	6	18	14	5	1	2	60.32
Work centred quality control	5	21	11	8	–	1	61.41
Zero defects	18	13	10	2	2	1	72.28
2. Analytical techniques							
Cause & effect diagram	6	7	20	9	2	2	51.8
Critical path Analysis	5	8	13	17	1	2	47.28
Failure mode & effect analysis	7	20	11	8	–	–	64.13
Fault tree diagram	7	15	13	6	4	1	57.06
Force field analysis	15	13	9	6	1	2	66.84
Reliability	14	17	7	4	4	–	67.93
Robust design	8	11	18	6	3	–	58.15
Taguchi methods	17	12	13	4	–	–	72.82
Tolerance design	3	9	16	12	2	4	45.1

(Table Contd.)

Table 2: 'Degree of difficulty' in implementation of JIT/TQM Quality Techniques (Contd.)

Quality Techniques	Highly difficult	Difficult	Average difficult	Little difficult	Easy	No Response	Mean Score (0- 100)
3. Idea generation techniques							
Brainstorming	0	8	16	12	7	3	36.97
Brain writing	2	13	13	11	4	3	45.63
Imagine ring	4	10	18	8	2	4	52.17
List reduction	4	16	12	8	6	–	48.91
Mind mapping	3	11	17	10	2	3	48.36
Multi voting	0	4	11	18	8	5	28.26
4. Data collection techniques							
Bar Charts	–	6	11	17	9	3	30.97
Box & whisker plots	2	6	18	18	–	2	43.47
C charts	1	4	15	22	4	–	36.95
Check sheets	–	1	8	19	15	3	20.65
Cusum chart	6	4	17	13	6	–	45.10
Process analysis	2	9	13	18	4	–	42.93
Flow charts	–	–	6	28	10	2	21.73
Histograms	–	3	5	24	9	5	23.36
Quality policy deployment	3	15	18	8	2	–	54.89
Matrix diagram	5	11	16	12	–	2	52.71
Matrix data analysis	4	11	21	7	3	–	53.26
Multi-vari chart	8	12	12	9	5	–	54.89
Dot plots	4	4	12	15	8	3	36.41
Process capability	2	6	23	12	3	–	45.65
Sampling	3	9	11	18	5	–	42.93
Scatter diagram	–	2	6	26	12	–	23.91
Statistical process control	7	5	12	13	9	–	43.47
Tree diagram	6	4	17	14	5	–	45.65
U-chart	–	7	21	13	2	3	40.21
X-moving range chart	–	3	17	21	5	–	34.23
Tally charts	–	5	9	22	9	1	29.89

ardisation, team work, critical path analysis, tolerance design, brainstorming, brain writing, list reduction, bar charts, check sheets, flow charts, histograms, dot plots, process capability, sampling, scatter chart, static process control, X-moving range (X-MR) and chart tally chart fall in zone 1, which pointed towards their great importance in Indian industries. In addition, Charts also indicate that fewer efforts are required to implement these techniques. On the contrary, the quality techniques under zone 4 (kanban, fault tree diagram, force field analysis, robust design, taguchi methods, imagineering, multi-vari chart) have been given less attention as compared to others. The zone 2 of chart indicates that number of quality techniques like affinity diagram, arrow diagram, automation & autonomation, benchmarking, cellular manufacturing, contingency planning, cost-benefit analysis, customer contingency table, Deming wheel (PDCA), error proofing (pokeyoke), ISO-9000, JIT purchasing, kiazen, long term contract, potential problem analysis, programme evaluation and review, quality circles, quality function deployment, set up time reduction, small lot size, total productive maintenance, W.I.P. reduction, work centred quality control, zero defects, cause and effect diagram, failure mode and effect analysis, reliability, quality policy deployment, matrix data analysis and matrix diagram have great importance in the Indian context but these techniques require sincere efforts for implementation. The quality techniques under zone 3 (departmental purpose analysis, process decision programme chart, relation diagram, mind mapping, multi voting, box & whisker plots, C charts, cusum chart, tree diagram) are easy to implement but surveyed companies have placed these techniques as less priority.

Table 3: 'Degree of importance' of 'JIT/TQM Quality Techniques'

1. Management techniques							
Quality Techniques	Very Good	Good	Fair	Little	Not at all	No response	Mean Score (0-100)
Acceptance quality level	29	13	4	–	–	–	88.58
Affinity diagram	8	12	13	10	1	2	56.52
Arrow diagram	13	11	11	7	1	3	61.65
Automation & autonomation	11	14	12	7	1	1	63.68
Benchmarking	26	11	8	1	–	–	83.93
Cellular manufacturing	14	9	12	6	2	3	61.41
Contingency planning	9	11	16	3	3	4	56.52
Cost-benefit analysis	20	14	8	4	–	–	77.17
Customer contingency table	12	8	14	9	2	1	59.23
Deming Wheel (PDCA)	13	17	12	2	–	2	70.10
Departmental Purpose Analysis	4	5	16	13	4	4	41.30
Error proofing (poke yoke)	11	8	15	10	2	–	58.69
Flexible workforce	16	16	7	4	1	2	70.65
Gantt Chart	8	13	18	5	–	2	60.86
ISO-9000	28	12	6	–	–	–	86.95
JIT purchasing	13	15	10	6	–	2	66.84
Kanban	22	16	6	1	–	1	80.97
Kaizen	6	8	17	10	2	3	50.00
Long term contract	11	12	16	4	2	1	63.04
Potential Problem analysis	22	12	9	3	–	–	78.08
Process decision programme chart	3	5	18	13	3	4	41.30
Program Evaluation & Review	6	17	13	7	1	2	58.69
Quality Circles	19	12	12	3	–	–	75.64
Quality fun. Deployment	14	16	7	8	1	–	68.40
Relation diagram	2	9	17	12	2	4	44.02
Set up time reduction	24	15	7	–	–	–	84.23
Small lot size	8	13	18	5	2	–	60.86
Standardisation	27	16	3	–	–	–	88.04
Team work	25	15	6	–	–	–	–
Total prod. Maintenance	16	21	7	2	–	–	77.71
W.I.P. reduction	16	18	8	2	–	2	73.91
Work centred quality control	15	12	17	2	–	–	71.39
Zero defects	25	17	4	–	–	–	86.41
2. Analytical techniques							
Cause & effect diagram	16	22	4	4	–	–	77.17
Critical path Analysis	9	13	18	6	–	–	63.58
Failure mode & effect analysis	17	18	6	3	–	2	74.45
Fault tree diagram	6	11	11	8	4	6	47.28
Force field analysis	2	10	8	15	8	3	37.50
Reliability	18	21	6	1	–	–	80.43
Robust design	5	7	17	11	2	4	46.73
Taguchi methods	5	5	12	17	2	5	41.30
Tolerance design	19	22	4	1	–	–	82.06

(Table Contd.)

Table 3: 'Degree of importance' of 'JIT/TQM Quality Techniques' (Contd.)

Quality Techniques	Very Good	Good	Fair	Little	Not at all	No response	Mean Score (0-100)
3. Idea generation techniques							
Brainstorming	28	12	5	1	–	–	86.41
Brain writing	14	16	9	3	2	2	67.93
Imagine ring	8	6	8	13	7	4	42.93
List reduction	15	13	10	5	2	1	67.39
Mind mapping	5	3	7	16	6	9	32.06
Multi voting	6	6	12	14	3	5	43.47
4. Data collection techniques							
Bar charts	20	19	4	3	–	–	80.43
Box & whisker plots	6	3	11	19	3	4	40.21
C charts	8	6	7	9	7	9	39.67
Check sheets	21	13	5	6	–	1	86.41
Cusum chart	–	–	16	17	5	8	26.63
Process analysis	–	6	18	13	7	2	36.41
Flow charts	14	19	11	2	–	–	74.45
Histograms	17	22	7	–	–	–	80.43
Quality policy deployment	16	19	8	3	–	–	76.08
Matrix diagram	12	8	14	8	2	2	58.69
Matrix data analysis	5	11	16	9	5	–	51.08
Multi-vari chart	3	3	11	17	7	5	32.6
Dot plots	2	9	13	18	3	1	42.93
Process capability	2	6	23	12	3	–	45.65
Sampling	3	9	11	18	5	–	42.93
Scatter diagram	–	2	6	26	9	3	23.91
Statistical process control	7	5	12	13	6	3	43.47
Tree diagram	6	4	17	14	4	1	45.65
U-chart	–	7	21	13	5	–	40.21
X-moving range chart	–	3	17	21	4	1	34.23
Tally charts	–	5	9	22	8	2	29.89

Conclusions

The survey conducted in this study reveals the great importance of 'JIT/TQM Quality Techniques' in the Indian context Furthermore, the techniques such as quality circle, total preventive maintenance, cause and effect diagram, quality policy deployment, affinity diagram, Kaizen, benchmarking, JIT purchasing, matrix diagram, require more attention since their efficient implementation may be helpful to determine the ways and means to improve the present position of Indian industries in the areas of quality, cost and flexibility by developing specific time bound improvement action plans. Based upon the discussion in this paper, the following issues need further scrutiny:

- Managers and employees think and behave differently in different countries. Therefore a cross-nation comparison can be made that would be helpful to highlight the performance of different quality improvement techniques in different regions.

Managers and employees think and behave differently in different countries.

- Some standard performance measures must be identified so that the impact of different quality techniques can be easily measured on organisational performance.
- Nowadays, the application of Supply Chain Management (SCM) is continuously growing in

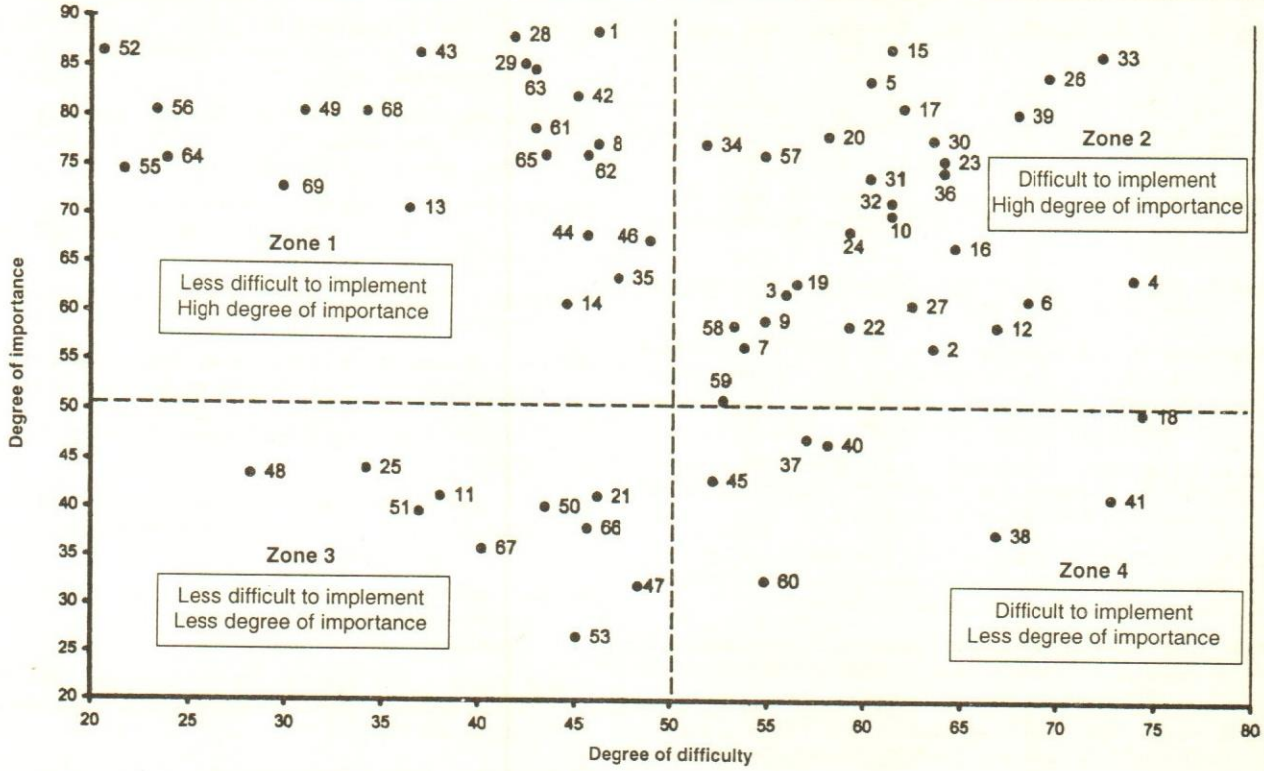


Fig. 1. Present Status of JIT/TOM practices in Indian industries

Attributes: 1. Acceptance quality level; 2 Affinity diagram; 3. Arrow diagram; 4. Automation & autonomation; 5. Benchmarking; 6. Cellular manufacturing; 7. Contingency planning; 8. Cost-benefit analysis; 9. Customer contingency table; 10. Deming Wheel (PDCA); 11. Departmental Purpose Analysis; 12. Error proofing (pokeyoke); 13. Flexible workforce; 14. Gantt chart; 15. ISO-9000; 16. JIT purchasing; 17. Kiazen; 18. Kanban; 19. Long term contract; 20. Potential problem Analysis; 21. Process decision program chart; 22. Programme evaluation & Review; 23. Quality Circles; 24. Quality function deployment; 25. Relation diagram; 26. Set up time reduction; 27. Small lot size; 28. Standardisation; 29. Team work; 30. Total productive maintenance; 31. W.I.P. reduction; 32. Work centered quality control; 33. Zero defects; 34. Cause & Effect diagram; 35. Critical Path analysis; 36. Failure Mode & Effect Analysis. 37. Fault tree diagram; 38. Force field analysis; 39. Reliability; 40. Robust design; 41. Taguchi Methods; 42. tolerance design; 43. Brainstorming; 44. Brain writing; 45. Imagineering; 46. List Reduction; 47. Mind mappin; 48. Multi voting; 49. Bar Charts; 50. Box & Whisker plots; 51. C charts; 52. Check sheets; 53. Cusum chart; 54. Process Analysis; 55. Flow charts; 56. Histograms; 57. Quality Policy Deployment; 58. Matrix Data Analysis; 59. Matix Diagram; 60. Multi-vari chart; 61. Dot plots; 62. Process capability; 63. Sampling; 64. Scatter Diagram; 65. Static process control; 66. Tree diagram; 67. U-chart; 68. X-moving range (x-MR) Chart; 69. Tally charts

practice. It is therefore essential to study the impact of Supply Chain Management on product quality.

- Information Technology (IT) has tremendous impact on quality control communication. Some successful manufacturing companies are using Information Technology to control the product quality more efficiently and also to increase their customer reach. Information technology changes the ways of conducting businesses. Internet, EDI, Electronic funds transfer, e-mail, have made several traditional systems obsolete. Therefore, Indian industries must implement these new technologies to speed up design and retrieval process through effective use of R & D.

In general, JIT/TQM Quality Techniques seem to generate awareness about quality and associated cost at every level, and in every sector of Indian industries. But, their effectiveness would depend upon the Indian workforce situation, people's socialisation, behaviour pattern, personality traits, attitudes and values.

References

Ackroyd S., Burrell G., Hughes M. and Whitaker A. (1988), "The Japanization of British Industries?" Industrial Relation Journal, Vol. 19. pp. 11-33.

Agrawal S.K., Prem Vrat and Karunes S. (1996), "Quality Management Self Assessment – Approach for Quality Improvement", Productivity Journal, Vol. 37, pp. 239-244.

Balakrishnan R., Linsmeier T.J. and Venkatakchalam M. (1996), "Financial benefits from JIT adoption: Effects of customer concentration and cost structure", The Accounting Review, Vol. 71, pp. 183-205.

Bonito J.G. (1990), "Motivating employees for continuous improvement efforts", Production and inventory Management Review with APICS news, Vol. 8, pp. 225-236.

Chakroborti T. (1997), "TQM-A Hard Climb", The Economics Times, (Supplementary) 28 Mar-3 April.

Chong V.K. and Rundus M.J. (2000), "The effect of new manufacturing practices and intensity of market competition on organisational performance: and empirical investigation", International Conference on Management Research Accounting Research and Case Symposium, Mesa, Arizona, U.S.A., 6-8 Jan.

Delbridge R. (1995), "Surviving JIT: control and resistance in Japanese transplants", Journal of Management Studies, Vol. 32, pp. 803-817.

Dutton B. (1990), "Switching to quality excellence", Manufacturing System, Vol. 8, pp. 245-256.

Ebrahimpour, M. and Schonberger R. J. (1984), "The Japanese Just-in-Time/Total Quality control production system: potential for developing countries", International Journal of Production research, Vol. 22, pp. 421-430.

Forza C. (1996), "Work organisation in lean production and traditional plants: what are the differences?", International Journal of Operations & Production Management, Vol. 16, pp. 42-62.

Flynn B., Salakibara S. and Schroeder R.G. (1995), "Relationship between JIT and TQM Practices and Performance", Academy Management Journal, Vol. 38, pp. 1325-1360.

Garg D., Deshmukh S.G. and Kaul O.N. (1996), "Critical analysis in JIT purchasing in Indian context", Productivity Journal, Vol. 37, pp. 271-279.

Garg D. (1997), "Relevance of JIT purchasing in Indian industries", Ph.D. thesis, Kurukshetra University, Kurukshetra, India (unpublished).

Garg D. and Deshmukh S.G. (1999), "JIT concepts and Relevance in Indian context", Industrial Engineering Journal, Vol. 28, pp. 14-18.

Hohner G. (1988), "JIT/TQC: Integration product design with shop floor effectiveness", Industrial Engineering, Vol. 20, pp. 42-47.

Hofstede (1982), "International Difference in Work Related Values", Beverly Hills: Sage Publications.

John Y.L., Patti Y.L. and Anne M.S. (2000), "Auditing- manufacturing clients in today's lean environment", CPA Journal, December, pp. 129-136.

Oliver N. and Wilkinson B. (1992), "The Japanization of British industries: New Developments in the 1990's", Blackwell publishers, London, pp. 155-158.

Powell T.C. (1995), "Total Quality Management as competitive advantage: a review and empirical study", Strategic Management Journal, Vol. 16, pp. 15-37.

Priestman S. (1985), "SQC and JIT: Partnership in quality", Quality Progress, May, pp. 31-35.

Selto F.H., Renner C.J. and Yong S.M. (1995), "Assessing the organisational fit of a Just-in-Time manufacturing system: testing selection, interaction and system models of contingency theory", Accounting, Organisation and Society, Vol. 20 pp. 665- 684.

Sewell G. and Wilkinson B. (1992), "Someone to watch over me: surveillance, discipline and Just-in-Time process", Sociology, Vol. 26, pp. 271-289.

Singh P. and Bhandarkar A. (1996), "Paradigm Shift in Indian Industries: The Need for Tolerance of Ambiguity", MDI Management Journal, Vol. 9, pp. 106-112.

Vrat P., Mittal S. and Tyagi K. (1993), "Implementation of JIT in Indian environment: A Delhi study", Productivity Journal, Vol. 34, pp. 251-256.

Vuppalipati K., Ahire S.L., and Gupta T. (1995), "JIT and TQM: A Case for Joint Implementation", International Journal of Operations and Production Management, Vol. 15, pp. 84-94.

Voss C.A. (1990), "Just-in-time manufacture", IFS (Publication) Limited, Springer-Verlag, UK.

Weisendanger F. (1993), "Deming's luster dims at Florida Power and Light", Journal of Business Strategy, September-October, pp. 148-159.

□

The optimist sees opportunity in every danger, the pesimists sees danger in every opportunity.

– Winston Churchill

Feature

Review of Quality Award Models

Arun Kanda, S.G. Deshmukh & Ramamoorty Shankar

This paper attempts to review the existing Quality Award Models to identify the various factors that make a Quality Organisation. The paper surveys Award Models and Quality Recognition Medals. Each Award Model is critically appraised for strengths/limitations. Finally a comparative analysis of major award categories is made. The Malcolm Baldrige National Quality Award (MBNQA) has been taken as the reference model to compare other national and international award models. In the International category, the award model that has been reviewed are MBNQA, European Foundation for Quality Management (EFQM) and Deming Prize. In the National Category, the awards considered are Confederation of Indian Industry–Export Import (CII-EXIM), Golden Peacock Award, Rajiv Gandhi National Quality Award, Tata Business Excellence Model and Ramakrishna Bajaj National Quality Award. Apart from these awards models, a number of medals offered by ASQ (American Society of Quality) are also reviewed. The survey reveals that leadership, customer focus, proper processes, societal/environmental concerns are core factors which are included in almost all the Quality Award Models and Recognition schemes.

Arun Kanda is with the Mechanical Dept, IIT-Delhi, S.G. Deshmukh is with the Mechanical Dept, IIT-Delhi and Ramamoorty Shankar is Head: Quality, Escosoft Technologies.

International Quality Award Models

Malcolm Baldrige Quality Award

The Malcolm Baldrige National Quality Award was created by Public Law 100-107, signed into law on August 20, 1987 in USA. The Award Program are responsive to the purposes of Public Law 100-107, led to the creation of a new public-private partnership. Principal support for the programme comes from the Foundation for the Malcolm Baldrige National Quality Award, established in 1988.

The Award is named for Malcolm Baldrige, who served as Secretary of Commerce from 1981 until his tragic death in a road accident in 1987. His managerial excellence contributed to long-term improvement in efficiency and effectiveness of government profitability.

Several major industrial nations have successfully coupled rigorous private-sector quality audits with national awards giving special recognition to those enterprises the audits identify as the very best:

A national quality award programme of this kind in the United States helped improve quality and productivity by:

(a) Helping to simulate American companies to improve quality and productivity while obtaining a competitive edge through increased profits.

(b) Recognising the achievements of those companies that improve the quality of their goods and services and providing an example to others.

Baldrige Award Criteria Framework: Dynamic Relationships

Goal

- Customer Satisfaction
- Customer Satisfaction Relative to Competitors

- Customer Retention
- Market Share Gain

Measures of Progress

- Product and Service Quality
- Productivity Improvement
- Waste Reduction/Elimination
- Supplier Quality

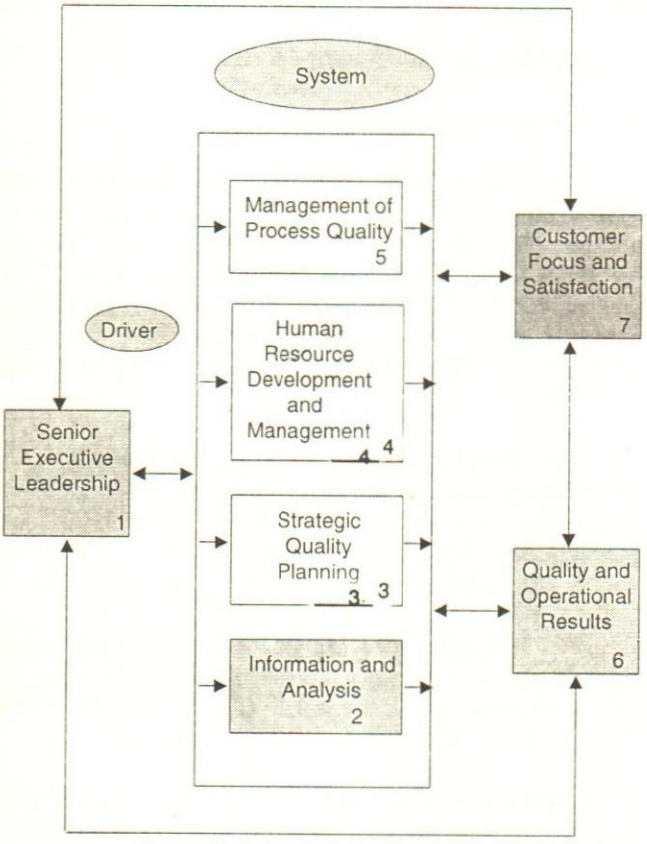


Fig. 1. Malcolm Baldrige Quality Award

EFQM Excellence Model

EFQM (European Foundation For Quality Management) was established in 1988 with the support of the European Commission to promote outstanding performance in European organisations. Its mission is to be the driving force for sustainable excellence in organisations in Europe through the systematic identification and promotion of best business practice.

Need for EFQM

Regardless of sector, size, structure or maturity, organisations need to establish an appropriate management system. The EFQM Excellence Model is a practical tool to help organisations do this by measuring where they are on the path to Excellence; helping them understand the gaps and then stimulating solutions. The EFQM is committed to researching and updating the Model with the inputs of tested good practices from thousands of organisations both within and outside of Europe. In this way we ensure the model remains dynamic and in line with current management thinking.

The Fundamental Concepts of EFQM Model

The EFQM Model is a non-prescriptive framework that recognises many approaches to achieving sustainable excellence. Within this non-prescriptive approach there are some Fundamental Concepts, which underpin the EFQM Model.

There is no significance intended in the order of the concepts. The list is not meant to be exhaustive and it will change as excellent organisations develop and improve.

Results Orientation

Excellence is dependent upon balancing and satisfying the needs of all relevant stakeholders (this includes the people employed, customers, suppliers and society in general as well as those with financial interests in the organisation).

Customer Focus

The customer is the final arbiter of product and service quality, customer loyalty, retention and market share gain are best optimised through a clear focus on the needs of current and potential customers.

Leadership & Constancy of Purpose

The behaviour of an organisation's leaders creates a clarity and unity of purpose within the organisation and an environment in which the organisation and its people can excel.

The behaviour of an organisation's leaders creates a clarity and unity of purpose.

Management by Processes & Facts

Organisations perform more effectively when all interrelated activities and understood and systematically

managed and decisions concerning current operations are planned. Improvements are made using reliable information that includes stakeholder perceptions.

People Development & Involvement

The full potential of an organisation's people is best realised through shared values and a culture of trust and empowerment, which encourages the involvement of everyone.

Continuous Learning, Innovation & Improvement

Organisational performance is maximised when it is based on the management and sharing of knowledge within a culture of continuous learning, innovation and improvement.

Partnership Development

An organisation works more effectively when it has mutually beneficial relationships, built on trust, sharing of knowledge and integration, with its Partners.

Public Responsibility

The long-term interest of the organisation and its people are best served by adopting an ethical approach and exceeding the expectations and regulations of the community at large.

The EFQM Excellence Model is a non-prescriptive framework based on nine criteria. Five of these are 'Enablers' and four are 'Results'. The 'Enabler' criteria cover what an organisation does. The 'Results' criteria cover what an organisation achieves. 'Results' are caused by 'Enablers'.

The EFQM Excellence Model is a non-prescriptive framework based on nine criteria.

The Model, which recognises there are many approaches to achieving sustainable excellence in all aspects of performance, is based on the premise that Excellent results with respect to Performance, Customers, People and Society are achieved through Partnerships and Resources and Processes.

The arrows emphasise the dynamic nature of the model. They show innovation and learning helping to improve enablers that in turn lead to improved results.

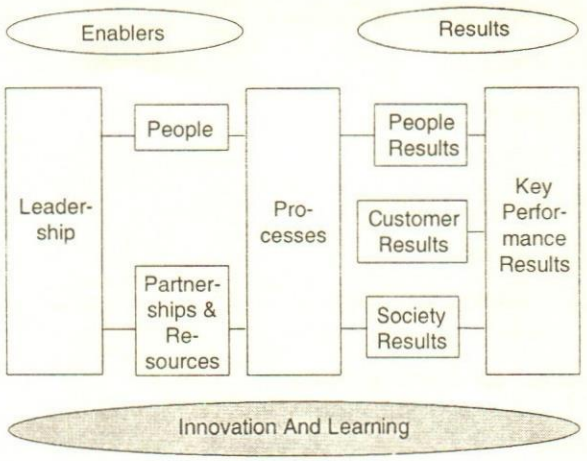


Fig. 2. EFQM Excellence Model

Model Contents Structure

The Model's nine boxes, shown above represent the criteria against which to assess an organisation's progress towards excellence. Each of the nine criteria has a definition, which explains the high level meaning of that criterion.

To develop the high level meaning further each criterion is supported by a number of sub-criteria. Sub-criteria pose a number of questions that should be considered in the course of an assessment.

Deming Prize

The annual Deming Prize(s) was established in 1950 and is wholly administered by the Union of Japanese Scientists and Engineers (JUSE).

The Deming Prize Medal was designed by Mr. Joji Yamawaki. The medal is used here with kind permission of Mrs. Fumi Yamawaki.

Dr. Deming wrote in the Preface to Out of the Crisis, "... The Union of Japanese Scientists and Engineers (JUSE) instituted the annual Deming Prize(s) for contributions to quality and dependability of product". JUSE published a booklet during the 1960s titled "The Deming Prize", by Kenichi Koyanagi, which provides the history of the prizes and other information.

Factors of Deming Prize are:

1. Policy
2. Organisation and its Management
3. Education and Dissemination

4. Information on Quality
5. Analysis
6. Standardisation
7. Control
8. Quality Assurance
9. Results
10. Planning for Future

Checklist for Deming Prize:

A.Policy

(i) There should be an articulated policy for quality control.

(ii) There has to be standardised methods to establish the policy.

(iii) Quality policy should be consistent with your business goals.

(iv) Policy should prescribe rigorous statistical methods.

B.Organisation and Its Management

(i) Responsibility for quality should be explicitly allocated.

(ii) Authority should be delegated to appropriate people.

(iii) There has to be right conditions for inter-divisional cooperation.

(iv) Committees should be created to deal with quality issues.

C.Education And Dissemination

(i) Need for quality control should be inculcated in employees.

(ii) Employees should be taught quality and control consciousness.

(iii) Training in statistical concepts should be imparted widely.

(iv) Training should bridge gaps in the knowledge of quality.

(v) Same training should be given to suppliers and distributors.

(vi) Quality-control activities should be built into the education.

(vii) There should be a system for suggesting ways of improvement.

D.Information on Quality

(i) Information should be collected regularly from external sources.

(ii) Data should flow freely between departments and functions.

(iii) Computers should be used to transfer data speedily.

(iv) Data should be analysed statistically and the results used.

E.Analysis

(i) Key problems should be identified and analysed in detail.

(ii) A validated analytical approach should be chosen.

(iii) All the statistical methods should be used for quality control.

(iv) Statistical analysis should be linked to the company's technology.

(v) Quality and process analysis should be conducted systematically.

(vi) The analytical results should be utilized to effect corrections.

(vii) Suggestions for improvement should be factored in the analyses.

F.Standardisation

(i) Standards should be set for the output of every process.

(ii) Standards should be established, revised and replaced.

(iii) Outcomes of changes should be monitored systematically.

(iv) Standards should be relevant to the needs of the customer.

(v) Statistical methods should be used to arrive at the standards.

(vi) Firm's technology should be factored into the standards.

(vii) Standards should be used to improve quality.

G.Control

(i) There should be systems for controlling quality, quantity and costs.

(ii) Items and critical central points should be identified.

(iii) Control charts should be an appropriate statistical method.

(iv) Quality circle activities should contribute to control systems.

(v) Actual conditions should allow the systems to function.

(vi) Organisational matters should be normally kept under control.

H.Quality Assurance

(i) Quality should be ensured in the development of new products.

(ii) Product design and manufacture should ensure safety.

(iii) Processes should be designed and analysed to ensure quality.

(iv) Process capabilities should ensure quality standards.

(v) Gauging, testing and inspection should be used.

(vi) Maintenance and outsourcing should ensure quality.

(vii) Quality assurance system should be audited on its performance.

(viii) Statistical methods should be utilised for quality assurance.

(ix) Level of quality should be ensured, evaluated and audited.

(x) Quality assurance system should deliver result.

I.Results

(i) Results of quality control procedures should be measured.

(ii) Quality, service, profits and delivery-time should be improved.

(iii) Intangible results should not be generated by quality.

(iv) Effectiveness of defect-correction should be measured.

J.Planning for The Future

(i) Company should have a concrete plan for the future.

(ii) There should be plans to improve the results of defect-correction.

(iii) Further advances in quality control should be planned.

(iv) Future plan for quality should be linked to long-term business.

Elcina Quality Awards

Principles and Concepts behind revision:

- The Elcina Quality Award Criteria have been revised to be in line with Quality Management Process Model contained in the proposed ISO 9000:2000 series of standards. The checklist largely includes the aspects outlined in the above standards, particularly ISO 9004: 2000 (Draft).
- In order to determine the acceptable level for the awards, certain performance maturity levels as contained in ISO 9004: 2000 (Draft) have been used in the criteria. The details are as follows:

Maturity Level	Performance Level	Guidance
1	No formal approach	No systematic approach evident; no results poor results or unpredictable results.
2	Reactive approach	Problem or prevention based systematic approach; minimum data on improvement result available.
3	Stable formal system approach	Systematic process-based approach early stage of systematic improvements; data available on conformance to objectives and existence of improvement trends.
4	Continual improvement emphasised	Improvements process in use; good results and sustained improvement.
5	Best-in-class performance	Strongly integrated improvement process; best-in-class benchmarked results demonstrated.

- To qualify for consideration for the ELCINA Quality Awards, the Organisations should be compulsory at the maturity level 3 tending towards 4 which is possible to be determined by the marking/weightage scheme proposed below:

Aspects	Criteria		Weightage
A. Enablers/ Mechanism	(01)	Leadership & Management Commitment	20
	(02)	Resource management	15
	(03)	Product realisation	15
	(04)	Measurement analysis & Improvements	15
B. Results	(05)	Product Quality	10
	(06)	Customer/stake holder satisfaction	10
	(07)	Business results	15

Correspondence between Maturity Levels and marking/weightage scheme:

As per the characteristics/features identified for different maturity levels, the corresponding marking/weightage are as follows:

Maturity level	Marking/weightage
Level 1	25
Level 2	50
Level 3	70
Level 4	80
Level 5	70-100

An organisation has to secure a minimum of 70 marks to be eligible for consideration of Elcina Quality Award.

Checklist for Elcina Awards

Enablers/Mechanism

Leadership and Management Commitment

A. Organisation should have the system of defining vision; policy and objectives for quality. It should involve and take care of all stakeholders' requirements.

B. There has to be a mechanism for

(i) Organisation wide communication awareness

(ii) Translating the contents if vision, policy and objectives into requirements at various levels in the organisation (Development) Enclose a sample copy of activity level deployment documents).

C. The organisation should have a system for quality planning. The planning should address the following:

(i) Needs and expectations of customers and other interested parties.

(ii) Performance of the products and/or services.

(iii) Performance of operational processes and associated parties.

(iv) Learning from previous experiences.

(v) Risk identification and analysis.

(vi) Reviews and revisions.

D. There has to be a mechanism of reviewing the quality management system at regular intervals for ensuring its continuing suitability and effectiveness. Review process should

(i) Involve top management.

(ii) Be consistent with organisations strategic planning cycle.

(iii) Address aspects such as: performance, customer satisfaction, benchmarking and opportunities for improvements.

E. Identify the systems in place to improve Management Information System (MIS).

Resource Management

A. There has to be a mechanism for

(i) Involvement and empowerment of people towards organisation's objectives.

(ii) Determining the competence level needed to achieve current and future objectives.

(iii) Addressing the training and developmental needs.

B. There has to be a plan for infrastructure (equipment, hardware, software, workspace and related services), to consider the associated risks and include strategies to maintain the quality of products and/or services? If yes, please enclose sample-supporting documents.

C. The work environment should address

(i) Human factor such as health and safety, ergonomics, employees' facility etc.

(ii) Physical factors such as hygiene, noise, light, pollution etc.

D. To prove mutually beneficial supplier/partner relationship, the organisation should have:

(i) Vender development and quality rating system.

(ii) Policy of limited suppliers, reduced/nil inspection, self-certification/ship to time etc.

(iii) Policy of encouraging continual improvement and recognising and rewarding efforts.

Product realisation

A. There should be a mechanism of translating the customer requirements into the requirements for the organisation.

B. There has to be a methodology to be followed during design phase of a product.

C. One has to carry out product failure mode and

effect analysis (FMEA) and design of experiments (DOE).

D. There should be a product realisation plan (process plan, flow chart etc.) including process and product performance criteria related to customer requirements.

Measurement Analysis and Improvements

A. There should be a system of internal audits to determine the effective implementation of quality system in the organisation.

B. There should be a mechanism for linking financial consideration with quality management system (quality cost).

C. There should be a mechanism for effectively obtaining the "voice of customer" (Internal/External customer satisfaction) for aligning the organisation's activities.

D. Indicate the parameters (such as Dependability, timeliness, responsiveness, reaction time etc.) and measurement methods used to evaluate the efficiency and effectiveness of internal processes.

E. One should have inspection and test plans to clearly specify the measurement requirements at various stages, including acceptance criteria of product and/or services.

F. There has to be a mechanism for effectively dealing with non-conformances (pre-shipment and post-shipment) as well as trends and determining appropriate corrective and preventive actions, including identification of improvement opportunities.

G. One must identify the effectiveness of preventive maintenance system.

Results

A. Product Quality

(i) Identify whether your products and/or services conform to:

a. National/International standards.

b. Organisations own specification.

c. Customers' specification.

(ii) Identify quality trend indicators.

(iii) One must provide data on product/process comparative studies/bench mark status along with sample cases of improvement opportunities.

(iv) One must provide data of quality cost studies and trends.

B. Customer/Stakeholder Satisfaction

One must provide details and trends of customer/stakeholder satisfaction studies (customer satisfaction surveys, employee motivation survey, industry studies, questionnaire, direct communications, customer complaint analysis etc.) done in the recent past.

C. Business Results

Relevant data/information in this category are:

- Business plan realisation (planned vs. actual).
- Market share and positioning.
- Growth and export trends.
- Expansion and Diversification plans.
- Awards, recognitions, certificates, marks etc.
- Training and R&D efforts (Policies concerning investment in terms of man days, percentage of turn over etc.).

Principles and Concepts behind revision

Checklist

National Quality Award Models

An overview of National Quality Award Models in India is clearly depicted in Table 1.

Rajiv Gandhi National Quality Award

Rajiv Gandhi National Quality Award was instituted by the Bureau of Indian Standards in 1991 and has been named after Late Prime Minister Rajiv Gandhi, with a view to encourage Indian manufacturing and service organisations to strive for excellence and giving special recognition to those who are considered to be the leaders of quality movement in India. This award is intended to generate interest and involvement of Indian Industry in quality programmes, drive our products and services to higher levels of quality and equip our Industry to meet the challenges of domestic and international markets.

Rajiv Gandhi National Quality Award helps Indian Industry to improve quality by:

- Encouraging Indian Industry to make significant im-

provements in quality for maximizing consumer satisfaction and for successfully facing competition in the global market as well.

Table 1

Award name (Started) in Year	By Whom	Criteria
Rajiv Gandhi National Quality Award (1991)	BIS – Bureau of Indian Standards	Leadership, Policies and Strategies, Human Resource Management, Resources, Processes, Customer Satisfaction, Employees Satisfaction, Impact on Society, Business Results
Golden Peacock Award (1991)	IOD – Institute of Directors	Organisational Leadership, Customer Satisfaction, Strategic Quality Planning, Human Resource Utilisation, Competitive Benchmarking, Product Quality and Service Quality Assurance, Suppliers Quality Progress, Impact on Society
Business Excellence National Quality Awards (1994)	CII – Confederation of Indian Industries	Leadership, People Management, Policy and Strategy, Resources, Processes, People Satisfaction, Customer Satisfaction, Impact on Society, Business Result
Ramakrishna Bajaj National Quality Award (1995)	IMC – Indian Merchant Chamber	Leadership, Information and Analysis, Strategic Management, Process Management, Business Results, Customer Focus and Satisfaction, Exports, Innovation, Environment and Safety

- Recognising the achievements of those organisations, which have improved the quality of their products and services and thereby set an example for others.
- Establishing guidelines and criteria that can be used by industry in evaluating their own quality improvement efforts.
- Providing specific guidance to other organisations that wish to learn how to achieve excellence in quality, by making available detailed information on the 'Quality Management Approach' adopted by award winning organisations to change their cultures and achieve eminence.

There are four awards given for:

1. Large scale manufacturing organisations
2. Small scale manufacturing organisations
3. Service sector organisations
4. One for Best of All

Golden Peacock Award

This award has been instituted by the Institute of Directors (IOD) in February 1991 to encourage Total Quality improvements in commercial, industrial as well as service organisations.

The awards are put in five categories. Public and Private Undertaking, All Sectors of Industry and Commerce, Government and Professional Associations, Educational, Service and Research Establishments.

The CII-EXIM Award For Business Excellence

The purpose of creating this Award is to set a challenge for Industry to scale new heights of quality and leadership. Its purpose is also to create 'role model' organisations, which exemplify the application of the TQM approach for achievement of Business Success through Business Excellence.

This Award is an effort of collaboration between EXIM bank and CII instituted and announced at the 2nd Quality Summit in 1994. The CII Quality Award is based directly on European Quality Award. The application is invited in these categories:

1. Large Scale (Annual sales more than Rs. 500 crores)
2. Medium scale (Annual sales less than Rs. 50 crores)
3. Small scale (Annual sales less than Rs. 50 Crores)

IMC Ramakrishna Bajaj National Quality Award

The Indian Merchants Chamber instituted IMC Ramakrishna Bajaj National Quality Award in 1995, with the aim to promote quality standards, both in processes and product, among Indian organisations, and to make them achieve global standards. The Malcolm Baldrige Award criteria have been customised to suit Indian conditions with special focus on exports, innovation, environment and safety. Award framework of Ramakrishna Bajaj National Quality Award is provided in Fig. 3.

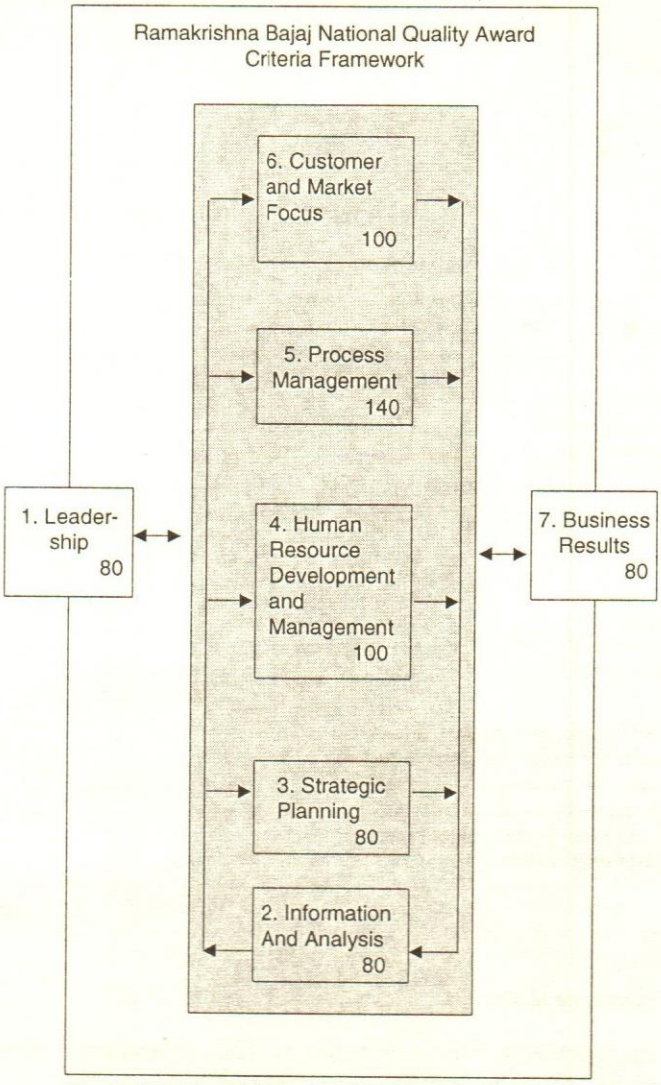


Fig. 3. IMC Ramakrishna Bajaj National Quality Award

Tata Business Excellence Model

The genesis of TBEM (Tata Business Excellence Model) started in 1994 with a need for making processes and practices customer centric, focus on agility, performance standards are shown in figure 4.0

Quality Recognition Schemes

These Awards of American Society for Quality recognise outstanding leadership in quality with ASQ's prestigious medals and awards. The awards recognise individuals for superior achievements in the development, promotion and communication of quality information and technology. Awards and medals are named after people who have made outstanding achievements in the field of quality. These awards are presented at ASQ's Annual Quality Congress in the spring of each year.

The Brumbaugh Award

Founded in 1949, the Brumbaugh Award is presented for the paper, published in the preceding year, that the committee decides has made the largest single contribution to the development of industrial application of quality control. There is no nomination form for this award.

Feigenbaum Medal

The Feigenbaum Medal is presented to the individual who is 35 years of age or younger, who has displayed outstanding characteristics of leadership, professionalism and potential in the field of quality and also whose work has been or will become of distinct benefit of mankind.

Freund-Marquardt Medal

The Freund-Marquardt Medal is presented to nominees who have applied quality principles to the development, implementation and literature of management standards.

E.L. Grant Medal

The E.L. Grant Medal is presented to the individual who has been deemed by the committee to have demonstrated outstanding leadership in the development and presentation of a meritorious educational programme in quality control.

Ishikawa Medal

The Ishikawa Medal will be awarded to an individual or a team whose work has had a major positive impact on human aspects.

E. Jack Lancaster Medal

The E. Jack Lancaster Medal is presented to the individual who has been recognised by the committee for dedication and outstanding contributions to the International Fraternity of Quality Professionals.

Shewhart Medal

The Shewhart Medal is awarded for technical leadership: "The Shewhart Medal committee may designate, not more often than once each year, that nominee, not previously so designated, who is deemed by it to have demonstrated the most outstanding technical leadership in the field of modern quality control, especially through the development to its theory, principles

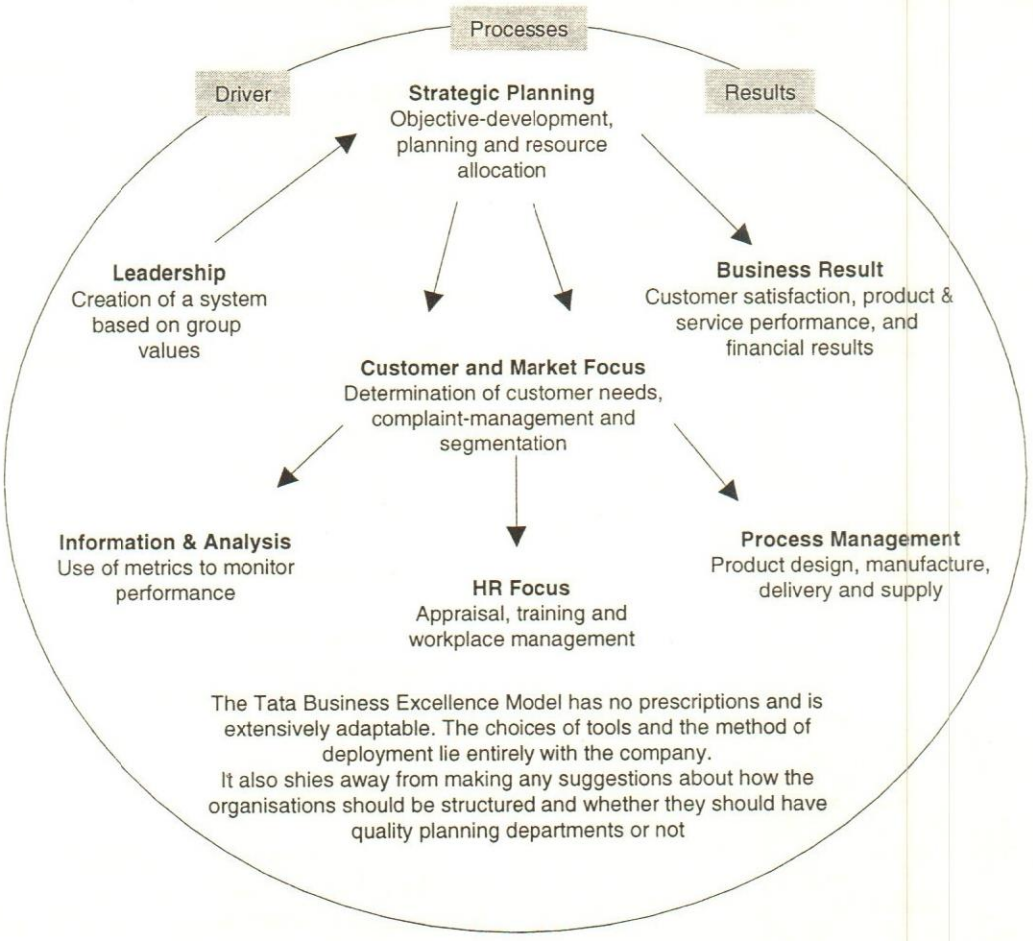


Fig. 4. Tata Business Excellence Model

and techniques..." (ASQ bylaws)

Deming Medal

The Deming Medal is presented to those who like Dr. Deming, have successfully combined the application of statistical thinking and management so that each supports and enhances the other, thus leading to quality in products and services.

Comparative Analysis of Award Models

Factors of Malcolm Baldrige National quality award, Deming Prize, European foundation for quality management is compared with Indian quality award models in the following table:

Critical Appraisal and Concluding Remarks

MBQNA stresses on factors like leadership where organisational leadership, organisational performance and citizen responsibility is taken into account. The other factors are strategic planning, customer and market focus, information and analysis, human resource focus, process management and business results.

Strategic planning factor examines any organisation's strategy development process including how an organisation develops strategic objectives; action plans and related human resource plans. Customer and market focus factor examines how an organisation determines requirements, expectations and preferences of customers and markets, how relationships with customers are built and how the satisfaction is determined.

Information and analysis category examines the organisation's performance measurement system and how the organisation analyses performance data and information.

Human resource focus factor examines the organisation to develop and utilise their full potential, aligned with the organisation's objectives. This factor examines how to build and maintain a work environment and an employee support climate conducive to performance excellence, full participation and personal and organisation-

Factor	MBNQA	Deming	EFQM-MAIT	CII-EXIM
Leadership	Integration of quality value in the personal leadership for creating and sustaining customer focus and the way a company responds to public responsibilities and corporate citizenship. (90 points)	No reference	Senior managers are personally and visibly involved and are role models inside and outside the company.	Senior managers are personally and visibly involved and role models inside and outside the company. It is given 100 points and it is an enabler for the model.
Information and analysis	Scope, validity, analysis management and use of data and information to drive quality excellence and to improve operational and competitive performance. (80 points)	No reference	No reference	No reference
Strategic Quality Planning	Planning process is tightly integrated with overall business planning. Short term and long term goals through competitive benchmarking of world class practices.	Planning for future and QP is a factor in Deming Price. However, no reference on integration.	Policy and strategy shows the intention but does not have any mapping to strategic quality planning of MBNQA.	Policy and strategy shows the intention but does not have any mapping to strategic quality planning of MBQNA.
HRM and Development	The focus is on HRM, Employee involvement, employee education and training, employee performance and recognition, employee well being/satisfaction.	No explicit focus on HRM but does talk of people involvement in quality.	People factor is given 9% weightage and role of people and their results contributes 18% in the model.	People factor is given 9% weightage and role of people and their results contributes 18% in the model.
Managing process quality	Systematic process that the company uses to pursue high quality and company operational performance. The key elements of process management are design, delivery, support and assessment for quality. Knowledge is documented, preserved, updated and IT-Enabled environment aids this factor tremendously. (140 points)	Talk about QA and Control	Reference is there on process and it accounts for 14%.	Reference is there on process and it accounts for 14%.
Quality and operational results	This factor talks of product and service quality results, company operational results, business process and support service results and supplier quality results.	Related to only product quality.	No reference on quality results.	No reference on quality results.
Customer focus and satisfaction	This factor talks about customer expectations, customer relationship management commitment to customers, customer satisfaction determination, customer satisfaction results, customer satisfaction comparison.	No reference for customer.	Customer satisfaction has been given the maximum weightage of 200 points (20%).	Customer satisfaction has been given the maximum weightage of 200 points (20%).
Quality Policy	No direct reference on policy	An articulated policy on quality control	Policy and strategy is give 8% weightage	Policy and strategy is give 8% weightage
Partnerships and resources	No reference	No reference	This factor accounts for 9% weightage	This factor accounts for 9% weightage
Impact on society	No reference	No reference	This model accounts for 6% weightage and focuses on societal benefits accrued due to Quality initiatives in terms of Quality of work life.	This model accounts for 6% weightage and focuses on societal benefits accrued due to Quality initiatives in terms of Quality of work life.
Key performance results/ business	No reference of key performance indicator	No reference	This model provides 15% weightage to this factor and this is the most important factor where the results of product and service performance, customer satisfaction and financial results are presented.	This model provides 15% weightage to this factor and this is the most important factor where the results of product and service performance, customer satisfaction and financial results are presented.

al growth. Process management examines the key aspects of your organisation's process management including customer focused design, product and service delivery, support and supplier and partnering processes involving all work units. Business results factor examines the organisation's key business areas like customer satisfaction, product and service performance, financial and marketplace performance, human resource results, supplier and partner results and operational performance. This factor also examines performance levels relative to competitors. Other international award models under this category is EFQM Excellence Model which is a non prescriptive framework that is based on nine criteria, five of these are Enablers and four are Results. The enabler criteria covers what an organisation does and Results covers what an organisation achieves. Another award model in the international category is the Deming Prize. The annual Deming Prize (s) was established in 1950 and is wholly administered by the Union of Japanese Scientists and Engineers (JUSE). The prize checklist has factors such as Policy, Organisation and its management, education and dissemination, information on quality, analysis, standardisation, control, quality assurance, results, planning for future.

All the Indian award models are derivatives of Malcolm Baldrige National Quality Award or European Foundation Quality though Indian award models need to understand the Indian economy targets and benchmarks before coming out with the parameters. Each organisation is felt to operate in their own environmental constraints and business goals and thus merely imitating the parameters of international model would not provide any tangible benefits to the company or organisation, apart from just getting an award for recognition. The award models need categorisation for IT hardware and software companies.

All the Indian award models are derivatives of Malcolm Baldrige National Quality Award.

Internationally acclaimed Deming Prize is silent on resource management, leadership and strategic management. Award models need deeper focus on all functional components of an organisation and quality of product or service is dependent on the orchestration/symphony exhibited by all these components. The research would attempt to create new Award criteria for all types of organisations. □

Programming today is a race between software engneers striving to build bigger and better idiot-proof programs, and the Universe trying to produce bigger and better idiots. So far, the Universe is winning.

– Rich Cook

Feature

Capturing the Customer's Voice – A Case Study in Banking

S.K. Bhattacharyya & Zillur Rahman

For sustainable competitive advantage a firm must be able to create and retain customers. One of the necessary conditions for this is that a firm's product must be able to meet customers' needs and wants. For product planning and development, a firm therefore needs to know what customers want from a product. Professor Kano suggests a model, that helps us identify which functions or features of a product cater to the basic needs, performance needs or excitement needs of a customer. This paper discusses how Kano's model can be applied to identify how customers perceive services of a bank. The importance of Kano Model lies in that it involves little mathematical computation and relevant information can be obtained quickly.

S.K. Bhattacharyya is Professor in the Department of Management Studies at Indian Institute of Technology, Roorkee and Dr. Zillur Rahman is Assistant Professor in the Department of Management Studies at Indian Institute of Technology, Roorkee.

Several years ago, Peter Drucker suggested that the purpose of a firm was to create customers. As the author put it, business is a process, which converts input, a distinct resource, into output of economic value in the market place. The purpose of business is to create a customer (Kelley, 1976). In today's competitive market, the purpose of a firm should be read as 'creating a loyal customer', which involves both capturing and retaining him. Importance of creating a loyal customer arises from that it costs more to create a new customer than to retain an existing one. For example, the cost of creating a new customer is five times more than that of retaining an existing customer (Reichheld, 1996). Research suggests that a loyal customer buys instead of being sold. He buys more than a new customer does as a firm introduces new products and upgrades existing products. It also costs less to serve loyal customers than new customers because the company knows a lot about them and how to get in touch with them. In other words, marketing transactions are routinized and therefore less expensive because a non-routinized transaction is subject to bargaining with it's resulting loss of efficiency (Davido & Bro, 1989). Besides, a loyal customer is less price sensitive and prefers the company's products (Kotler, 1999). A product is more than a tangible thing; it is a promise – a complex network of value satisfactions (Levitt,).

Category of Needs

Dr. Noriaki Kano, a Japanese professor, proposes a model, which helps us ascertain the extent to which a given set of functions and features of a product satisfies customers' wants and needs (Kano et al, 1984). By doing so, the model helps us evaluate the efficacy of an existing product to satisfy customer wants or develop a product concept that will ensure customer satisfaction.

According to Kano, people expect that a product should meet three kinds of need – basic needs, performance needs and excitement needs. The basic needs are so fundamental in nature that unless a product satisfies them, it cannot simply be sold. For example, customers take it for granted that a new car will start quickly, a toaster will toast bread evenly or a printer will print all the characters of software. In other words, features and functions that cater to the basic needs of customers form the table stakes of business (Levitt, 1981). However the best performance of a company in these features will only result in customers who are not unhappy. In addition to those that satisfy basic needs, customers also expect other functions and features in a product. They satisfy the performance needs of customers and they normally express their opinion on these needs during a survey. They form a positive co-relationship with the customers' happiness in that higher the performance of a product on these functions and features, the happier the customers are. Consider, for example, the mileage of a car. Higher the mileage per litre of petrol, better is the satisfaction level. Lastly, there are certain other functions and features, which customers normally do not expect in a product. Consequently, when they find them in a product they become delightfully excited. Further increase in performance in these functions or features also cause more delight in customers. These functions and features constitute the primary source of differentiation of a company's product from its competitors'. A schematic representation of Kano's model is provided in Figure 1.

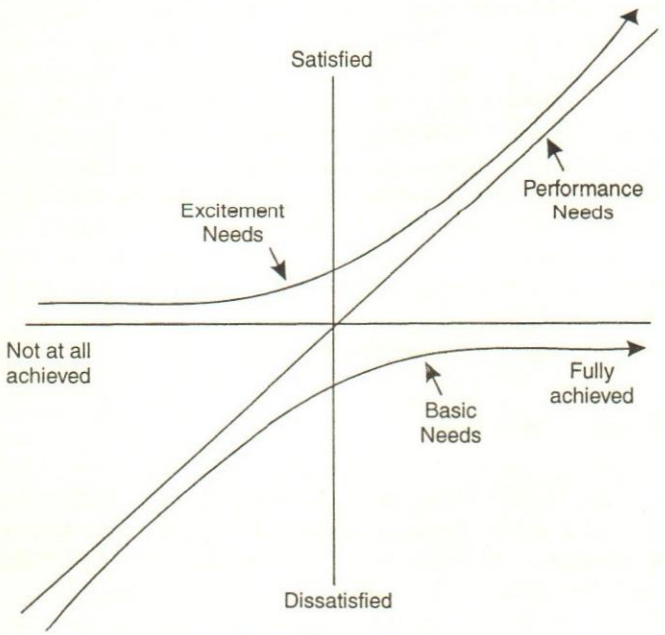


Fig. 1. Kano's Model

Kano suggests that in product planning, a firm should first identify functions and features that customers want in a product. It should then develop the product incorporating those functions and features so that the product caters to customer values at the maximum. In order to elicit customer's opinion about a particular function or feature, a set of paired questions can be used. These questions are so constructed that while the first one captures the respondent's feeling when a product has a given function or feature, the second one seeks to identify the respondent's feeling if the product does not have it. The respondent is asked to record his feeling on a category scale in which 1 stands for 'I really like it'. 2 for 'I like it', 3 for 'I am indifferent', 4 for 'I do not like it', and 5 for 'I do not really like it', respectively. The combinations of answers given by a respondent to a paired set of questions indicate whether a particular function or feature meets his basic need, performance need or excitement need. The matrix (Fig. 1) suggested below can be used to sort customer's needs in different categories (Terninko, 1997).

A product should meet three kinds of need – basic needs, performance needs and excitement needs.

Presence of a function / Absence of the function		I really like it	I like it	I feel indifferent	I do not like it	I really do not like it
		A	B	C	D	E
1.	I really like it		E	E	P	
2.	I like it			NI	NI	B
3.	I feel indifferent			NI	NI	B
4.	I do not like it			NE		No E
5.	I really do not like it					

Notations:

E = Excitement Needs

P = Performance Needs

B = Basic Needs

NI = Not Interested (Functions and features which neither increase nor decrease customer value)

NE = Negative Evaluation (Functions and features which does not increase customers value but decrease it in their present form).

No E = No Effect (Functions and features which need to be improved).

ID = Indifferent

Fig. 2. Matrix for Categorisation of Needs

Table 1: Relationship between Bank Services and Category of Customer needs

	Tangibility	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Forms and other written material easy to understand	8	12	(56)	24	0	0
B.	Simplified Procedures	2	8	(56)	0	34	0
C.	Bank has a Good Ambience	16	28	10	0	(46)	0
D.	Guard is pleasant and courteous	24	8	8	12	(48)	0
E.	Soft music in the bank	16	14	6	20	(34)	0
F.	Bank offers convenient waiting place for its customers	(36)	0	28	16	20	0
G.	The branch is fully computerised	0	(52)	24	16	8	0
H.	The bank has well dressed staff	12	12	4	32	(40)	0
I.	The bank has special dedicated staff to sort customers' problems	30	(36)	24	0	10	0
J.	The bank provides for direct access to the relevant service providers	(38)	36	10	0	16	0

	Reliability	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Passbook entries are up to date and free of error	8	22	(70)	0	0	0
B.	Bank provides prompt service	12	(46)	42	0	0	0
C.	Bank provides right services first time and every time	24	20	(46)	0	10	0
D.	Bank employees provides accurate information	16	(44)	36	0	4	0
E.	Delivery of error free reports	0	(44)	40	16	0	0

	Competence	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Bank staff is competent and knowledgeable about their work	14	(26)	24		0	0
B	Low charges for banking services i.e. issue of draft and overdraft charges	0	(50)	0	30	20	0
C.	Bank with large number of accounts	0	16	8	(56)	20	0
D.	Bank provides equal treatment to large as well as small account holders	0	18	30	(40)	12	0
E.	ATM facility	0	(50)	26	10	14	0
F.	All employees know about all services of bank	(40)	20	30	0	10	0

	Courtesy	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Waiting account holders are offered light snacks and cold drinks	(50)	10	14	10	16	0
B.	The bank has a May I help You counter	(40)	20	30	0	10	0

(Table 1 contd.)

Table 1: Relationship between Bank Services and Category of Customer needs (Contd.)

	Understanding Customer	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Ability of employee to understand customer problem and guide appropriately	30	28	(42)	0	0	0
B.	Bank employees are flexible enough to provide services according to account holder's schedule	30	(32)	30	0	8	0
C.	Bank employees address the account holders by their first name	(38)	36	8	10	8	0
D.	Bank employees respond to specific problems of account holders	0	(50)	26	10	14	0

	Communication	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Account holders are informed about new services from time to time	(50)	26	24	0	0	0
B.	Bank advises on how to get best returns from account holders' deposits	(36)	24	20	12	8	0
C.	Employees avoid using technical terms while explaining something to the customer	0	(44)	38	8	10	0
D.	Bank employees must be able to communicate in local dialect	20	30	(38)	12	0	0

	Access	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Bank is located at a convenient place	0	24	(40)	10	26	0
B.	At any time account holder can approach top management for problem solving	18	(40)	24	10	8	0

	Responsiveness	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Prompt correction of account balance	20	(44)	36	0	0	0
B.	The bank is willing to provide emergency loans if need arises	(40)	20	4	6	0	0
C.	Bank employees are ever willing to help customers	14	(44)	30	12	0	0

	Credibility	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	The bank has a reputation to provide error free service	0	32	(40)	16	12	0
B.	Bank holds customer day on 15th of every month	(38)	20	24	16	12	0

	Security	Excitement Need	Performance Quality	Basic Need	No Effect	Not Interested	Negative Evaluation
A.	Bank keeps account holders' documents safely	4	44	(52)	0	0	0

Application of Kano's model

We have applied the Kano's model to understand what drives customers' satisfaction and dissatisfaction in a bank. We selected a branch of a nationalised bank, which operated from the campus of the Indian Institute of Technology Roorkee, situated at Roorkee, a town of moderate size in Uttaranchal State of India. The bank is a recipient of ISO9002 certificate, is fully computerised and offers many services including foreign exchange transactions. The number of account holders in the bank in 2002 is around 3000 of which 150 are current account holders. Although the number of current account holders are small, they account for a large part of the bank's business. The bank is therefore interested in increasing the traffic flow of current account holders and wanted to know those attributes of a bank service which added value to the customers.

We conducted an exploratory research, which included the study of the secondary literature, detailed discussion with the bank management and interview of a number of current account holders. It was decided that customers' perception about the bank should be studied along the five principal dimensions that comprise service quality – tangibility, reliability, responsiveness, assurance and empathy (Zeithmal, Berry and Parasuraman, 1988). The first two dimensions relate to the possibility of differentiation at the product level while the other dimensions refer to that at the social level.

The term 'tangibles' stands for the physical appearance of bank facilities, communication materials, equipment and bank personnel. As bank services are largely intangibles, the tangibles provide an impression of what customers may expect from a bank. After all, people use appearances to make judgements about realities (Levitt, 1981). Reliability refers to the ability to perform the promised service dependably and accurately. In our study, the bank's promise to perform the service task/process within an appropriate time frame. Issues like whether the service content was adequately performed or the service was delivered in an ordered or efficient manner etc. were considered under the dimension reliability. Responsiveness refers to the degree to which bank employees are willing to help customers and provide prompt service. It is concerned with such issues as the degree to which bank employees anticipate consumers' needs and wants, provide prompt service, or respond to situations where service recovery is required. This behavioural aspect is different from the inter-personal and relationship-based aspects of service interactions, such as a customer's perceptions of service personnel's attitude towards their service tasks. Assurance is defined as employees' competence, courtesy and ability to inspire trust and confidence. For eliciting customers' perceptions, this dimension has been divided into competence, courtesy, credibility and security. Competence depends on the service provider's possession of the required skills and knowledge to perform the service. The politeness, respect, consideration and friendliness of the service providers together constitute what is called courtesy. Credibility refers to the perceived trustworthiness, believability, and honesty of the service provider. Security refers to the fact that the service should be free from danger, risk, and doubt. Empathy relates to the caring and individualised attention that the bank provides to its customers. It includes access, communication and understanding. Access refers to the approachability and ease with which the customer can contact the bank management. Communication refers to keeping the customer informed in the language they can understand and listening to them. Understanding corresponds with the efforts made by the service provider to know customers and their needs. The various factors on which customers were interviewed are provided in Table 1. For the survey purpose, the list of current account holders was obtained and the interviewees (50 in number) were selected using the systematic sampling process. Prior appointment was taken from the interviewees on the pretext that the bank wanted to know their opinions about the bank's current services.

Analysis of the results

The questionnaire was analysed using the matrix suggested in Fig. 2 and the responses against a particular service component were tabulated to identify the category of needs it caters to (vide Table 1 and vide Table 2). The entries in Table 1 represent the perception of the respondents in percentages, and the circled number refer to the category of needs a service component falls under.

Table 2: Categorisation of Service components in Categories of Needs

	Basic Needs
1	Forms and other written material easy to understand.
2	Simplified procedures.
3	Passbook entries are up to date and free of error.
4	Bank provides right service first and every time.
5	Ability of employees to understand customer problems and guide appropriately.
6	Bank employees must be able to communicate in local dialect.
7	Bank is located at a convenient place.
8	The bank has a reputation to provide error free service.
9	Bank keeps account holders' documents safely.

	Performance Needs
1	The bank is fully computerised.
2	The bank has special dedicated staff to sort customers' problems.
3	Bank provides prompt service.
4	Bank employees provide accurate information.
5	Delivery of error free reports.
6	Bank staff is competent and knowledgeable about their work.
7	Low charges for banking services.
8	ATM facility.
9	Bank employees are flexible enough to provide services according to account holders' schedule.
10	Bank employees respond to specific problems of account holders.
11	Employees avoid using technical terms while explaining something to the customer.
12	At any time, the account holder can approach the top management for problem solving.
13	Prompt correction of account balance.
14	Bank employees are ever willing to help customers.

	Excitement Needs
1	Bank offers convenient waiting place for the customers.
2	The bank provides for direct access to the relevant service provider.
3	All employees know about all services of the bank.
4	Waiting account holders are offered light snacks and cold drink.
5	The bank has a May I Help You counter.
6	Bank employees address the account holders by their first name.
7	Account holders are informed about new services from time to time.
8	Bank advises about how to get best returns from account holder's deposits.
9	The bank is willing to give emergency loans if need arises.
10	Bank holds customers' day on 15th of every month.
	Dimensions of Services in which customers are not interested
1	Competent and knowledgeable staff.
2	Bank with large number of accounts.

	Dimensions of Services having no effect on customer's perception
1	Good ambience.
2	Welcome by guard.
3	Light music.
4	Well dressed staff.

Analysis of the data suggests that in order to be included in the consideration set of a current account holder, a bank should be reputed and strategically located. It should be perceived as a safe custodian of customers' money and documents, easy to work with and staffed with responsive employees. In respect of performance needs, interviewees felt that a bank should be computerised, have ATM facility and should provide error free information, It should have knowledgeable employees who can provide personalised attention and prompt redressal to customers' problems. The bank charges should also be low. Customers will be delighted if the bank sees to it that customers's waiting in the bank is pleasant. Employees are courteous and friendly and have requisite skills so that the customers need not move around to seek solution to their problems. Customers are also provided with loans in case of emergency, advised about how to get the best return on their deposits and are regularly informed about any new service introduced by the bank. And lastly the bank management organises an open forum session for listening to and solving customers' problems.

Conclusion

The voice of the customer is regarded as the cornerstone of the Quality Function Deployment process and Kano's model helps us capture this voice. QFD is a technique, which helps a firm design and develop a product that meets customers' wants and needs. It facilitates a customer focussed product and process design by making explicit the relationship between design characteristics and customer requirements. Kano's technique offers a quick and efficient way of identifying different categories of customer needs. It, however, uses a nominal scale to elicit customers' opinions and the scale does not permit statistical tests to be conducted for identifying whether a particular function truly falls under a particular category of need when respondents' opinions are distributed across the different categories of needs. Kano's model does not also provide customers' perception about the relative importance of different features of a product. For this, one may however use a weighted average score model. The respondents may be asked to divide 100 points among the categories of needs based on their relative importance. Further, within a particular category, they may be asked to divide 100 points reflecting the relative importance of the factors that comprise the category. Finally, the weighted average score for each of the factors can be calculated using the following formula:

Kano's technique offers a quick and efficient way of identifying different categories of customer needs.

Where: A_j = customers' overall perception of the relative importance of the service component j.

W_k = the relative importance of a category of need

B_{jk} = the relative importance of the j th service component under the category of need k.

References

Comstock, T.N. and Dooley, K. (1998), "A Tale of Two QFDs", QMJ 5, No. 4, 32-45.

Davido, W.H. and Bro, Uttal (1989), "Total Customer Service: the Ultimate Weapon", New York: Harper and Row, 30.

Kelley, Eugene J. (1976), "Marketing Planning and Competitive strategy", New Delhi: Prentice Hall of India Private Limited.

Kotler, Philip (1999), "Marketing Management – The Millennium Edition", New Delhi: Prentice – Hall of India Private Limited, 48.

Levitt, Theodore (1980), "Marketing Success through Differentiation – of Anything", Harvard Business Review, (Jan-Feb), 83-91.

Levitt, Theodore (1981), "Marketing intangible products and product intangibles", Harvard Business Review, (May-June), 95- 102.

Nariaki, Kano, Seraku Nobuhira, Fumio Takahashi and Shinichi Tsuji (1984), "Attractive Quality and Must be Quality", Quality 14, No. 2, 39-48.

Reichheld, Frederick F. (1996), "The Loyalty Effect". Harvard Business School Press.

Terninko, John (1997), "Step by step QFD, Customer-Driven Product Design", Boca Raton, Florida: St. Lucie Press, 68-69.

Zeithmal Valerie A., Berry L. Leonard, Parasuraman A. (1988), "Communication and Control process in the Delivery of Service Quality", Journal of marketing, (April), 35-48.

□

An economic forecaster is like a cross-eyed javelin thrower: they don't win many accuracy contests, but they keep the crowd's attention.

– Anonymous

Feature

Impressing Your Way to Success

Biswajeet Pattanayak & Phalgu Niranjana

This article discusses different aspects of Impression Management which deals with managing the perception and acceptance of significance in one's life. The changing perspectives of the theory, its motives and the factors that influence it are discussed in detail. The functioning of Impression Management in organisations is dealt with in the last section.

Biswajeet Pattanayak is Professor with the Indian Institute of Management, Indore and Phalgu Niranjana is Research Associate with the Indian Institute of Management, Indore.

In the dynamic business scenario, the individual persona is very important is terms of perception of the significant others both in the organisation and society. It is a normal phenomenon that people perceive themselves as more dynamic, organised and effective in comparison to their counterparts. Though self- perception is necessary in developing self-confidence to achieve goals in life, it is also equally important to know how others perceive us. Individual's success and effectiveness is dependent largely on the perception and acceptance of the significant others in their life. When we perceive others, we try to organise the perceptual information based on which we form an impression. David Elkind (1967), a developmental psychologist, who studied the characteristics of egocentrism in adolescence says young people can rather be observed in their self images and mistakenly assume others join them in that absorption. He found that one feature of this egocentrism is a preoccupation with the imaginary audience. During this state in life, how much others are watching and evaluating show they feel unduly self conscious about the impression they are making.

Our cognitive miserliness emerges in the tendency to use categories and stereotypes to impressions about people, regardless of the person's own behaviour. The impression a person makes is also the result of his observer's perceived biases. Generally the speediest route is chosen by the individual to form an impression, even if it leads to some misperception and mistakes. Age and gender are two categories, which are often used people as the short-cut route in forming impressions. Marilyn Brewer (1988) showed how powerful these two categories are when people are forming first impressions about personality. She collected 140 facial photographs of Caucasian men and women of all ages and asked her subjects to sort the photos into different stacks that contained pictures of the people they thought were similar in character. The piles always contained people of the same gender and approximate age. Nevertheless when the people were asked to provide verbal levels of their stacks, they rarely used age or gender as part of the description.

Generally the first impressions are notoriously susceptible to misconception. Soon after World War II, Solomon Asch (1946) did a provocative study on first impressions and found that people tend to leap to conclusions with few cues of guide them. He first described a man as intelligent, skillful, industrious, warm, determined, practical and cautious. The people who heard these brief descriptions had not trouble penning in the rest of the personality. They assumed he was also honest, good natured, wise, popular, sociable and imaginative and a good fellow all around. Asch wondered how small changes in the list of traits might affect the impressions the man was making. He read the list again to other groups substituting cold, polite or blunt, far the single word warm. Neither polite nor blunt changed the impression very much. But when the man turned cold, he was transformed to a very unlikable fellow. Warm and cold say a great deal about our dispositions and influence how others will react to us in social settings. They are heavily weighted central traits when people are forming a first impression.

First impressions are notoriously susceptible to misconception.

Impression management is basically dressing for success. It is the process that the individuals seek to influence the perception of others about their own image. Basically it is used in three interrelated ways to maximise reward-cost ratio by gaining social and material outcomes to enhance self-esteem and to facilitate the development of desired public identity. In today's business scenario, most of the organisations have systematic deliberated image building activity to boost the corporate image in front of shareholders are stakeholders. Similarly the individual needs to develop an image which should be more constructive and impressive for the significant others in the organisation and also outside. It has been evident from the series of research findings that the impression of others can be managed at the individual level in a systematic and scientific and scientific manner.

Erving Goffman, the Father of Impression Management theory, believed that everyone uses tactics to present themselves in whatever light they think appropriate for the context. Her considered that the motives of the individuals are key – if the wants to be liked by his audience, he can choose different tactics for self-presentations that will help in accomplishing his goals. He will also want to be very careful about being perceived as a manipulative social chameleon that fakes an impression for social gain. Generally individuals spend a lot of time in managing and refining impression they want to make, but they certainly do not want others to know how hard they work at this. He calls it an information gain – a potentially infinite cycle of concealment, discovery, false revelation and re-discovery.

Erving Goffman, the Father of Impression Management theory, believed that everyone uses tactics to present themselves in whatever light they think appropriate.

Impression management is a valuable tool, which if used well, can enhance the visibility of their true strength and committed performance. This concept reflects the idea that people attempt to regulate and control, sometimes consciously and sometimes unknowingly, the information they present to audiences, particularly those about themselves. It is assumed that people do not deal with the information randomly or dispassionately. Instead, their agenda is to systematically influence their preference for interpretation and package of information for consumption by audiences. By agenda basically it is meant what people want to accomplish and how they plan to go about doing so. The impressions can be regulated through imagining oneself through the role of others, anticipating others' likely reactions to various actions and selecting the conduct accordingly, ultimately shaping or reshaping how one views oneself and how one is viewed by others (Scheibe, 1985). These insights were expanded in Goffman's dramatological analysis of social behaviour, which viewed people as actors on the life stage and their interpersonal conduct as performance by the participants. Further, he has suggested that whenever an individual appears in the presence of others, there will always be some reason for him to mobilise his activity so that it will convey an impression to others, as per his wish. This work has been criticised for de-emphasising the psychology of the individual and focussing on what often seemed to be an illicit behaviour to manipulate others (Scheibe, 1985; Schlenker, 1980), but his insights provided the springboard for contemporary research. Although Goffman recognised that self presentations are instrumental in gaining approval and achieving valuable outcomes in life, he regarded self presentations as a condition of interaction, one that is inherent in the fundamental structure of social life. It is imperative that people define that situation depending on which will be selected the relevant cognitive scripts and the roles each person will play. Self-presentation solves the necessary function of communicating definitions of each person's identity and plans. Once identities are

established, each participant has a moral obligation to behave congruently with the identity he or she has selected and also to accept and respect the identities selected by others. Failing which it may lead to identity crisis and conflict in the original personae. Impression management activities, thereby, permit the participants to define who each person will be and permit interactions to run smoothly and efficiently.

Each participant has a moral obligation to behave congruently with the identity he or she has selected.

Impression management was once associated with the attempt to maximise social approval and material outcome. But the motives that have been highlighted as emerging and guiding it, are as varied as those postulated to underline virtually any behaviour. Basically these motives are of three types: (i) Self-glorification (self-esteem maintenance and enhancement), (ii) Self-consistency (validating the self by confirming self-beliefs) and iii. Self- authentication (trying to learn the truth about self by perceiving diagnostic information).

Self glorification—These illusions, at least in moderation, not only feel good and look good to others but are also associated with physical adjustments, mental health and superior functioning (Brown, 1991). Self esteem needs have been cited at the basis for self glorifying descriptions of self, self serving attributional biases, self flattering social comparisons, preference for positive interpersonal evaluations, and self justificatory activities. Attributions that glorify the self usually generate positive effect, provided they do not compel or force the individual to perform at an unrealistic level. But attributions diminishing the self usually generate negative effect. Higgins (1989) proposed that people are motivated to reach a condition in which their self concept matches their personally relevant self which consists of their ideal-self (attributes that they would like to possess) and their ought self (attributes that they think they should possess), Discrepancies between the actual self and the ideal self generate dejection related emotions (sadness and disappointments) whereas that between the actual self and the ought self generate hesitation related emotions (fear, anxiety and threat).

Attributions that glorify the self usually generate positive effect.

Self-consistency—People may prefer information consistent with their self-belief for reasons other than their consistency motive. One such reason is that people with low self evaluations on particular dimensions employ a self protecting rather than self assertive interaction style (Arkin & Sheppard, 1990). These tendencies would produce consistency type effects.

Self-authentication—It is basically the quest for accuracy. Trope (1986) has proposed that people are motivated to acquire diagnostic information that permits accurate self-knowledge. His reviewed evidence indicated that the preference for diagnostic information is strongest but erroneous self-beliefs is likely to lead to important adverse consequences.

The preceding factors provide three different answers to the question of what constitutes a desirable identity: it may be primarily self-glorifying or consistent with self-beliefs or accurate. The likelihood that a particular self-identification will occur is increased by factors that

(a) Increase the expected positive consequences if the identification is believed.

(b) Reduce the expected negative consequences if the identification is disbelieved or

(c) Increase the likelihood that the salient audience will believe the self identification.

There is no single best image to cultivate in optimising power or achieving goals. Many different types of self-prevention can be effective depending on the person's resources and his immediate environment. Research has shown that people will even present themselves negatively if they believe a well adjusted person will be assigned to perform an embarrassing task, if they believe a self glorifying claim will threaten the audiences or if they prefer to avoid excessive public expectations for onerous responsibilities. People do not merely want to present themselves goals and these goals may involve modest or even unflattering self-presentations.

Kilduff and Day (1994) suggest that skillful impression can enhance an individual's chances of career success. An exploratory study on British and Swedish managers reveals that they manage their promotions through impression management techniques. Further it has been evident that males prefer using more work-related strategy while females build closure upward relationship.

In an organisational context, impression management has an important role to play in influencing and managing subordinates, peers and superiors. An im-

Males prefer using more work-related strategy while females build closure upward relationship.

pression can be found and managed through a systematic approach to ensure career and business. Impression management can be constructed through six important factors.

(i) Self-concept – The first factor that helps in constructing impression is self-concept. The person should be able to understand himself – what he wants to do and what he is really doing. And if there is any discrepancy, it is his task to minimise or erase it. But if he does not know or is not clear of himself, he will not be able to impress others in a positive way.

(ii) Desired identity image – After drawing self-clarity, the person should choose and develop an identity image, which is desired by his immediate environment. Then he should try to develop that image accordingly. This accurate image will help in building the perfect impression.

(iii) Role constraints – Individual plays multiple roles in a work setting. While playing the roles, he faces some constraints. Understanding these constraints can help the individual to choose a proper role that he would be able to discharge efficiently to manage the impressions of others.

(iv) Target values – Individual should identify and target certain values, which he wants to project in himself to form the impression.

(v) Enhanced reputation – Reputation forms social impression. It is essential to enhance the self-reputation to manage the impression of others.

(vi) Current or potential social image – The current image of the individual is normally highly social images. Individual should understand and consider the current image before trying to build up the impression management process.

Impression management consist of two phases. It starts with self-motivation and develops through deliberate construction of the impression. It eventually makes the person realise what he wants to do in his life.

(i) Impression Motivation – The degree of this motivation depends on such factors as the relevance of the impressions on the individual's goals, the value of these goals and the discrepancy between the image one would like others to hold and the image one believes others already hold. If the person does not motivate himself, he cannot manage the people's impression.

(ii) Impression Construction – The construction phase is basically concerned with the specific types of impression people want to make and the process involved in it. Before the attempt to build up the impression, the prerequisite is to draw clarification on what type of impression the individual wants to create on the audience.

Impression management starts with self-motivation and develops through deliberate construction of the impression.

In work organisations, people use different tactics to draw attention and to manage the impression of significant others. In general, individuals use five different tactics to form impression.

(i) Reasons – Justify the action in sighting valid reasons.

(ii) Friendliness – Projecting friendly attitude to impress.

(iii) Assertiveness – Putting forward views with high self- confidence.

(iv) Bargaining – Drawing attention using bargaining style.

(v) Higher authority and coalition – Use of authority and coalition as techniques to prove supremacy over others.

Research findings show that people in the organisations across levels use three strategies to manage impressions.

(i) Demotion-preventive strategy – If the individual can not be promoted, he tries himself to be prevented from demotion. Thus he uses some strategies to impress his colleagues in the organisation which are as follows:

- Accounts – Here the person attempts to give explanations and justify his actions in a way so that he can pass on his fault on any other's name. Then he is not held responsible for the act and one innocent person is forced to suffer.

- Apologies – In this case, the person admits his fault for what he has done, may be unknowingly, and apologises to the Boss promising that he will not commit the same mistake again.
- Disassociation – In this case the person secretly communicates to the Boss when anything goes wrong. If he has made the mistake, he may try to shift the responsibility to some other person. And if he is not the mischief-maker, he informs the Boss of every even and odd thing happening in the organisation. Generally he is perceived as the informer of the chief.

(ii) Promotion-enhancing strategy – The individuals in the organisation try to get promotion by impressing their superiors. Though most of the organisations have systematic procedures to be followed for promoting a person, by and large it is influenced by the impression of the evaluating superiors. The following are some of the common techniques used by the employees in the organisations.

- Entitlement – Employees feel that they have not been given credit for a positive outcome.
- Enhancement – Employees may have received credit, but they point out that they really did more.
- Obstacle Disclosure – There are some individuals who do not take initiative. And when asked to do the work, they tend to highlight the obstacles more. In this way, not only they get the credit but also become successful in impressing the Boss.
- Association – Sometimes it is thought that to be seen with the right person at the right time creates a good impression of that person so others. So people always want to be associated with an influential or powerful person so that they can encash that opportunity later.
- Conceptual Strategies – By delivering a task in time, the individual tries to project himself as sincere and committed to his work.
- Conformity to the social norm – Though each organisation has a culture of its own, it is very much dependent on its society. People always prefer to go by the social norm. For example, if a group of ladies are talking, it is always perceived that they are gossiping whereas when a group of men talk, they are perceived as having a very serious discussion.
- Organisational Citizenship Behaviour – This concept refers to all positive organisationally relevant behaviours of individual members of any organisation. This includes traditional in-role job performance behaviours, organisationally functional extra- role behaviours and political behaviours, such as full and responsible organisational participation.

(iii) Self focussed strategy – In addition to the above stated techniques the following self-focussed strategies are also effective in managing impression.

- Self-confidence – Each and every person needs to have self-confidence to rise in his life and to fulfill the goals he has set for himself. This makes the person more competent and committed to his job and in turn helps in managing his impression on others.
- Emotional Quotient – It is considered that to achieve, one needs to handle his emotions as well as that of his significant others. Intelligence alone without emotion can not help him in gaining his goals.
- Self-discipline – The individual should develop his heart, mind and outward appearance. If he will be self-disciplined, his acts will speak of his personality and automatically impress others.

Benefits of impression management

Impression management leads to enhancement of reputation that in turn may lead to increased effectiveness because of that reputation. It has been observed that IM user is seen to be significantly more productive than the non-user.

Skillful impression management can enhance an individual's chances of career success. An implication for practitioners is that those who are unaware of self-promotion or unwilling to take such action may result in another invisible career barrier. Findings indicate the importance to ambitious managers of visibility of commitment to senior position gatekeepers.

Findings indicate the importance to ambitious managers of visibility of commitment.

In contemporary organisations, it is required that the individual should act as a team player to cooperate in achieving the organisational targets but at the same time it is desired that he must differentiate himself from

others to show that he is unique and distinct. Hence, while the organisation highlights the necessity in visibility of team characteristics within the individual, it also rewards the employees, who manage better impression, through promotions.

However, it is very important that the individual should never try to be something, which he is not while selecting an image because others will be able to see his weakness through the facade. In sum, the person should try to project his best to others but never at the cost of his identity or integrity. He must edit the information about himself in his everyday life to provide the best descriptions possible to the outside world. He should at just like a text book writer who edits all the information to present it in a readable, concise fashion.

References

Arkin, R.M. & Sheppard, J.A. (1990), "Strategic self presentation: An overview". In Cody, M.J. and McLaugjhlin, M.L. (Eds.) The Psychology of Tactical Communication. Bristol, PA: Multilingual Matters Ltd.

Asch, S. (1946), "Forming impressions of personality", Journal of Abnormal and Social Psychology, 41, 258-290.

Brewer, M. (1988), "A dual process model of impression formation", In T.S. Scrull, and R.S. Wyrer Jr. (Eds.), Advances in Social Cognition, Volume I. A Dual Process Model of Impression Formation. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Brown, J.D. (1991), "Accuracy and bias in self knowledge in Snyder", C.R. and Forsyth, D.R. (Eds.) Handbook of Social and Clinical Psychology. New York: Pergamon.

Elkind, D. (1967), "Egocentrism in adolescence", Child Development, 38, 1025-1034.

Goffman, E. (1996), "The Presentation of Self in Everyday Life", Garden City, NY: Doubleday.

Higgins, E.T. (1989), "Self discrepancy theory: What patterns of self belief cause people to suffer?" Adv. Experimental Social Psychology, 22, 93-136.

Kilduff, M. & Day, D.V. (1994), "Do chameleons get ahead? The effects of self-monitoring on managerial careers". Academy of Management Journal, 37(4), 1947-1060.

Scheibe, K.E. (1985), "Historical perspectives on the presented self", In Schlenker, B.R. (Ed.) The Self and Social Life. New York: McGraw Hill.

Schlenker, B.R. (1980), "Impression Management", Monterey, CA: Brookes/Cole.

Trope, Y. (1986), "Self-enhancement, self-assessment and achievement behaviour", In Sorrentino, R.M. and Higgins, E.T. (Eds.) Handbook of Motivation and Cognition, 350-378. New York: Guilford.

□

An economist is a man who states the obvious in terms of the incomprehensible.

– Alfred A. Knop

Feature

Redundancy of Labour & Workers' Protection: An Analysis

Bhaskar Majumdar

Production of any commodity presupposes technology. Technology evolves as the necessity emerges. Commodity is the domain that gives expression to technology, while human labour and man- transformed resources are the means by which technology is expressed. Absence of technological progress for a firm means ultimate exit of the firm, while presence of technological progress leads to changing skill requirement, and hence, redundancy of a section of workers previously employed in the firm. Technology-led changing requirement for skill also offers the scope for additional labour employment. The final outcome depends on both exit and absorption of workers, intra-firm and inter-firm. The explanations and examinations of the questions linked with technological progress are more relevant for the industrially developed countries. The relevance of the paper lies in showing to the developing countries the necessity to protect the labourers prone to be technology-led redundant, as are their counterparts in the developed world.

Bhaskar Majumdar is with the G.B. Pant Social Science Institute Jhusi, Allahabad.

Production in a functional sense implies combination of inputs with respect to time to produce a commodity. While commodity has a physical shape or volume, technology may be non-physical, like knowledge for doing a socially useful thing. Technology evolves as the necessity emerges. There exists at any point of time an accumulation of already evolved technologies. Commodity is the domain that gives expression to technology, while human labour and man-transformed resources (like machinery and equipment) are the means by which technology is expressed. Technology by itself is not quantified. What may be quantified are some of its indicators, like a particular technique of production, productivity of a particular input, expansion in production unit by size of quantified inputs, gestation period etc. This does not imply non-existence of the technologies that are yet to be understood and recorded.

As in conventional analysis, we assume two identifiable resources, labour and capital. For simplicity of analysis, we assume that labour-time applied on nature generates machinery; combined application of labour and machinery smoothens the transformation of nature into output. In this process, a section of the productive people previously called labourers now will be owners of machinery or may be seen now as owners of non-labour resources in addition to being owners of labour power. Hence, social division of labour gradually accommodates two sections of producers, one as owners of labour-cum-non-labour resources and the other as owners of only labour power. In fact, the initial commodity, which may be a machine, shows a crystallised form of labour of both these sections of producers and nature. However, once this distinction is accepted, we can write the production function as

$$Q = f(L, K),\ f_L > 0,\ f_{LL} > 0 \qquad (1)$$

Q = Physical volume of output

L = Labour Time (hour) applied in producing Q

K = Machinery and equipment.

The geometric representation of (1) gives the total product curve. One such curve shows one state of technology, and shifting curves represent changing technologies. The commodity-technology association for the economy, thus, can be written as:

$$(Q, T) = (Q_i, T_j) \qquad (2)$$

where Q is a vector of produceable commodities, and T is a vector of technologies in production of Q.

$$Q = (Q_i),\ i = 1, 2, ..., n.$$
$$T = (T_j),\ j = 1, 2, ..., m. \qquad (3)$$

where $m \leq n$, on the assumption of non-identical technology for any two commodities.

While alternative combinations of L and K show movement of a firm along a single total product (TP) curve, T is an operator that explains the shift of the TP curve. If a single product is considered, then technological improvement denotes improved ways of producing this product, i.e., the scale of production becomes higher which potentially offers more efficiency (Hicks, 1971, p. 109).

Technological Progress and Labour Employment

We assume that (i) there are two firms, A_1 and A_2, who produce two commodities, Q_1 and Q_2. (ii) Each firm uses single non-identical technology, T_1 by A_1 and T_2 by A_2. The technologies (production function) follow a conventional neoclassical path. (iii) A_1 learns to improvise, so that for him technology shifts upward, expressed by an upward shift in total product curve. (iv) A_2 does not learn in parallel, so that for him technology curve remains unchanged.

We intend to examine the implications of this 'technological progress' on labour employment, and exit of the labourers, for A_1 and A_2, and for $(A_1 + A_2)$, that is, total economy.

Suppose, the initial state of technology, T_1, is known to the firm A_1 'by doing', so that the total product (TP) curve, $Q_1 (T_1)$ is known to A_1. Each point on $Q_1 (T_1)$ shows maximum possible output (Fig. 1) of the product Q_1, when A_1 uses least labour time (hour) OL_0, given full utilisation of the capital stock that he possesses and given the technique of production (K/L) at tan alpha. For A_1, the level of output, thus, is determined at $0Q_1^0$. The relevant point on $Q_1 (T_1)$ curve for A_1 is F, productivity of labour (AP_L) is tan F and productivity of capital (AP_K) is tan β_1.

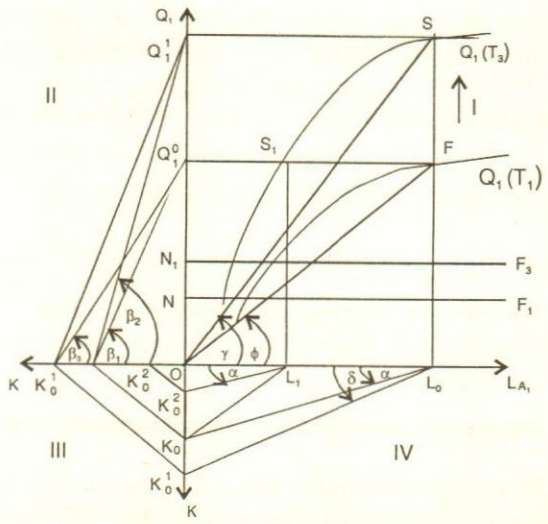


Fig. 1. (Firm A_1)

Suppose, corresponding to a chosen technique of production, tanα, the previously employed labourers working for OL_0 labour-time invent improved methods of producing the same product, so that the TP curve shifts upward to $Q_1 (T_3)$, T_3 being an improved technology. This means, with same L and same K/L, Q rises from OQ_1^0 to OQ_1^1, AP_L rises from tanΦ tanγ and AP_K rises from tan β_1 to tan β_2.

Let ON be the portion of Q_1, required by A_1 for internal use (used for both consumption and intermediate purposes). The line NF_1 may be interpreted as real wages to support labourers inside the firm. For initial labour employment at OL_0, and output at OQ_1^0, the surplus (over what is paid to labour) is NQ_1^0 that goes as return to capital used as OK_0.

Because of labour-led (knowledge, skill, training etc.) higher output for A_1 at OQ_1^1, surplus becomes NQ_1^1 i.e, rises by $Q_1^0 Q_1^1$. Because of increased labour productivity at tan γ (associated with increased capital productivity at tan β_2, curiously for same capital used), both the owners of labour-power and capital claim a higher share of $Q_1^0 Q_1^1$. The real wage line for labour in A_1 thus shifts upward to $N_1 F_3$, $NN_1 < Q_1^0 Q_1^1$, the gap $(Q_1^0 Q_1^1 - NN_1)$ goes as reward on capital used. One positive way for this gap to be utilised is outward (south-west) parallel shift of the K-stock (cum-use) line in quad-

rant-III to $K_0 K_0$. This raises K/L to tan delta if OK_0^1 is actually used and it leads to reduced capital productivity to tan β_3. Reduced capital productivity may have implications like reduced rate of reward on capital (less than what corresponded to tan β_1). If labour rate of reward remains unchanged at ON (correspond to higher labour productivity at tanγ), then the initial gap ($Q_1^0 Q_1^1 - NN_1$) goes to capital owner, higher capital used multiplied by lower reward on capital per capita.

Reduced capital productivity may have implications like reduced rate of reward on capital.

Let us consider now firm A_2, who produces Q_2. Given the state of technology T_2, the TP curve is $Q_2 (T_2)$. For full utilisation of the capital stock (OK_2) that A_2 possesses, labour employment by time (hour) is OL_2, given the technique of production at tanΦ_1. The quantity produced by A_2 is OQ_2^0, that the maximum A_2 can produce with determined labour employment and technique of production under the assumption of full utilisation of capital stock (Fig. 2).

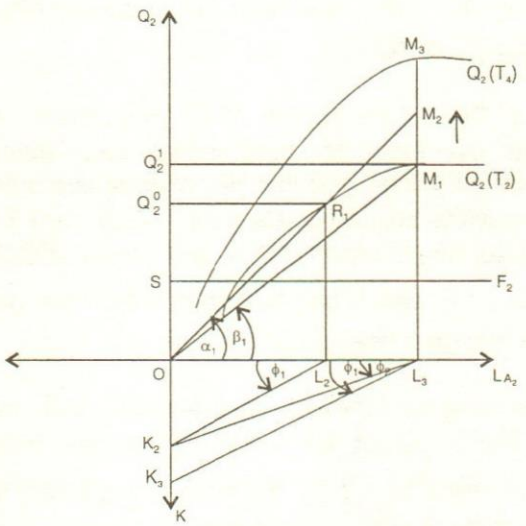


Fig. 2. (Firm A_2)

If OS is the real wage for labourers in A_2, then roman SQ_2^0 is the surplus for owners of non-labour (capital) resources. If A_1 and A_2 constitute the domain of production-cum-exchange and if all output is exchanged, then $NQ_1^0 \cong SQ_2^0$ shows the initial equivalence in exchange.

Now, following technological progress in A_1 and no technological progress in A_2, new exchange relation becomes $N_1Q_1^1 \cong SQ_2$, where $N_1Q_1^1 > NQ_1^0 \cong SQ_2^0$ so that the terms of trade for A_1 becomes adverse. Being the technology leader, A_1 can suppress this situation by restricting itself to point S_1 on $Q_1 (T_3)$, whereby A_1 produces the initial output with less labour, OL_1. At S_1, the technique4 of production becomes more capital-intensive at tan m or less labour-intensive (Fig. 1). If OL_0 labour employment is required for full utilisation of capital at OK_0, then restricting labour employment to OL_1 means lesser-required capital and utilisation, so that tan alpha is restored by capital employment at $K_0^2 \cdot K_0 K_0^2$ capital thus remains un (under) utilised and labour exit from A_1 is $L_0 L_1$. With previous output, OQ_1^0, restored at S_1 on $Q_1 (T_3)$ [west of F on $Q_1 (T_1)$], technological improvement for A_1 shows resource saving.

What are the implications for A_2 and for the economy ($A_1 + A_2$)?

Suppose there is inter-firm labour mobility. Then $L_0 L_1$ labour (time contributed by labourers) Shifts from A_1 to A_2. Suppose A_2 agrees to absorb it, labourers in A_1 being more productive. Thus, labour employment in A_2 becomes OL_3 (OL_2 by $L_2 L_3 = L_0 L_1$), so that even with reduced labour productivity (tan α_1 tan β_1), total output increases to OQ_2^1 and surplus rises to SQ_2^1 (SQ_2^0). In the new situation, capital-labour ratio falls from tanΦ_1 to tanΦ_2. A capital stock of OK_2 needed OL_2 labour for full utilisation of OK_2, given technique of production at tanΦ_1. Thus, OL_3 labour can only be absorbed if higher capital stock is generated at OK_3. This requires depressing real wage rate below OS in A_2, which is possible, when labour productivity has declined in A_2. The paradox is that absorption of $L_2 L_3$ labourers with past higher productivity (in A_1) leads to reduced labour productivity (along with initial labour OL_2) in A_2.

If either because of initial reaction to adverse terms of trade, or for resource-saving, A_1 comes back to producing OQ_1^0 output, generating initial surplus NQ_1^0, A_1 will be gainer, because NQ_1^0 will now be exchanged for SQ_2^1 (SQ_2^0). A_2 with static technology that absorbs higher labour, thus, becomes a loser in exchange of commodities.

Either through wage depression (below OS) in A_2,

or, through import of capital from A_1 ($= K_2 K_3 = K_0 K_0^1$), A_2 can move up the 'technology ladder' by combining increasing L and K. This will imply an upward shift of the TP curve, Q_2 (T_2) for A_2.

Even being a technology follower, one strategy of A_2, while absorbing additional labour from A_1, is to raise 'total labour productivity', thus, shifting the TP curve to Q_2 (T_4). This works when OL_2 and $L_2 L_3$ ($= L_0 L_1$ in Fig. 1) contribute in combination towards raising productivity. The OR_1 line (ray), R_1 being the initial input-output combination on Q_2 (T_2), thus gets vertical push to M_3 above OR_1 M_2, when OR_1 M_2 shows $\tan\alpha_1$, that is, initial labour productivity. In other words, 'new labourer', rather than reducing 'combined labour productivity', raises labour productivity. Thus, for A_2 also there is a possibility of the TP curve getting an upward shift to Q_2 (T_4). To elaborate, the section of labourers that gets exit from A_1 contributed positively to 'combined enhancement of labour productivity' or 'technological improvement' in A_1. A section of labourers in A_1 who now move to A_2 get absorbed, may raise combined labour productivity in A_2. This may bring about similar situation in A_2 as experienced in A_1.

Redundancy of Labour and Scope for its Absorption

The labourers declared redundant in A_1 (measured via labour time, and not via identification of a section of labourers) by $L_0 L_1$ gets the scope to be employed in A_2 (may be with a time lag) if A_2 agrees. On the supposition that all the labourers in A_1 contributed to technology shift, A_2 agrees on the assumption of fulfillment of 'new employment-led technological progress'. in practice, the accommodation of labourers that move from A_1 to A_2 may be a difficult task in A_2 because of a number of reasons. These include (i) capital constraint in A_2, where additional employment in A_2 is constrained by rigid per capita capital initially employed, (ii) established productivity-cum-wage linked labour hierarchy in A_2, limiting the scope for rearrangement of the established hierarchy, (iii) In case of violation of (ii), a possibility of increasing intra-labour hierarchic differentiation in the domain of production in A_2, and hence non-cooperative production relation in A_2, (iv) the labourers initially employed in A_1 had particular skill (job-specific) which may not be reflected in A_2, (v) As a corollary of (iv), A_2 may not climb up the technology ladder via accommodating labourers from A_1, (vi) A section of the labourers employed in A_2 may be willing to shift to A_1, because of higher real wage in A_1, which is, however, constrained by the particular skill required for absorption in A_1.

There is technological possibility for A_2 to move up the technology ladder. There is also possibility for A_2 to get capital from A_1 (capital export by A_1 to A_2). There is also the organisational possibility for A_2 to depress the wage rate for labourers (initial plus new) in A_2, in case it moves along the initial total product (TP) curve, that is, raising output via employing more labour at reduced labour productivity. Suppose, then, A_2 declines to produce more via employing more labour (either on the initial TP curve or on a new shifted TP curve), for fear of facing adverse terms of trade vis-a-vis A_1. What happens to the economy, ($A_1 + A_2$), in this situation? A_2 continues to produce OQ_2^0 and expects that the initial equivalence in exchange, or real terms of trade, will be restored. This terms of trade will be restored if A_1 chooses point S_1 on shifted technology curve Q_1 (T_3). This means A_1 will have to manage labour unemployment intra-A_1 by lessening working hours per labourer, i.e., offering more leisure without reducing real wage rate and without reducing the portion of Q_1 for internal use. A_1 cannot choose point F, because choosing F means surrendering the resource-saving benefits of technological progress.

Generally, the labourers at a low real wage rate prefer work to leisure. Thus, the choice of A_1 for reduction in per capita working hours per labourer is limited. Either A_1 moves up to point S, or point S_1 or any point between S and S_1, all the points chosen are on new technology curve, Q_1 (T_3). Choosing S (which is rational for deriving the benefits of technological progress) means A_1 produces higher output at OQ_1^1. The additional output produced. Q_1^0 Q_1^1, will have two channels to be utilised: if A_1 does not (and since she can not, without making her real terms of trade adverse) export it to A_2 (and A_2 can not buy it at the same equivalence, given that her level of output remains unchanged with the same initial technology): (1) raising real wage rate, an upward parallel shift in NF_1 to $N_1 F_3$, implying higher real wage corresponding to higher labour productivity, (2) capital formation, shown in quadrant III by an outward (south-west) movement, from $K_0 K_0$ to $K_0^1 K_0^1$. The

Generally, the labourers at a low real wage rate prefer work to leisure.

magnitude of these shifts will depend on the relative power exercise by the controllers of capital and owners of labour power.

Example I: Technology-led Redundancy of Workers

In Australia the largest steel producer is the Broken Hill Proprietary Company Limited (BHP). BHP has an integrated mill at Port Kembla that produces over 60.0 per cent of its output. Since the introduction of new technology associated with large investments on it, labour productivity has increased from 381 tonnes per employee per year in 1990 to 636 tonnes per employee per year in 1996. BHP also introduced 'team work' for quality improvement. What happened was a fall in employment at Port Kembla from 9,406 in 1990 to 7,036 in 1996. Unskilled ironworkers were most adversely affected by redundancy and recruitment slowdown.

To counter redundancy as a problem, BHP developed up-skilling and career path advancement of ironworkers. This career path incorporated both off-the-job training and on-the-job training and on-the-job competency testing. To supplement training, BHP developed adequate off-site training facilities in the region (ILO, 1998-99, p. 40).

Absence of technological progress for a firm means ultimate exit of the firm, while presence of technological progress leads to changing sill requirement, and hence obsolescence/redundancy of a section of workers previously employed in the firm. The initial labour employment was based on initial technology that included knowledge of the owners of labour-power and non-labour resources. Evolution of new knowledge leads to exit of owners of old knowledge. Pending a resolution on which type of knowledge is socially superior, the workers that face exit need protection for survival.

The workers that face exit need protection for survival.

Social Protection of the Workers: Experience across Countries

Case I: Developed Market Economies (DMEs)

The Countries in the developed market economies (DMEs) have extensive unemployment insurance coverage and employment protection legislation that aim at employment security. This includes Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland. These countries offer for the working population high level and long duration unemployment insurance benefit payments. In contrast, within the DMEs, the duration of unemployment benefit payments is short, with benefits payable for less than twelve months, in countries like UK and US. The second layer of unemployment insurance, usually called unemployment assistance, that covers the unemployed workers who have exhausted their entitlement to unemployment insurance benefits, exists in countries such as Denmark, France, Spain and Sweden, In contrast, in Canada and the US, the unemployment benefit payments are not followed up with a second layer of unemployment assistance (ILO, 2000, p. 148-149).

Employment protection legislation is strongly enforced in France, Germany and Spain.

Employment protection legislation is strongly enforced in France, Germany and Spain. These are the countries where the most frequent cause of labour disputes arises from termination of employment contracts and judgements tend to be more favourable to employees. In Spain and Italy, labour court rulings seem to be favourable to workers because the beneficiary rate under unemployment insurance is lower than 20.0 per cent of the total of unemployed. The recent labour market reform in Germany strengthens the link between employment protection and unemployment insurance. In Germany, the amount of severance pay is partly taken into account in the calculation of the unemployment benefits, and particularly in part-time early retirement (ILO, 2000, p. 156).

In countries like Austria and Germany generous severance pay arrangements are increasingly transformed into job search and retraining plans for retrenched workers while they are still under contract with their previous employers (ILO, 2000, p. 156). The assumption is that execution of unemployment benefit schemes contributes to consumption smoothing and leaves people sufficient time to find a suitable job. In the DMEs, the calculation of unemployment benefits rests on the 'replacement level', that is, the benefit to be offered as a percentage of previous earnings and subject to the maximum period for which benefit is payable (ILO, 2000, p. 152-153). There are, problems in execution of the benefit schemes. The reason is, employment

protection is frequently dealt with in sectoral agreements between trade unions and employers or in enterprise-level collective agreements. This leaves the legislators with limited scope to influence overall trends in employment protection, especially in the already less-protected non-unionised segment of the labour force (ILO, 2000, p. 155-156).

There are problems in execution of the benefit schemes.

Case II: Central and Eastern European (CEE) Countries

The post-1989 countries in Central and Eastern Europe (CEE) established an employment fund that provided unemployment benefits and labour market support. This was a time when unemployment was still low in these countries. Average unemployment benefit replacement levels in the transition countries during post-1989, seem comparable to those of the European Union. The replacement levels are calculated as a percentage of the worker's previous wage or of the average wage, but their maximum is usually not permitted to exceed a certain percentage of the national minimum wage. In post-1997 Hungary, maximum replacement levels could reach 75.0 per cent of the previous wage but could not exceed twice the value of the minimum wage. The rising and persistently high levels of unemployment in countries such as Bulgaria, Hungary, Poland, and Slovakia caused strains on unemployment benefit systems. This led to tighter eligibility rules, lower levels of replacement, shorter duration of benefits and lower beneficiary rates (ILO, 2000, p. 157-158).

Immediately after 1989 many countries in CEE provided unemployment benefits for more than one year, but in the 1990s the length of duration often got reduced to three to six months. In Czech Republic, for example, unemployment benefits last for six months. In countries like Bulgaria, Lithuania, Poland, Slovakia, and Slovenia, the governments recognise the contribution of workers in building the country's wealth, and hence make short-term benefits policy more liberal by linking job seniority on the one hand and the duration and rate of benefits on the other (ILO, 2000, p. 158). In Croatia unemployment benefits are confined to a narrow range of low-level benefits.

In CEE countries on an average not more than half of the unemployed receive either unemployment benefits or social assistance. The percentage declined during the 1990s. During 1992-95 (January-December), the unemployment beneficiary rate declined from 80.0 per cent to less than 40.0 per cent in Hungary, from 75.0 per cent to 55.0 per cent in Poland, and from 82.0 per cent to 27.0 per cent in Slovakia. In Poland only one-third of the registered unemployed have started receiving benefits of late (ILO, 2000, p. 158).

Case III: Developing Economies in Asia, Africa, and Latin America

Latin America and the Caribbean: Countries in Latin America like Argentina, Barbados, Ecuador, Uruguay, and Venezuela have implemented unemployment insurance schemes, integrated within their social insurance schemes. In Brazil the unemployment insurance scheme is financed from a tax on enterprise revenues. In Chile this scheme is supported from general tax revenues. In Uruguay this scheme is supported from social insurance contributions and a part from value added tax. In Mexico the scheme is limited to workers between 60 and 64 years of age. The benefit entitlements to a worker depend in Mexico on the worker's contribution record. There are inter-country differentials in percentages of unemployed persons actually receiving unemployment insurance benefits. For example, the proportion of unemployed persons receiving unemployment insurance benefits was 10.0 per cent in Argentina, 16.0 per cent in Uruguay, both in December 1994, and 8.0 per cent in Chile as in 1993. For Barbados, the percentage of workers supported by unemployment insurance was 73.0 per cent in 1986, which declined to 60.0 per cent in 1994. Argentina and Chile pay unemployment benefits, which decline in steps, with duration of benefit ranging from four months to one year. Argentina, Brazil, Mexico, Peru, and Uruguay introduced measures in the 1990s that aimed at devising or augmenting active labour market policies in an effort to deal with the problem of unemployment (ILO, 2000, p. 159-160).

Countries in Latin America have implemented unemployment insurance schemes, integrated within their social insurance schemes.

Asia

The countries in Asia in general do not care much for the need for unemployment protection legislation or unemployment insurance benefits. As late as in 1998 only four South-East Asian countries, namely, China,

Mongolia, the Republic of Korea, and Hong Kong had any form of unemployment benefit scheme (ILO, 2000, p. 160-161). The unemployment insurance scheme in the Republic of Korea has been expanded in response to the massive rise in unemployment. The coverage of the unemployment benefit scheme in Korea was initially limited to firms with 30 or more workers. Since January 1, 1998, a planned extension of coverage to firms with ten or more workers was implemented and further to firms with five or more workers from March 1, 1998 (ILO, 2000, p. 162). In South Asia, only three countries, Bangladesh, India, and Pakistan have employer liability schemes to disburse severance or retrenchment payments on termination of employment.

In South Asia, only three countries, Bangladesh, India, and Pakistan have employer liability schemes.

Africa

We have not come across any country is Africa that has been practicing unemployment insurance benefits. Some of these countries have supporting employment and hence income-generating schemes. In eastern and southern Africa, ILO-supported employment-intensive programmes have been operating in Botswana, Kenya, the United Republic of Tanazania, and recently, in South Africa. Such schemes, however, are to be seen as measures for short-term protection of people, rather than any mechanism for substitution of unemployment insurance schemes.

Concluding Comments

Each firm in an economy is an optimiser of its own goal. Each firm tries to develop and more up the technology ladder, thus, try to reap the benefits of higher productivity. This may lead to exit of a section of labourers from the firm that experiences technological improvement first. In a situation of practiced technological progress and derived technological gap, the inter-firm impact is felt by exercise of non-technology-led relative power of the participants, e.g., agreement/disagreement on joint benefits, sharing of real wages and sharing of products Unless there comes a vent-for-surplus which may be thought of as a market (or autonomous demand) external for A_1 (the technology leader) where initial capital formation occurs, the options for expanding output with respect to technological improvement will not materialise. Thus, it may lead to: (i) possible exit of a section of labourers from the firm where they were initially employed, (ii) possible entry of this section of labourers into another firm, (iii) in absence of (ii), raising social costs of unemployment.

Technological progress leads to both additional employment and unemployment, depending on the changing skill required. The requirement in for both up-skilling and multi-skilling, both intra-firm and inter-firm. The organised industrial economies like the OECD countries, that experience technological progresses most, also cover most of the unemployed people as percentage of world total unemployed people. In countries like Austria and Germany, generous severance pay arrangements are increasingly transformed into job search and retraining plans for retrenched workers while they are still under contract with their previous employers (ILO, 2000, p. 156). The unemployment insurance benefits may also be used for investment in setting up a small business or to obtain training. Even the unused benefit entitlements of the unemployed workers may be used to subsidise enterprises, which hire these workers (ILO, 2000, P. 157).

The unemployment insurance benefits may also be used for investment in setting up a small business.

In countries in the developing world, the problems are radically different from those experienced in the industrially developed countries. In the developing world, the size of the industrial sector is very small in terms of regular employment. These countries generally have underemployment, both in terms of productive man-days and the real wage rate. Hence, the kind of discussion that we made in the initial sections shows the realities in the industrially developed world as well as the possibilities in the developing world. This may show to the developing countries the necessity to protect the labourers prone to be technology-led redundant, as are their counterparts in the developed world. The small size of the existing labour force in the organised industrial sector is no excuse to bypass the issue.

References

Hicks, J.R. (1971), "The Social Framework", Oxford Univ. Press, London.

ILO, (1999), "World Employment Report", 1998-99, Bookwell, Delhi.

ILO, (2000), "World Labour Report", International Labour Office, Geneva.

□

Feature

Innovative Clusters: Implications for Public Policy

Vijay Kumar Kaul

Since Silicon Valley first emerged as a High-tech cluster in the mid-1960s, other regions and countries throughout the world have adopted similar business clusters. Two types of Innovative or High-tech clusters have been observed: one emerging without explicit policies and those emerging in an environment of active technological and industrial policies favouring high-tech industry. The paper aims at examining the role of technology policy in the promotion of innovative clusters, especially in developing countries. First, the nature of innovation is outlined; second, the relationship between innovation, collective learning and cluster is examined; third, the role of technology and innovation policy is explored; fourth, innovative clusters, their emergence and other contributory factors are discussed; finally, the implications of the study for the technology and innovation policy of developing countries is presented.

Vijay Kumar Kaul is with the Department of Business Economics, University of Delhi.

The emergence of the knowledge-based economy, particularly in the developed world, has highlighted the role of knowledge as a key asset, learning as a key process and innovation as a key to competitive success of firms. High-tech sectors have emerged as key drivers of economic growth. However, it is found that the observed growth and competitiveness of High-tech industries and the corporate sector cannot be explained by focusing on individual enterprises. Clustering is essential to their success. Such Clusters are manifestations of increasing returns. The cluster of innovative firms has thus become the basis of the more competitive cities, region and nation.

Innovation: Non-linear and Interactive Activity

Increasingly, innovation is regarded as an evolutionary, non-linear and interactive process between the firm and its environment (Kline, and Rosenberg, 1986; Dosi, 1988). The concept of non-linearity implies that innovation is stimulated and influenced by many actors and sources of information, both inside and outside the firm. The interactivity of the innovation process refers to internal collaboration between several departments of a company as well as to external co-operations with other firms, knowledge providers, finance, training and public administration (See Fig. 1 and 2). These are all contributing to a firm's capacity to innovate.

Much of the recent literature on innovation systems (Nelson, 1993; Lundvall, 1992) stress the fact that national specificity's patterns of interaction between users and producers of innovations are at the very core of what defines a national innovations systems (Freeman, 1991; Freeman, 1995; Lundvall, 1992,; Nelson, 1993, Edquist, 1997). Being important constitutive elements of national systems of innovation, these patterns of interaction are regulated by institutions in terms of rules, norms and habits. More recently, there has been a

growing interest in innovation systems at the regional level. Clustering of innovative firms, their emergence and promotion are becoming the focus of study.

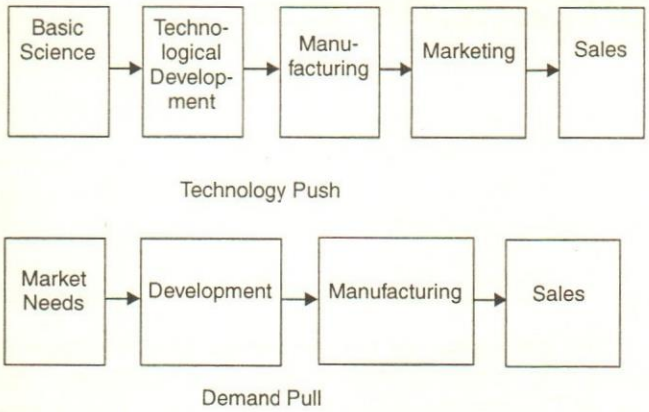


Fig. 1. Linear Models of Innovation

Innovation, Collective Learning and Clusters

Since Alfred Marshall, there has been a general interest in the clustering of industries in specific geographic locations. Recently, various economic geographers such as Walker (1985) and Storper and Walker (1989), evolutionary and path-dependence economists such as Arthur (1994), and business strategists such as Porter (1990) have developed explanations for this economic clustering. Krugman (1991) points to three supply-side externalities – labour-market pooling, the provision of specialised intermediate goods and services, and technology spill-over effects – that favour concentration of firms in a common industry even during a period of increasing economic globalisation. The incentives for such clustering are even greater, when a new technology is just emerging, as the knowledge associate associated with it is predominantly tacit, and thus difficult to transmit to those not directly involved in its creation. Arthur, in his explanation goes beyond agglomeration economies, to formally demonstrate conditions under which small events or historical accidents can be critical triggers that enable one region to become the centre of a particular type of economic activity. Porter (1990) focuses upon the inter-relationship between competing firms, supporting industries, the government and the market. Finegold (1999) identified four requirements that high-skilled clusters share in common with natural systems: a catalyst to trigger the start of their development, ongoing nourishment, a supportive host environment, and a high degree of interdependence among the actors in the system. All agree industrial growth in globally competitive regions is driven by economic benefits accruing from proximity (Kenney, and Burg, 1999).

Proximity plays a fundamental role in the process of innovation and learning, since innovations are in most cases less the product of individual firms than of the assembled resources, knowledge and other inputs and capabilities that are localised in specific places. The clustering of inputs such as industrial and university R & D, agglomerations of manufacturing firms in related industries, and networks of business-service providers may create scale economies, facilitate knowledge-sharing and cross-fertilisation of ideas and promote face-to-face interactions of the sort that enhance effective technology transfer. Two main features help explain the advantage of spatial agglomeration in this context: the involvement of inputs of knowledge and information which are essentially 'person embodies', and a high degree of uncertainty surrounding outputs. Both require intense and frequent personal communications and rapid decision-making, which are arguably enhanced by geographic proximity between the parties taking part in the exchange.

This proximity is particularly of great significance in relation to high-tech sectors where a pre-condition for success is the ability to share and utilise diverse

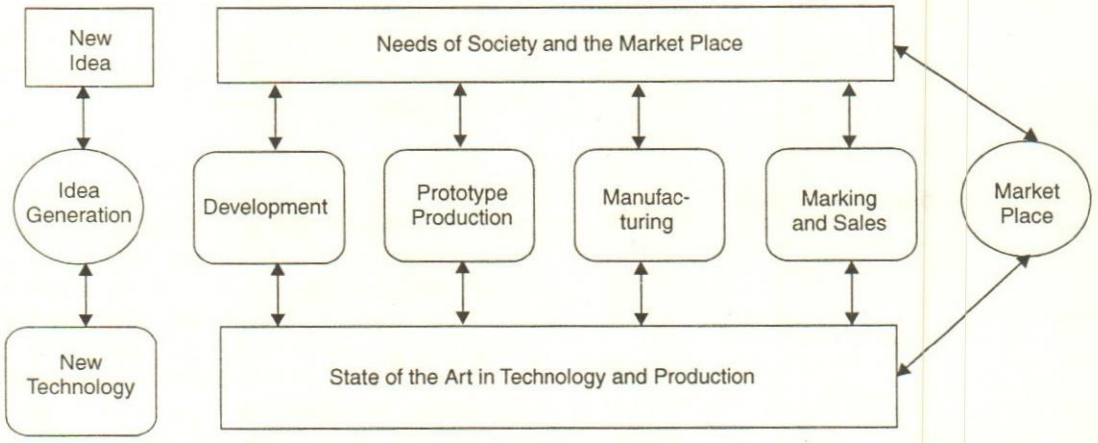


Fig. 2. An Interactive Model

knowledge. Moreover, in an increasingly rapid and radical technological change, they need continuous adaptations and restructuring. A cumulative and interactive learning is a critical aspect of their functioning.

High-tech sectors a pre-condition for success is the ability to share and utilise diverse knowledge.

The concept of regional collective learning focuses on the argument that regional clusters of small and medium sized enterprises can, given favourable environmental, socio-economic and institutional conditions and sufficient historical evolution, develop a capacity for self-sustaining technological learning, innovation and the generation of new products and enterprises. The development of a regional capacity for collective learning involves both the establishment of preconditions for learning, in the form of culturally based rules of behaviour, engagement and collaboration and accepted but tacit codes of conduct between individuals and firms which enable the development of trust, and conscious and unconscious regional processes of interfirm and organisation networking, and diffusion of embodied expertise. Three key mechanisms or processes of collective learning: degree of local movement and spin-off of embodied technological and managerial expertise in entrepreneurs, the frequency and importance of inter-firm networking and interaction, and the importance of flows of research and professional staff between local firms.

The association between organisational and technological learning within an agglomeration has two roots. The first concerns localised input-output relations, or traded interdependencies, which constitute webs of user-producer relations essential to information exchange. The second, and more important, factor concerns the role of untraded interdependencies, which constitute webs of user-producer relations essential to information exchange. The second, and more important, factor concerns the role of untraded interdependencies (like labour markets, regional convention, norms and values, public or semi-public institutions) which are attached to the process of economic and organisational learning and coordination (Stroper 1992, 1995).

Further, it has been found that some organisational forms and social conventions are more conducive to fostering innovation and learning than others. It is also recognised that there is no single best way to organise for innovation in different institutional settings. Rather, firms must seek to exploit the virtues of their environment. These institutional factors such as labour market, venture capital, and buyer-supplier relations, in turn, poses issues in being able to sustain it overtime. Emulating the 'best practices' of different countries' innovation system ignores the internal logic and the complementarities that knit these practices into a coherent system. Piecemeal adaptations at the margin that result from copying individual country policies fail to account for such complementarities, and therefore are likely to produce disappointing results (Chesbrough, 1999). Hence, when designing the technology and innovation policy to promote innovation and linkages, this point needs to be taken care of. The existing institutional factors, their interaction and result should be clearly understood. The technology and innovation policy can be used to intervene at this point.

There is no single best way to organise for innovation in different institutional settings.

Innovative Clusters and Technology and Innovation Policy

Analyzing seven high-tech areas Sternberg (1996a) found that government R&D expenditures, agglomeration (city-size), the research and education infrastructure, and the age of the region are the most significant factors behind the success of a high-tech region. He concludes that the growth and development of high-tech regions is determined by a number of factors similar to those proposed by Porter's (1990) model: interrelated production networks of large and small enterprises, endowments of production factors such as skilled labour and risk capital, the demand for new knowledge-intensive products, and entrepreneurial strategies and competition. To these he adds a factor more significant at the regional level: 'both implicit and explicit technology policy' (Sternberg, 1996b).

Most of the governments have intervened in the area of technology to correct market failures, or the tendency of the private sector to under-invest in technology development due to the inability of firms to capture all of the benefits from such investments. In the interest of maximising returns to the general public, technology policies have focused on stimulating or supporting R&D spending by industry through instruments such as R&D tax credits and subsidies. In addition to market failure, there is may a possibility of systemic failure also which may impede the innovation performance of industry. The lack of interaction between the actors in the system,

mismatches between basic research in the public sector and more applied research in industry, malfunctioning of technology transfer institutions, and information and absorptive deficiencies on the part of enterprises may all contribute to poor innovative performance in country (OECD, 1998). The concept of national innovation systems directs the attention of policy makers to this systemic failure.

New type of policies are needed to address systemic failures, particularly policies directed to networking and improving firm absorptive capacities. Enhancing the innovative capacity of firms is another policy priority. Technology policies should seek not just to diffuse equipment and technologies to firms but also to upgrade their ability to find and adopt technology themselves. Technology policies should aim not only at technology-based firms but also at firms with lesser technological capabilities, in traditional and mature industries, and in services sectors. And these policies should focus not just on upgrading the abilities of individual firms but also on enhancing the networking and innovative performance of clusters of firms and sectors.

New type of policies are needed to address systemic failures.

Innovative clusters

An understanding of the factors responsible for the emergence, reconfiguration and transformation of successful Innovative clusters will help in designing the technology policy appropriate for the development of other clusters. Three case studies are presented below. Silicon Valley which emerged without any explicit public policy and Toronto, Ontario where public policy has played a role. Third case is of Banglore, Silicon Valley of India, which developed and benefited by Government policy and international linkages of technocrat entrepreneurs.

Silicon Valley, California

The Silicon Valley economy is dominated by rapid innovation and commercialisation in an expanding set of now technologies. Microelectronics, semiconductors (e.g. Intel, AMD, National Semiconductor and later computers Apple, Sun Microsystems, Hewlett-Packard) put the Valley on the world map. Computer networking, both hardware and software (e.g. Cisco, Netscape, Yahoo, and Broadvision) have recently exploded as a shaping activity. Biotechnology along with medical devices and drug delivery systems constitutes the third major new technology. Along with these core industries, venture finances and intellectual property laws have become significant activities in their own right.

The emergence of Silicon Valley involved a long process beginning before the World War II, during the 50s and 60s during the semiconductor industry made its appearance side by side with the more traditional Electronics Instruments area. The 70's was a period both of consolidation of the cluster and of a self- reinforcing dynamic of industrial growth (impact of the cluster).

For this computer cluster one key stimulus was a large surge in Department of Defense funding for research and demand for new military hardware in the field of electronics in the 1940s and 1950s. This helped create a cluster of aerospace firms in Southern California (Scott and Paul, 1990). As this cluster grew, some of these firms set up new facilities in the Santa Clara Valley, attracted by cheap land, access to military bases, and the supply of engineers from the nearby universities. When the aerospace industry went into one of its periodic downturns, this left an abundance of unemployed engineers who had settled in the area with cutting-edge electronics skills that could be transferred easily from military applications.

During this period, Fred Terman, a Stanford engineering professor, had encouraged two of his students, William Hewlett and David Packard, to turn their graduate thesis into a commercial product (Aley, 1997). The resulting company not only acted as a magnet for growth and new product innovation in a variety of electronic sectors, but also helped generations of engineer-entrepreneurs who then left to set up their own enterprises. Terman was a driving force in establishing some of the crucial initial links between stanford and industry: the Honors Cooperative Program, that offered part-time degrees to engineers in industry, and one of the world's first science parks, the Stanford Park.

Stanford University provided the intellectual foundation. It is the source of the most important nutrient – new talent – that sustains their growth. The Stanford Industrial Park built by the university, provided laboratory and manufacturing space for the emerging industry. Stanford provided continuing education to top talent working in small companies. It also created an Industrial Affiliates Program that promoted research collaborations between individual faculty and companies. The University of California at Berkeley undertook a rapid expansion of engineering programs particularly Electrical Engineering. It also focused research Computer Science and on Semiconductor.

The Stanford Industrial Park, provided laboratory and manufacturing space for the emerging industry.

In addition to the large supply of graduates coming from California's research universities, the region attracted number of graduates from other US universities and foreign countries. Across the USA, over 40 per cent of all the science and engineering Ph.Ds are now awarded to foreign-born students (North, 1995), and the leading California research universities along with private institutions are among the top choices for these applicants. These foreign-born students and entrepreneurs represent some of the most talented technical human resources from around the world and have played a key role in fostering the growth of this cluster.

Alongside the steady intake of human capital, the other vital nutrient that sustains the development of this cluster is financial capital. The venture capital industry serves the vital function of sharing risk—taking much of the financial burden off the researcher or entrepreneur who comes up with the innovation, and distributing it among the pool of investors. Venture capitalists, whether 'angels' or firms, provide far more than financial advice to new enterprises. They also supply vital capabilities, e.g. managerial, financial, marketing, legal, and procurement skills, based on years of experience in the sector that the scientist or often very young engineer who has founded the firm may lack. They tend to play an active role in the daily operations of the enterprise, helping to formulate strategy and brokering partnership with other suppliers and customers in other parts of the value chain (Conger et al., 1998).

Three elements of self sustaining high tech clusters are: basic infrastructure, a climate that is attractive to knowledge workers, and regulatory regime that supports risk-taking. In addition to possessing a high quality physical and communications infrastructure, this region has gone beyond these basics to create more specialised infrastructure tailored to the needs of new, high-tech enterprises through mechanisms such as incubators, and science or technology parts. These facilities have been created by universities, public authorities, or private developers to provide an array of services that small firms are likely to need as they develop.

The region also provided a climate and the availability of cultural, recreational or other leisure activities, and/or the availability of affordable housing, safe neighbourhoods, and high-quality schools. Further, it provided low levels of regulations regarding work hours and other company practices that are likely to frustrate entrepreneurs, along with a set of laws that makes it easy to: (1) start a business, (2) take the business public if the initial idea proves successful, and (3) go bankrupt without severe penalties if the business does not succeed.

Strong universities, good infrastructure, abundance of human and financial capital are common to many urban areas that do not qualify as innovative cluster. What the firms and individuals in these regions lack is the shared focus on common sector and\or technology and a high degree of cooperation among the actors that facilitates the learning process. There are three different types of interdependency or networks, each of which can play a vital role in building innovative cluster and region: (i) horizontal linkages among specialised enterprises, (ii) vertical connections between firms along different segments of the value chain, and iii) networks among individuals. All these exist in the Silicon Valley.

In the fifties Lockheed, IBM, Xerox and other companies were attracted by the local infrastructure. In turn they contributed to the emerging cluster e.g. through spin-offs of personnel to create new companies.

By the 1970s problems arose from explosive growth. Local businesses formed an umbrella organisation, Santa Clara Country Manufacturing Group (SCCMG) whose 26 founding members included older Electronic companies (HP, IBM), new firms (Intel), non electronic and banks. The objective was to work side by side with representatives of the county government in solving social and political problems. The group set voluntary targets and indicative plans. Some firms committed money and expertise to devise solutions to land, transportation, environment problems. Cooperation between Industry and Government then became a 'model' for local policy making. Other organisations included WEMA (Western Electronic Manufacturing Association) and SEMI (Semiconductor Equipment & Materials Association). They also contributed to integrate a decentralised structure.

Along with the decentralised industrial community of start-ups, large established corporations developed particular organisational configurations. These corporations blurred the boundaries between corporate functions within firms, and in their place, created an interdependent confederation of project teams linked by intense informal communication. The system was pioneered by Hewlett and Packard and by Noyce (Intel). The model included trust in individual motivation, professional autonomy and generous employee benefits.

In the eighties, Silicon Valley faced a crisis. Semiconductor (SC) producer lost market share to SC memory producers in Japan. However, Silicon Valley recovered from this crisis. It is a reconfiguration or transformation phase of cluster. A new generation of Startups in SC and in computers emerged (e.g. Sun Microsystems, Conner Peripherals, Cypress Semiconductors); and there was reorganisation and continued dynamics in existing large companies like HP and Intel. Silicon Valley firms introduced a continuing stream of high value added products in semiconductors, computers, components and software-related products. They helped maintain US dominance in these areas over Japan. Sexenian (1994) argues convincingly that the basic Silicon Valley cluster features enabled such a successful adaptation.

In the eighties, Silicon Valley faced a crisis.

Silicon Valley's advantage lies in an institutional environment that supports continuous innovation and collective learning—one that by its very nature undermines technological trajectories or path dependency. In the post-war period, the region's engineers rejected the management models and practices of mainstream corporate America in their effort to preserve the flexibility and innovative dynamism of their early entrepreneurial success. The institutions and social structures they created combine intense inter-firm communication and learning with a continually deepening social division of labour. As a result, growth in Silicon Valley today occurs more through the conceptual advances and innovations that derive from specialisation, experimentation and recombination than from the scale economies associated with progress along a predetermined technological paradigm. It is precisely the openness, multiplicity and diversity of interconnections in Silicon Valley that allows economic actors to continually scan the environment for new opportunities and to invest in novel technologies, markets and applications with unprecedented speed (Sexenian, 1994).

Multimedia cluster Toronto, Ontario

Toronto has been a traditional financial and manufacturing centre of Canada. It saw considerable erosion of its core industries through the recession of the early 1980s and 1990s. The effects of the latter were intensified by the impact of the Free Trade Agreement (FTA) with the USA and the subsequent NAFTA. Although the Greater Toronto AREA (GTA) remains the second largest automotive production centre in North America, it also witnessed the rapid decline of many of its core manufacturing industries and the loss of a host of lower value-added firms. Yet, at the same time, it began to emerge as one of the core centres for software and animation as well as becoming one of the three major North American localities for multimedia production and services (with Silicon Valley and New York).

There were two preconditions that were critical in spurring this development: (a) the presence and strong value of key software capabilities at the university level (University of Toronto; University of Waterloo) created through substantial investments by national and provincial governments in expanding the education and research infrastructure in the 1960s; and (b) the centrality of Toronto as a broadcasting, entertainment, and cultural production centre within Canada, with many of these industries growing or locating in Toronto as a result of federal policies in the 1970s to promote the development of Canada's cultural industries. The unintended and indirect effects of these policies led to the growth of a multimedia software sector because the cultural industries' skills base was already present. The dynamism of this sector continues to depend primarily on the ready supply of highly qualified labour. This has been assured by judicious investment by governments in continuous upgrading and expansion of the training infrastructure, including the establishment of highly specialised training and research institutes. The end result has been an agglomeration of such companies in the Toronto area not only supplying, but also demanding, various multimedia related services and products (Gertler and Brail, 1999; Wolfe, forthcoming).

Bangalore: Silicon Valley of India

Bangalore is India's fifth largest city with a population of nearly 5 million. During the late 1980s, there has been explosive growth of the software industry, which has given Bangalore the title of the 'Silicon Valley' of India among business circles worldwide. This was a result of a partnership between large public sector firms (Indian Telephone Industries, Bharat Electronics), large private firms (like Wipro, making computers) and smaller firms which were either ancillaries to the big factories or marketed their own specialised products. In addition to the older industrial estates, mostly for 'small-scale industries', the state government established the Peenya Industrial Area on the edge of the city, mainly in engineering and electronics, and an 'Electronics City' near Bangalore. The city enjoyed a thriving subculture of small and medium enterprises connected by contractual arrangements to the public sector.

The city enjoyed a thriving subculture of small and medium enterprises connected to the public sector.

Bangalore had a long history as a centre for textile production. During the late 19th and early 20th centuries, large mills were introduced in the city. With the encouragement of the government of Mysore, other industries began to grow in the Bangalore area. India's leading industrial firm Tata endowed what is now the Indian Institute of Science, to be followed by a host of publicly and privately funded research institutes. During the second world war the establishment of a number of public sector companies (including Hindustan Aircraft, now Hindustan Aeronautics) helped the city to grow fast.

Heitzman (1999) distinguish four phases in the economic history of the city since independence. The first phase, during the 1950's and 1960s, was dominated by the government of India initiatives in locating public sector research and production facilities in Bangalore. These institutions still have a major impact on the city, the five largest public sector companies in 1991 officially employing over 81000 people in their Bangalore plants. Their direct impact, including management of their own townships, housing schemes, and transport systems, was supplemented by the numerous subcontracting opportunities they provided for small and medium enterprises. The second, beginning in the late 1960s and running through the 1970s, witnessed the rapid growth of state government bureaucracy, employment and eventually state-run businesses, helping to fuel the second largest spurt in the city's population growth during the decade of the 1970s. The third phase began during the 1980s, when Bangalore began to experience the effects of preliminary 'liberalisation' and private enterprises became growth engines, especially in micro electronics based companies. The fourth phase, beginning in the late 1980s, brought increasing and more varied relationships with multinational corporations. The announcement by Central Government in 1985 of a software technology park scheme, with special rules and connections for 100 per cent export-oriented units (EOU) attracted many MNCs.

The city boasts 3 Universities, 14 engineering colleges, 47 polytechnic schools, and a wide variety of research institutes. There are also various industrial-training institutes, including a high-tech village that houses the acclaimed Indian Institute of Management. The main operations for such public-sector giants are Hindustan Aeronautics, Bharat Electronics, Indian Telephone Industries, Hindustan Machine Tools, and the Indian Space Research Organisations (which develops and launches satellites for civilian purposes). Two institutions have been of strategic importance in stimulating high-quality innovative production. The Central Machine Tool Institute (CMTI), funded by the national government, and Nettur Technical Training foundations (NTTF).

There are many clubs and trade associations, like KASSIA (Karanataka Small Scale Industries Association), CLIK (Consortium of Electronic Industries of Karnataka), Peenya Industries Association etc. In the past, the main task of the associations was to represent members' interests to national and state governments. Now they concentrate on advising new or established entrepreneurs, putting members in touch with markets and suppliers, publishing newsletters and trade directories, while still lobbying the government where they believe it necessary.

Both public and private sector factories subcontracted the manufacture of components to small ancillary workshops, often set up by engineers or skilled workers with experience of working in the larger factories, who took advantage of the incentives for 'small-scale industries'. Small or medium firms compete to get job work from larger ones. They also put out work to each other, for example manufacture of components, different stages in production work which requires special equipment like a CNC, capacity subcontracting to meet a deadline. This division of labour between firms cannot depend entirely on short-term considerations of profit in a competitive market. It requires a degree of trust, just as running a successful and flexible enterprises depends on some minimum level of trust between employers and workers: not unlimited trust in either case, but a shared understanding about the situations where conflict or competition are appropriate.

Factories subcontracted the manufacture of components to small ancillary workshops.

The cases of successful small and medium businesses indicate that they owe a great debt to the public sector for the training of their management. Entrepreneurs emerged from government-supported institutions and utilised their contacts there to understand emerging markets inside and outside those institutions in order to create new businesses. Many of the skilled personnel essential to the competitive advantage of these companies had spent their early careers in the

public sector, but migrated out in search of better wages and more interesting projects.

Innovative Clusters - With or Without Explicit Policy

These three studies show that high-tech innovative clusters are the result of either explicit public policy or without any explicit policy. There is a visible pattern in the growth of successful high-technology clusters. First, they emerge due to explicit or indirect policy of the government. A change in the technology or other external threats force clusters to reconfigure, adopt and transform. A culture of collective learning helps in its transformation. In most of the developed countries, however, it is observed that the success of High- technology clusters are the direct result of enabling policies, such as the provision of venture capital or research support (Sternberg, 1996a). For example, the Advanced Research Program in Texas has provided support for basic research and the strengthening of the infrastructure of the University of Texas which has played a central role in developing a high-technology cluster around Austin. The Thomas Edison Centers in Ohio, the Advanced Technology Centers in New Jersey, and the Centers for Advanced Technology at Case Western Reserve University, Rutgers University, and the University of Rochester have supported generic, pre-competitive research. This support has generally provided diversified technology development involving a mix of activities encompassing a broad spectrum of industrial collaborators. There are various methods and mechanism of collective learning. The roles of University and industry associations are important.

Change in the technology or other external threats force clusters to reconfigure.

In developing countries also, cooperation and collective learning has been observed. This varies from casual exchanges of information and tools to highly collaborative forms of production relations. Horizontal relations between firms are marked by competition. Yet, cooperation between firms at a horizontal level in also apparent, first, as a coping strategy in the form of capacity contracting; and second, through the functioning of various local business and sectoral associations. Bangalore cluster is one such example. Generally, caste and ethnic identities are important criteria in delineating social groups in clusters in developing countries. Sociocultural identity serves the function of providing a commonly accepted set of codified knowledge and interpersonal trust relations, through which production arrangements were made, information exchanged, skills transferred and capital allocated. Trust-based interaction between lead firms and technologically-specialised subcontractors is reinforced by interpersonal networks of acquaintance. Common educational/professional experiences also form the basis of cooperation in the high-tech cluster. However, these clusters have yet to develop as Innovative clusters. The technology and innovation policy need to take account of this.

Implications for Public Policy

It can be concluded that innovation is a critical factor for the success of High-tech sectors. Innovation requires interaction and continuous learning. The synergy that arise from the combination of complementary knowledge within different firms and the need for firms to cope with the increasing dependency upon their environment is the driving force for the emergence of innovative clusters. The economic viability of these clusters where continuous adaptation and restructuring are needed depend on collective learning. Though some clusters have emerged without any explicit public policy, majority of others have been benefited by this. The public policies (technology and innovation policy), particularly cluster-based policies, aim at removing imperfections of the innovation system (systemic imperfections).

The economic viability of these clusters depend on collective learning.

Most of the studies conducted on High-tech clusters are based on the developed country's experience. However, their findings have clear implications for the developing countries which are entering and targeting the high-tech sector. In developing countries, the system of innovation is less dynamic. For instance, in India, the system of Innovation was directed towards import substitutions and Mega-science project in a protective and regulated environment. There are weak linkages and interaction among the various actors of the National system of Innovation. Some high tech clusters are also emerging particularly linked with Information technology.

Realising the strategic importance of IT for the economy, the Indian Government has set itself an ambitious target of making India a Global IT power. In 1998, a national IT task force was set up and a national IT policy formulated. Recently, Indian Government passed IT Bill aimed at facilitating e-commerce and the growth

of Internet. It also strengthens the country's human infrastructure through the establishment of an Indian Institute of Information Technology (IIT) in very state. Emboldened by the thrust given by the central government to IT development, 14 of the 26 state governments have already come up with their own IT policies that aim to leverage the comparative advantages of their respective states. Main focus of activity is going to be the state. Learning about clusters and clusters enabling policies are going to the crucial.

Establishing an innovative cluster is an essential policy instrument to enhance the technological capacities of regions. In India, the government has initiated several measures overtime such as establishing Industrial Estate, District Industrial centre, Software Technology Park etc. to solve the problems of small and medium size enterprise. These programmes have several problems and weaknesses, because of which their full benefits have not been realised by small enterprises. However, they resulted in the agglomeration of small and medium sized enterprises in certain localities. There are numbers of clusters of small and medium size enterprises all over the country. Some of these clusters are in the traditional sector and products; others are emerging in the new technology areas. To make small and medium enterprises more efficient and competitive, the resources and institutions located in clusters need to be exploited fully. Their effectiveness in supporting the small and medium enterprises needs to be examined. The institutional gaps need to be filled. Further, there is a need to develop policies to bring integration, and generate and strengthen the culture of collective learning.

Generally, it is observed that there is an evolutionary process in the clusters. Initially, specialised areas emerge from simple geographical proximity with the growth of stable inter-small and medium sized enterprises. It helps in developing linkages among firms and the establishment of a local labour market for the required skills. This continuity over time for local technological and scientific know-how. This leads to the development of Industrial districts. There is close social interaction. The supportive institutions generate high trust and encourage informal and tacit knowledge transfers. This leads to industrial atmosphere, external economies and savings in transaction costs. From cooperative relations and the free flow of knowledge, synergies and innovative capacity evolve and the industrial district becomes an innovative cluster. The hallmark of the innovative cluster is that the localised labour markets, inter-firm relationships and firm spinouts enrich the local knowledge base and enable exploitation of localised collective learning capabilities to develop profitable new products and processes (Capello, 1999).

In India, most of the clusters are at the first and second stages of development. Except for some clusters like, Ludhiana, Tirupur, Banglore etc, others are stagnating and declining. In order to be more competitive, there is a need to strengthen existing clusters and transform the industrial district into innovative clusters. This will help in regional development. According to Lundvall and Borras, a cluster helps the weak region in three crucial ways. First, it builds up the 'social capital' in the region, exploiting the learning potential of individual and human resources. Second, it expands the (generally very weak) institutional capacities of the region. Third, it enhances partnerships between public and private sector players in the region, and aids in devising collective strategies.

Innovative cluster is a result of geographical specificity, interaction of different actors and collective leaning. Being a part of the national system of innovation, it has a two way relationship. It gains strength from the innovation system and in turn it also strengthens it. There are a number of deficiencies in the national system of innovation of developing countries which contribute to its poor innovative performance: lack of interaction between the actors in the system, mismatches between basic research in the public sector and more applied research in industry, malfunctioning of technology transfer institutions, and information and absorptive deficiencies on the part of enterprises. This that policy measures are required which focus on networking and improving the absorptive capacity of firms in clusters. Further, it also an enhancement of innovative capacity of needs firms. All this is a part of innovation system. To remove these deficiencies and strengthen the national system of innovation the following to steps and policy measures are to be taken:

Innovative cluster is a result of geographical specificity.

First, conduct detailed regional cluster studies: Identify the existing clusters. Examine the status of small enterprises and large and medium size enterprises in the cluster. Identify the resources available in the locality. Analyse the performance of the cluster over time, faced by the industry and then find solutions for it. It will provide a picture of the strength and weakness of the region and its learning capabilities.

Second, identify the linkages: There are different linkages between different industries located in the cluster. In some cases, linkages are based on trade, innovation, knowledge flows, or a common knowledge

base or common factor conditions.

Third, identify the gaps: Using value chain approach, gaps in the clusters should be identified in terms of institutional structures and linkages etc. The value chain approach links the different stages of a product starting from raw material procurement to operations, outbound logistics, marketing and sales, after sale services, and other specialised services. The same can be extended to examine the industries located at a region, starting from the input suppliers, finished goods manufacturers, professional service providers etc.

The value chain approach links the different stages of a product.

Fourth, develop innovation policy and programmes: Develop innovation policy of the state. It will be a comprehensive policy with the inclusion of education policy, industrial policy, regional policy, etc. And these policies should focus on upgrading the abilities of individual firms and on enhancing the networking and innovative performance of clusters of firms and sectors. It should also decide the policies and programmes to enhance competitiveness, innovative capacity of firms, and collective learning.

It must be noted that region, network, information technologies and industrial districts are inanimate objects. They can do nothing without the help of the two: highly qualified personnel (linked in their ability to innovate), and adequate public and private funding. Concentration of highly qualified professional workers who learn and innovate is very important for any region. Knowledge contained in highly qualified professional workers is an essential ingredient of real technology transfer. The government can promote and generate spin-off by encouraging staff to move out of government funded research establishment or create commercially viable off shoots within the government setup. Even setting up of incubation centres can also be considered. Those centres are becoming an important part of innovative cluster. A clearcut policy guidelines and direction be given to promote such center by encouraging university and other centers.

There is a general tendency to resist change. However, changes in economic and business environment led by the process of privatisation and opening up of economy to foreign investment has forced companies to restructure to remain competitive. The public policies and programmes can be designed to encourage and promote such restructuring with the aim of upgrading their technological capabilities. The policy should not just focus on supply of new technology etc. An exclusive emphasis on supply has dangerous 'linear model of innovation' overtones. Policies should be directed at building the demand for higher level technological activities along with responding to existing demand. In the absence of collective learning, firms may not realise the value of such activity and remain passively dependent on imported technologies, raising the costs of technology transfer and reducing their ability to exploit new technological opportunities. This is one of the main reasons why policies have to be directed at promoting collective learning.

References

Aley, J., "Why Standford – the Nexus of Capital, High Technology, and Brainpower – is the Intellectual Incubator of the Digital Age". The Heart of the Silicon Valley', Web Page, http://www.pathfinder.com/future/1997/970/970707/st.html

Arthur, W.B. (1994), "Increasing Return and Path Dependence in the Economy", University of Michigan Press: Ann Arbor.

Capello, R. (1999), "Spatial Transfer of Knowledge in High Technology Milieux: Learning Versus Collective Learning Processes", Regional Studies 33, 1999, pp 353-65.

Chesbrough, Henry W. (1999), "The Organisational Impact of Technological Change: A Comparative Theory of National Institutional Factors, Industrial and Corporate Change", Volume 8, Number 3.

Conger, J., Finegold, D. and Lawler E. (1998), "Assessing the Board, Harvard Business Review", Jan-Feb.

Dosi, G. (1988), "Sources, Procedures, and Microeconomic Effect of Innovation", Journal of Economic Literature, 26:1120-71.

Edquist, C. (ed.) (1997), "Systems of Innovation: Technologies, Institutions and Organisations", Pinter Publishers, London.

Finegold, David (1999), "Creating Self-Sustaining High-Skill Ecosystems", Oxford Review of Economic Policy, Vol. 15, No. 1.

Freeman, C. (1991), "Networks of Innovators: A Synthesis of Research Issues", Research Policy, Vol. 20, No. 5.

Freeman, C. (1995), "The National System of Innovation in Historical Perspective", Cambridge Journal of Economics, Vol. 19, No. 1.

Gertler M.S. and S. Brail (1999), "The Digital Regional: Emergence and Evolution of Toronto's Multimedia Clusters", eds. H.-J. Braczyk, G. Fuchs and H.G. Wolf, Multimedia and Regional Economic Restructuring, London: Routledge.

Heitzman, James (1999), "Corporate Strategy and Planning in the Science City-Bangalore as 'Silicon-Valley', Economic and Political Weekly", January 30.

Holmstrom, Mark (1998), "Bangalore as an Industrial District: Flexible Specialization in a Labour Surplus Economy?" In Cadene, Philippe and Holmstrom, Mark (ED.), Decentralized Production in India-Industrial Districts, Flexible Specialization and Employment, Sage: New Delhi.

Kenney, Martin and Urvon Burg (1999), "Technology, Entrepreneurship and Path Dependence: Industrial clustering

in Silicon Valley and Route 128", Industrial and Corporate Change, Vol. 8 and Number 1.

Kline S.J. and N. Rosenberg (1986), "An Overview of Innovation", In Landau R., and N. Rosenberg (eds.), The Positive Sum Strategy, Washington, National Academy Press, 275-305.

Krugman, P. (1991), "Geography and Trade, Cambridge", M.A., MIT Press.

Lundvall, B.A., and Susana Borras (1998), "The Globalising Learning Economy: Implications for Innovation Policy", Report Based on Contribution from Seven Projects Under TSER Programme, DG XII, Commission of the European Union, December.

Lundvall, B.A. (1992), "National System of Innovation: Towards a Theory of Innovation and Interactive Learning", Pinter Publishers, London.

Nelson, R.R. (ed.), (1993), "National Innovation Systems: A Comparative Analysis", Oxford University Press Oxford and New York.

North, D. (1995), "Soothing the Establishment: The Impact of Foreign-Born Scientists and Engineers on America", Lanham, M.D., University Press of America.

OECD, (1998), "NIS Focus Groups: Draft Summary Reports-Working Group on Innovation and Technology Policy", OECD, 23-24 November.

Porter, M. (1990), "The Competitive Advantage of Nations", Free Press: New York.

Scott A. and Paul A.S. (1990), "Industrial Development in Southern California", 1970-1987, in J.F. Hart (ed.), Our Changing Cities, Baltimore, M.D., Johns Hopkins University Press, 189- 217.

Sexenian, A. (1994), "Regional Advantage", Harvard University Press, Cambridge, MA.

Sternberg, R. (1996a), "Government R&D Expenditure and Space: Empirical Evidence from Five Industrialised Countries", Research Policy, 25:741-58.

Sternberg, R. (1996b), "Technology Policies and the Growth of Regions: Evidence from Four Countries, Small Business Economics, 8: 75-86.

Storper M. and R. Walker (1989), "The Capitalist Imperative: Territory, Technology and Industrial Growth", Basil Blackwell: London.

Stroper, M. (1992), "The Limits to Globalisation: Technology Districts and International Trade", Economic Geography, 68, 60-93.

Stroper, M. (1995), "The Resurgence of Regional Economics, Ten Years Later: The Region as A Nexus of Untraded Interdependencies", European Urban and Regional Studies, 2, 191-221.

Walker, R. (1985), "Technological Determination and Determinism: Industrial Growth and Location", in M. Castells (ed.) High Technology, Space and Society, Sage: Beverely Hills, CA, pp 226-64.

Wolfe, David A., "Globalization, Information and Communication Technologies and Local and Regional System of Innovation, in Kjell Rubenson and Hans Schutze (ed.), Transition of the Knowledge Society: Conference Proceedings, University of British Columbia Press, Vancouver, Forthcoming.

□

Every day I get up and look through the Forbes list of the richest people in America. If I'm not there, I go to work.

– Rovert Orben

Feature

Industrial Recession in India: Is Interest Rate the Cause?

L.M. Bhole & Pradyumna Dash

It has been argued by some that the high real rate of interest is one of the significant causes of industrial recession in India in the latter half of the 1990s. Consequently, the level of interest rate has been brought down. The paper tries to find out how far the current industrial recession can be attributed to interest rate in India. It also discusses various other causes of industrial slowdown in our country. The paper finds that high volatility and the low growth rate in agricultural production, trade reforms, and the co-ordination failure among economic agents during the 1990s are the plausible causes of the industrial recession in India. Therefore, the potential industrial output can be produced in a sustainable manner if appropriate policy measures are taken to increase agricultural production, to encourage the small-scale and tiny industries and off-farm activities, and to reduce risk and uncertainty. Interest rate reduction alone can't revive the Indian economy.

L.M. Bhole is Professor of Economics in the Department of Humanities and Social Sciences in Indian Institute of Technology, Mumbai, and Pradyumna Dash is Research Scholar in the Department of Humanities and Social Sciences in Indian Institute of Technology, Mumbai.

The major goals of the New Economic Policy that was introduced at the beginning of 1991 were to achieve a higher growth rate of gross domestic product (GDP) in a persistent way and to maintain a moderate inflation. These objectives have been broadly achieved. However, the recession in the industrial sector in the second half of the 1990s and in the year 2001 has posed a serious threat to the credibility of economic reforms. The manifestation of economic downturn twice in less than a decade is really a major issue in the post-reform period and is likely to have tremendous economic and political repercussions.

Many factors have been pointed out as being the causes of this persistent recession and one of them is the alleged existence of high real rates of interest in India. For example, it has been stated that the high real rates of interest which are in turn caused by high fiscal deficit are responsible for the current recession in India (Economic Survey, 2001). It has been argued that the existing interest rate structure is not only one of the important causes of recession but also it has been a contributory factor for many unwholesome and undesirable developments in the Indian Economy. Many researchers and policy makers, therefore, have been either directly or indirectly pleading for the interest rate cut. It has been argued, on the basis of the working of stock market, that the fall in the share prices combined with high interest rates on fixed deposits has contributed to the disenchantment of the ordinary investor with share markets, and, therefore, lower interest rates are essential to revive the stock market (Goyal, 1997). It has also been stated that the lowering of interest rates and thereby of the interest burden of the State is essential to revive investment (Patnaik, 1999). The Indian government has accordingly made an attempt to create a conducive environment by reducing the general level of interest rates, as a result of which, we have now entered into a low interest rate regime in our country. It is in this context that the objective of this paper is to identify the causes of industrial recession in India during

Table 1: Sectoral Real Growth Rates in Gross Domestic Product (GDP), 1993-94 to 2001-2002.

	Percent Change over the Previous Year								
	1993-94	94-95	95-96	96-97	97-98	98-99	99-2000(P)	2000-2001(Q)	2001-2002(A)
Agriculture and Allied Activities	4.1	5.0	–0.9	9.6	–2.4	6.1	1.3	–0.2	5.7
Industry	5.2	10.2	11.6	7.1	4.3	3.7	4.9	6.3	3.3
Services	7.6	7.1	10.5	7.2	9.8	8.3	9.5	4.8	6.5
Total GDP at Factor Cost	5.9	7.3	7.3	7.8	4.8	6.5	6.1	4.0	5.4

Note: P: Provisional Estimates; Q: Quick Estimates; and A: Advanced Estimates.

Source: Government of India, Ministry of Finance, Economic Survey, 2001-2002.

the second half of 1990s. It particularly attempts to reflect on whether the recession has been caused by high rates of interest and whether the low interest rates regime would help the economic revival in the country.

We have now entered into a low interest rate regime in our country.

Is there A Recession In India?

The National Bureau of Economic Research (NBER) defines recession as a significant decline in economic activity across the economy, lasting for more than a few months, visible in a decline in industrial production, employment, real income (inflation adjusted) and trade (business sales). "Contraction", "slump", "downturn", are often used as synonymous with recession. According to some macroeconomists, a "recession" is a slackening of demand in any one or more industries or sectors of the economy while a "slump" is a general slow down in the tempo of the entire economy. Slump is, therefore, a wider concept that hits and affects nearly all the segments of the economy. Recession is a state of affairs in which real income produced, real income consumed, and the rate of employment are falling, and there are idle resources, unemployed workers and unused capacity (Heberlar, 1966).

Tables 1 to 5 and graphs 1 to 4 indicate the following points regarding the performance of the Indian economy in general and industrial sector in particular. They more or less clearly establish the fact of industrial recession in India during later part of 1990s:

(i) The buoyancy in the growth of National Income that was witnessed after the introduction of New Economic Policy (NEP) has not been maintained during the later years of 1990s. The annual average rate of growth of real GDP was 5.35 percent during 1997-98 to 2000-2001 compared to the rate of 7.07 percent during 1993-94 to 1996-97 (See Table 1).

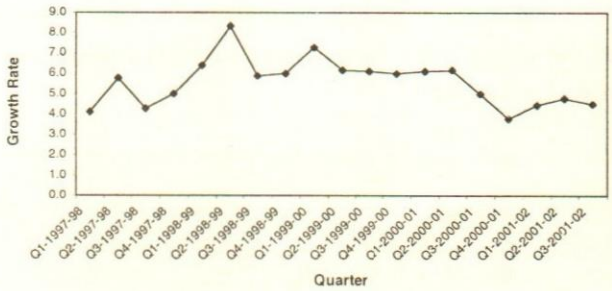


Fig. 1. Quarterly Growth Rates of Real GDP, Q1-1997-98 to Q3-2001-2002 (Base: 1993-94 = 100)

Note: Growth rate is over the corresponding period of the previous year.

Source: Reserve Bank of India, Handbook of Statistics on Indian Economy, 2001, Mumbai, 2002.

(ii) The rate of growth of industrial output has similarly declined during the 1990s; the annual average rate of growth of real industrial output at 4.8 percent during 1997-98 to 2000-2001 was almost half of the similar rate of 8.52 percent from 1993-94 to 1996-97. The annual rate of growth of production has noticeably declined over the years in various sub-sectors of industry also. For example, the rate of growth in the manufacturing sector has declined from 14.1 percent in 1995-96 to 5.3 percent in 2000-2001 (See Table 2, and Figs. 2 and 3). Further, the recession has hit hard basic goods industry, consumer goods industry, capital goods industry, and intermediate goods industry. The annual

Recession has hit hard basic goods industry, consumer goods industry, capital goods industry, and intermediate goods industry.

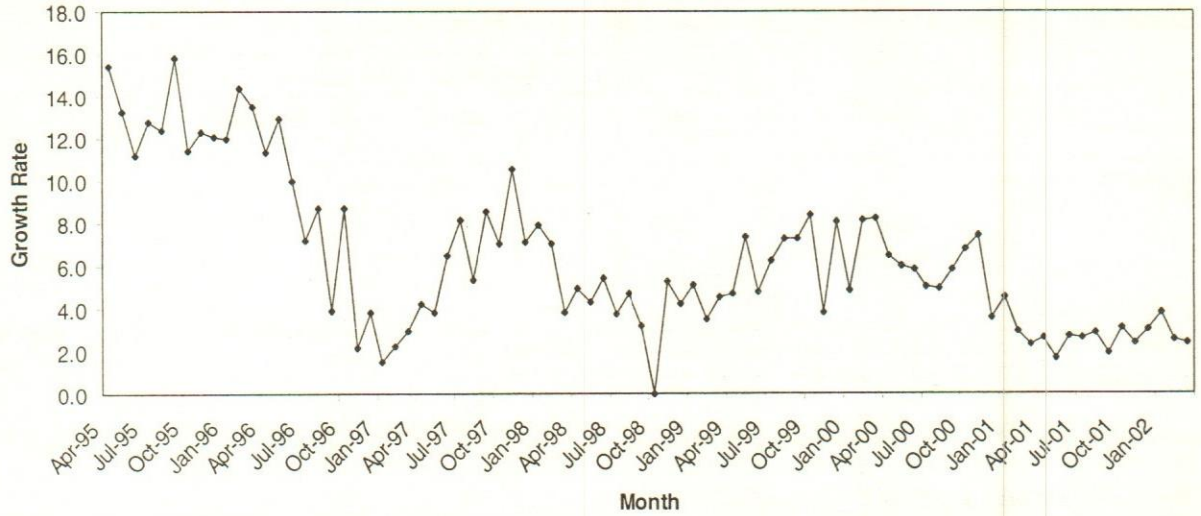


Fig. 2. Monthly Growth Rates of General Index of Industrial Production, April 1995 to March -2002 (Base: 1993-94 = 100)

Note: Growth rate is over the corresponding period of the previous year.

Source: Same as Fig. 1.

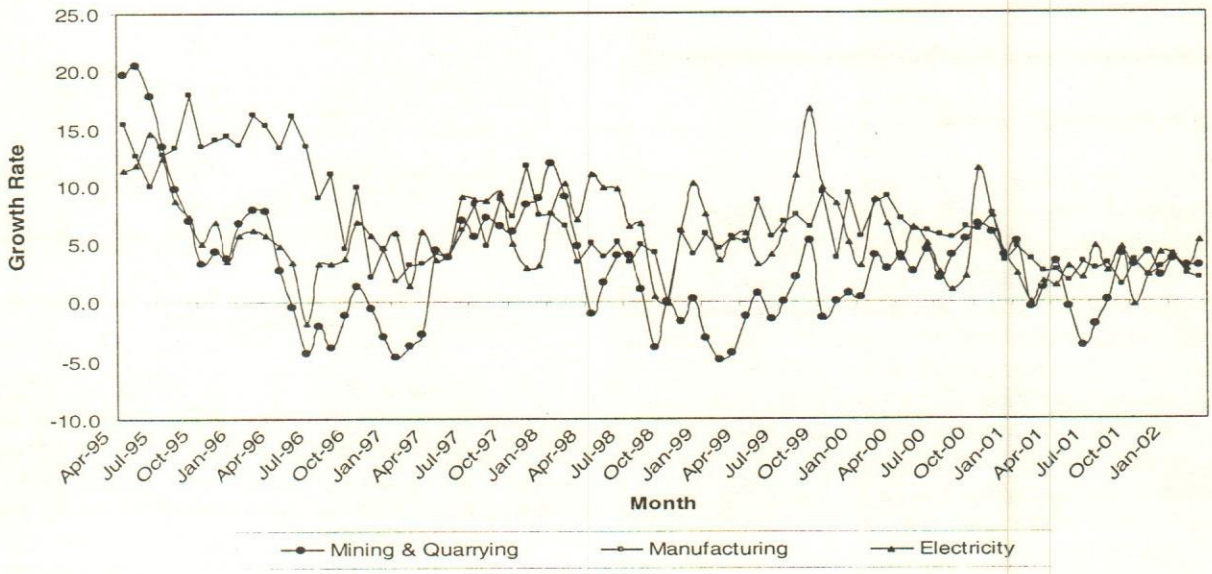


Fig. 3. Monthly Growth Rates of Industrial Sectors, April 1995 to March 2002 (Base: 1993-94 = 100)

Note: Growth rate is over the corresponding period of the previous year.

Source: Same as Fig. 1.

average growth rate of all sectors has declined from 1997-98 to 2000-2001 as compared to 1994-95 to 1996-97 (See Table 3).

(iii) The growth of output in the agricultural and allied activities sector also has decelerated, it has been negative in certain years, and it has been characterised by much higher degree of fluctuations during the period under discussion (See Tables 1, 6, and 7).

(iv) A number of performance indicators of the private corporate sector in India as presented in Table 4 lend further support to the view that the Indian industry has been suffering from recessionary tendencies during the latter half of 1990s. The respective annual rates growth of production, sales, and profits have either declined or turned to be negative, and the utilisation of fixed capital has suffered a setback, which is reflected in a clear decline in the ratio of value added to fixed assets and the ratio of sales to fixed assets, respectively from 1995-96 to 1999-2000 (See Cols. 1, 2, 3, 4, 5, and 6 in Table 4). The gross profitability, net profitability, and dividend payment have also declined during the period just mentioned.

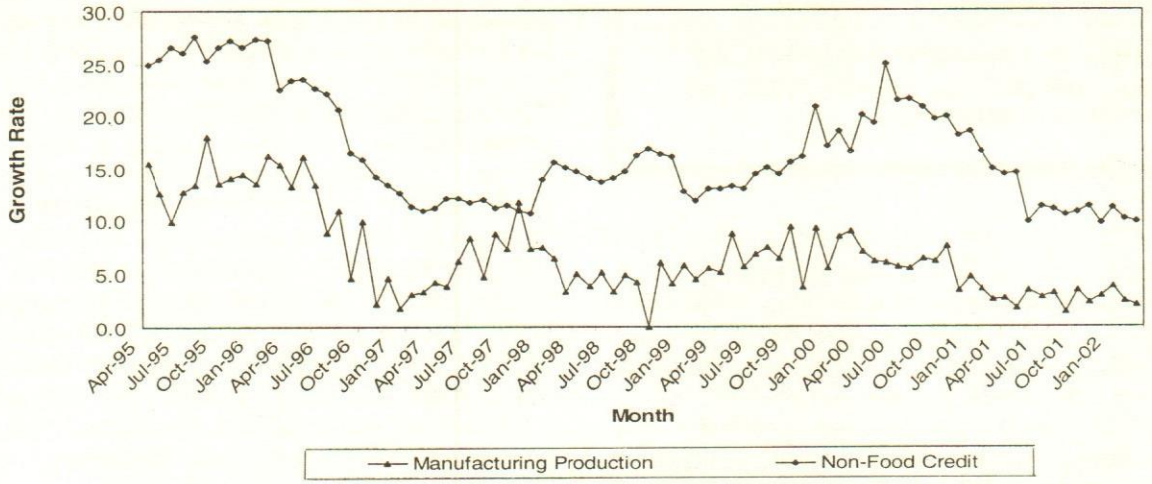


Fig. 4. Monthly Growth Rates of Manufacturing Production and Non-Food Credit, April 1995 to March 2002

Note: Growth rate is over the corresponding period of the previous year.

Source: Same as Fig. 1.

Table: 2: Annual Growth Rates of Industrial Production in Major Sectors of Industry, 1994-95 to 2001-02 (Percentages) (Base: 1993-94 = 100).

Year (weight)	General (100)	Mining and Quarrying (10.47)	Manufacturing (79.36)	Electricity (10.17)
1994-95	9.1	9.8	9.1	8.5
1995-96	13.0	9.7	14.1	8.1
1996-97	6.1	–1.9	7.3	4.0
1997-98	6.7	6.9	6.7	6.6
1998-99	4.1	–0.8	4.4	6.5
1999-2000	6.7	1.0	7.1	7.3
2000-2001	5.0	3.7	5.3	4.0

Source: Same as in Table 1.

(v) The proposed investment and proposed employment given in Industrial Entrepreneur Memoranda (IEM) and Letter of Intents (LOIs) also give a fairly good idea about the industrial climate or the level of industrial activity. Table 5 shows that proposed investment as well as proposed employment has generally declined from 1995 to 2000.

Causes of Industrial Slowdown

Has the industrial decline been due to higher interest rates? The relationship between the level of real interest rates and real economic growth has been discussed in academic literature especially in the less developed countries. In contrast to Keynesian line of thinking that interest rate has to be kept at a low level to promote investment and growth, it has been argued that the financial repression – interest rate ceilings, high reserve requirements, regulatory credit policies – discourages the development of domestic financial markets and is detrimental to economic growth. Financial liberalisation leading to high interest rates is expected to channel savings to their most productive uses and generate greater efficiency in investment projects. In other words, the financial liberalisation process implies a positive relationship between real interest rates and economic growth via increased savings and investments. Many studies have found a direct relationship between the real rate of interest and economic growth (Lanyi, A. and R. Scacaglu, 1983; Gupta, K. L, 1986; Koyck and Hooft Welvaars, 1960; Matthews, 1960; Sen, A. 1971). In the case of India also, it has been stated that "... higher real rates of interest seem to promote both financial and total savings...financial savings promote investment through the provision of bank lending to the private sector and higher deposit rate promotes investment through facilitating self-financed capital accumulation" (Athukorala, 1998).

Financial liberalisation leading to high interest rates is expected to channel savings to their most productive uses.

The positive relationship between the real rate of interest and economic growth may hold true as long as the former reflects the productivity of investment. The optimum real rate of interest in the economies growing at six to eight percent per annum should be higher than that of the advanced economies growing at two to three percent (Brahmananda, 2000). In India the real rate of interest has remained high to contain capital outflow on

Increase in procurement prices is not being reflected in market prices of agricultural commodities.

account of rise in risk and uncertainty in the aftermath of liberalisation. The rise in risk and uncertainty can be attributable to many factors like communal violence, rise of terrorism, political instability, the Kargil War, possibility of war between India and Pakistan etc. At any point of time, investment not only depends on real rate of interest but also on the expected profitability of investment. Keynes called the latter as the Marginal Efficiency of Capital (MEC) which is highly volatile and driven by hopes and fears, optimism and pessimism. The MEC has been fluctuating due to high risk and uncertainty and real shocks in the Indian economy. As a result the usefulness of interest rate policy to influence the volume of investment has been limited. The Keynesian Effect has failed to operate because of the existence of liquidity trap. The nexus between money supply, inflation and income elasticity of demand for money can elucidate it. The 17.4 percent average growth rate of money supply during 1994-95 to 1999-2000 has been absorbed on account of the decline in the income velocity of money from 2.2 percent in 1994-95 to 1.8 percent in 1999-2000. The high growth rate of money supply has been accompanied by a low rate of inflation but has had little positive impact on the growth rate of output.

The Keynesian Effect has failed to operate because of the existence of liquidity trap.

The explanation of current recession in India has, therefore, to go beyond interest rates policy. The following plausible factors can help us to understand it.

(1) The agricultural production has been highly volatile and has had a declining trend during 1990s in general and second half of the 1990s in particular as compared to 1980s (See Tables 1, 6 and 7). The impact of agricultural production on the pace of industrialisation through its linkage effect is quite well-known (Patnaik, 1994; Raj, 1994; and Vaidyanathan, 1994). In India, the consumption demand to a large extent depends on agricultural production. The agricultural sector employs 60 per cent of total labour force and contributes 26 per cent of the total gross domestic product. The causality runs from the agricultural sector to industrial sector. The expansion of agricultural sector has three advantages: (1) it creates greater employment opportunities for the rural poor; (2) it can alleviate poverty in rural areas by increasing both the availability of food as well as purchasing power; and (3) it creates a large domestic market for industrial products. The last one is probably most important so far as the linkage effect is concerned because the demand for industrial products increases with the increase in agricultural production. It is estimated that a 10 percent increase in agricultural output would increase industrial output by 5 percent and urban workers would benefit by both increased industrial employment and price deflation (Rangarajan, 1988). Therefore, the industrial sector is affected severely if the agricultural sector doesn't grow sufficiently.

Table 3: Average Growth Rates of Industrial Production by Use-Based Classification (Percentages) (Base: 1993-94 = 100)

Year Sector (Weight)	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-2001
Basic Goods (35.51)	9.6	10.8	3.0	6.9	1.6	5.5	3.9
Capital Goods (9.69)	9.2	5.3	11.5	5.8	12.6	6.9	1.8
Inter-mediate Goods (26.54)	5.3	19.4	8.1	8.0	6.1	8.8	4.7
Consumer Goods (28.36)	12.1	12.8	6.2	5.5	2.2	5.7	8.0

Source: Same as in Table 1.

As far as the level of income of the farmers is concerned, it should have somewhat stabilised on account of the rise in procurement prices inspite of low agricultural production. For example, the agricultural price index as a percent of the manufacturing price index has risen from 116.4 in 1991-92 to 128.9 in 2000-01. But the increase in procurement prices is not being reflected in market prices of agricultural commodities due to the nature of the agricultural commodity market. The benefit of the increase in procurement has not been reaching a large number of small and marginal farmers. The existence of the interlinked contracts in agricultural commodities markets force farmers (particularly small and marginal farmers) to accept a sub-optimal price that is much lower than the economic and market determined price (Gangopadhyay, 1994). Inter-linkages arise out of the agrarian contracts between credit, factor, and product markets. For example, a farmer is said to be adversely affected by factor-product market interlinkage if he borrows from a large farmer and is forced to sell his product at a price much below the existing

Table 4: Selected Growth Rates And Ratios of Selected Non-Government Non-Financial Public Limited Companies, 1991-92 to 1999-2000.

Year	Sales %	Value of Production %	Gross Profit %	Profit after Tax %	Sales to Gross Fixed Assets %	Gross Value Added to Gross Fixed Assets %	Gross Profit to Total Net Assets %	Profit after Tax to Net Worth %	Dividends to Net Worth %
	1	2	3	4	5	6	7	8	9
1991-92	19.0	19.4	22.2	6.5	139.3	35.0	10.8	13.9	4.9
1992-93	12.2	12.6	6.6	–1.5	135.5	33.7	10.7	12.0	4.5
1993-94	15.4	12.7	22.5	68.6	123.5	30.0	9.5	9.4	3.9
1994-95	21.1	22.8	32.9	60.9	119.9	28.7	9.5	12.0	3.9
1995-96	23.7	24.5	23.3	23.9	120.9	29.5	10.2	14.4	4.0
1996-97	12.2	9.3	1.2	–24.6	122.7	29.9	10.9	14.4	3.8
1997-98	7.5	8.1	–2.8	–13.7	113.4	27.3	9.5	9.8	3.4
1998-99	7.2	6.3	–2.9	–18.6	108.7	24.3	8.0	7.6	–
1999-00	11.4	12.3	11.1	21.0	96.4	22.9	7.2	5.9	2.8

Source: (a) Reserve Bank of India, Private Corporate Business Sector in India, Selected Financial Statistics from 1950-51 to 1997-98, Mumbai, 2000.

(b) Reserve Bank of India, Monthly Bulletin, Finances of Public Limited Companies, 1999-2000, June 2001.

market price. Similarly, geographically segmented markets for agricultural commodities also force farmers to accept a price level that is lower than the market determined price level. Hence, given the prices of non-agricultural products, the farmers' purchasing power has been deteriorating. Moreover, the share as well as the growth rate of farm employment hinges directly on agricultural production. The share of farm employment in the total private and public sector employment has declined from 7.3 percent in 1992 to 5.11 and 4.93 per cent in 1997 and 1999 respectively (Bhole and Dash, 2002).

The poor agricultural performance coupled with high food prices has worsened the industrial production during the later half of the 1990s. The rural income elasticity of demand can be divided into (1) income elasticity of food demand and (2) income elasticity of non-food demand. Given the level of disposable income, a certain proportion of income is spent on non-food products. If food prices increase the rural poor are bound to shift their demand away from non-food to food articles. This has happened in India because of the policy of curbing the subsidy bill. The Composite Price Index of Agricultural Production has risen faster than both the Consumer Price Index of Industrial Workers and General Wholesale Price Index. The Price Index of Agricultural Production has risen by 124 percent between 1990-91 and 2000-01 whereas Wholesale Price Index has risen by 111.17 percent during the same time period. This has also led to poor off-take of food grains when food stocks have been the highest. The total food stock in India increased to 58.0 million tonnes by January 2002

Table 5: Industrial Proposed Investment And Employment, 1995 to 2000

Year	Proposed Investment (LOIs + IEM) (Crores)	Proposed Employment (LOIs + IEM) (Nos.)
1995	139774	1205588
1996	103210	876873
1997	61907	617667
1998	60659	547541
1999	129719	494483
2000	73374	442114

Note: LOIs indicates Letter of Intents and IEM indicates Industrial Entrepreneur Memorandum.

Source: Same as in Table 1.

Table 6: Annual Average Compound Growth Rate of Agricultural Production (%)

	1980-81 to 1989-90	1990-91 to 2000-01
All Crops	3.19	1.73
Total Food Grains	2.85	1.66
Rice	3.62	1.79
Wheat	3.57	3.04
Coarse Cereals	0.40	0.06
Pulses	1.52	–0.58
Non-Food Grains	3.77	1.86

Source: Same as in Table 1.

(32.4 and 25.6 million tonnes of wheat and rice respectively), whereas the minimum food stock norm is only 16.8 million tonnes of food grains (8.4 million tonnes of wheat and rice each).

The decline in rural poverty has been arrested, there has been a widening of rural-urban income disparity, and the annual growth rate of rural per capita expenditure has declined during 1990s. The rural poverty ratio had declined to 33.70 per cent in 1989-90 from 45.65 per cent in 1983, but it has increased to and remained at about 38 per cent during 1990s. On the other hand, the urban poverty ratio has declined to about 34 percent in 1990s from 36 percent in 1989-90 (Gupta, 1999). The widening rural-urban income disparity is a matter of serious concern. A myriad of factors like low agricultural growth rate, a rise in relative prices of food, a decline in developmental public expenditure, a decline in non-agricultural employment, low investment in rural roads and agricultural R & D are relevant in this context (Sen, 1996 and Fan et al 1999).

The industrial growth rate has also declined because of the type of economic reforms in general and the trade reforms in particular which have been carried out since 1991. The trade reforms consisting of freer access to foreign capital and technology, abolition of import licensing on most of the tradables, phased reduction of tariffs, and removal or reduction of quantitative restrictions on imports. The demand for industrial products comprise domestic and external demand. Any change in industrial production can be either on account of a change in domestic demand or external trade or a combination of both. A change in either export or import of any industrial product can have some impact on the domestic production and employment of the respective industry. An import of a machine reduces the activity not only in a machine-making industry but also in other industries which supply inputs to that industry. The degree and the speed with which this happens depends on the strength of industrial linkages. Nambiar et al (1999) have estimated the effect of import liberalisation on value added and employment in manufacturing sector in India. According to them, trade has been one of the root causes for crippling Indian industry. The industrial production has not only declined but also its composition has undergone a drastic change in the recent past. The share of capital and intermediate goods sector in total industrial production has declined from 68.63 per cent in 1960-66 to 28.15 per cent in 1990-98 and that of consumer goods sector has increased from 31.38 per cent in 1960-66 to 52.45 per cent in 1990-98 (Chaudhury, 2002).

Trade has been one of the root causes for crippling Indian industry.

The gradual removal of quantitative restrictions on imports of various items through Open General Licence (OGL) system due to Indo-US agreement has adversely affected many small-scale and tiny industries. Many small-scale and tiny industries have either closed down or running with low capacity utilisation, or they have switched over to other kinds of activities, reduced the number of working shifts. Jaina Time industry which had a turnover of 9 crores and had employed 900 workers has been closed down. Other units that have already been closed down include Bifora, Allwyn, Timestar, and Action. The current capacity utilisation in watch and toy industries has come down to 25 percent. All small-scale and tiny industries which were producing wall clocks, alarm clocks, watches have switched over to importing smuggled watches, fixing glasses on them, encasing them and selling them in the grey market. Jewel Plastics which was previously working three shifts is currently operating only one shift. All these can be attributable to dumping, underinvoicing of imports, price and quantity differentiation, and smuggled imports that are, in fact, the result of import liberalisation. The growth rate of the number of units of small-scale industries has declined from 7.9 percent in 1992-93 to 5.0 percent in 1999-2000. The growth rate of exports of small-scale industrial sector has dwindled to 5.0 percent in 2000-01 from 14.8 percent in 1994-95. The growth rate of output of small-scale industries that had shown an initial increase from 7.1 percent in 1993-94 to 11.3 percent in 1996-97 has declined to 8.1 percent in 2000-2001. Similarly its growth rate of employment that had shown an initial increase from 4.1 percent in 1993-94 to 4.8 percent in 1996-97 has declined to 4.0 percent in 2000-01 (Economic Survey, 2001-2002).

The growth rate of exports of small-scale industrial sector has dwindled.

The growth rates of both the workers (who are employed in the manufacturing process, or any other kind connected with the manufacturing process) and total persons employed (workers, working proprietors and those who hold supervisory or managerial position), respectively, have declined in the latter half of the 1990s (See Table 8). India is a country with surplus labour. Therefore, it is desirable that labour-intensive industries should grow and the wage inequality should decline. But the share of labour-intensive industries in the ag-

gregate value added and employment, respectively, has gone down in 1997-98 as compared to 1990-91. The growth rate of output (value added) of capital-intensive sector has been higher than that of the labour intensive sector (Chaudhury, 2002). There has also been a marginal widening of wage differential between skilled and unskilled workers (Nambiar et al, 1999). The rise in capital intensity i.e. rise in real net fixed capital stock per worker can occur either because of technological upgradation or the substitution of capital for labour. But in India, in a number of sectors accounting for more than half of the total output, an increase in capital intensity between 1990-91 and 1997-98 has occurred due to the substitution of capital for labour rather than a general technological upgradation. It is well-known that in the cotton textile industry, the mill owners have been cutting production costs by reducing employment (Dhanraj, 2001).

The trends in and the structure of employment-unemployment, and the real wage rate during the reform period need to be examined. The National Sample Survey Organisation (NSSO) provides employment-unemployment data according to activity status: Usual Status, Current Weekly Status, and Daily Status. The employment rate, i.e., the number of persons per one thousand population, has declined in each of the above categories in rural, urban and all-India categories during the 1990s. The share of self-employed and regular wage earners has declined and the casualisation of workers has increased during the 1990s (Bhole and Dash, 2002).

Table 7: Indices of Agricultural Production (Base: Triennium Ending 1981-82 = 100)

	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-2001
All Commodities	160.7 (–2.6)	175.7 (9.3)	165.3 (–5.9)	177.9 (7.6)	175.6 (–1.3)	163.9 (–6.6)
Food Grains	146.1 (–6.2)	160.9 (10.1)	155.7 (–3.2)	165.2 (6.1)	169.7 (2.7)	157.5 (–7.2)
Rice	154.8 (–5.9)	164.4 (6.8)	166.0 (0.9)	173.0 (4.2)	180.3 (4.2)	170.7 (–5.3)
Wheat	176.4 (–5.6)	197.0 (11.7)	188.5 (–4.3)	202.5 (7.4)	217.0 (7.2)	195.4 (–9.9)
Coarse Cereals	100.2 (-2.9)	118.2 (17.9)	104.9 (–11.2)	108.1 (3.05)	104.8 (–3.05)	109.0 (4.0)
Pulses	121.0 (–11.9)	140.1 (15.8)	126.9 (–9.4)	145.8 (14.9)	132.1 (–9.4)	105.4 (–20.2)
Non-Food Grains	185.4 (2.5)	200.9 (8.4)	181.6 (–9.6)	199.4 (9.8)	185.6 (–6.9)	174.8 (–5.8)

Note: Figures in brackets indicate growth rate over the previous year.

Source: Same as in Table 1.

The credit-deposit ratio has declined consistently throughout the period of economic contraction.

Table 8: ASI Manufacturing Registered Sector Employment

Year	No. of Workers	Annual Growth Rate	Total Persons Employed	Annual Growth Rate
1989-90	5517800		7096492	
1990-91	5500907	–0.31	7126099	0.42
1991-92	5513561	0.23	7176184	0.70
1992-93	5816352	5.49	7624563	6.25
1993-94	5797102	–0.33	7612797	–0.15
1994-95	6033669	4.08	7890907	3.65
1995-96	6603790	9.45	8719814	10.50
1996-97	6526360	–1.17	8502192	–2.50
1997-98	6521534	–0.07	8462263	–0.47
1998-99	6242983	–4.27	8403551	–0.69

Source: Chaudhuri (2002).

(3) The contraction in industrial growth rate can also be attributable to the co-ordination failure among economic agents like households, corporates, banks, and the government. Co-ordination among economic agents depends on confidence and expectations about the future economic activity which, in turn, depends on a myriad of factors like industrial structure, past performance of the industrial production, nature of technical knowledge, and the policy environment. Writers like Keynes, Lavington, Pigou, and Taussig have laid great stress on expectations in explaining various phases of business cycle. In contrast to Arrow–Debrew's model of co-ordination success in a competitive environment, co-ordination failure is very much prevalent in the present uncertain milieu. Under such circumstances, the most desirable strategies become riskier and economic agents either fail or become powerless. At the same time they are concerned about their individual behaviour and are guided by the existing trade-off between risk and returns. As a result, a risk-dominated sub-optimal, instead of Pareto-optimal equilibrium is attained. The Pareto-preferred outcome is not obtained in an uncertain environment because the individual economic agents cannot internalise the externalities. (Cooper, 1999).

Let us see how the co-ordination failure has emerged among economic agents in India in the latter half of the 1990s. The households and the corporates have misdirected the flows of funds from the most productive sectors to Information Technology, Telecommunications, and Entertainment (ICE) stocks. The share

of market capitalisation of a few ICE stocks in the total capital marketisation has increased from 8.6 percent in 1998 to around 50.0 percent in 2000. This implies that the money has been circulated among only a few ICE stocks in the secondary market at the cost of capital formation. On the other hand, the growth rate of bank deposits has declined from 19.0 per cent in 1997-98 to 17.9 and 13.4 per cent in 1998-99 and 1999-2000, respectively.

Freedom for portfolio diversification and price determination given to the financial intermediaries in the wake of financial liberalisation has given them wider choice in portfolio selection. In the pre-liberalisation era, banks were required to invest a certain proportion of their deposits in government securities under SLR obligations. The SLR has now been reduced from 35 to 25 percent to increase the liquidity of banks. But the investment-deposit ratio (which includes investment in both government and other approved securities) has remained, on an average, at 38 to 40 percent. On the other hand, the credit-deposit ratio has declined consistently throughout the period of economic contraction (from 58.0 percent in 1995-96 to 55.1 percent in 1996-97, 54.1 percent in 1997-98, and 51.6 percent in 1998-99). The annual rate of growth of bank credit, on an average, has declined from 9.4 percent in 1970s and 5.8 percent in 1980s to 5.3 percent in 1990s (See Fig. 4). This has happened due to both demand and supply factors. According to the industrialists, the high cost of credit has discouraged them from borrowing from the banks and financial institutions. At the same time, it is also true that banks and financial institutions have shown reluctance to lend to sectors such as agriculture, small-scale industries, rural and small borrowers. This is reflected in the change in the structure of bank credit that has occurred during 1990s. The share of agriculture in total bank credit declined from 13 per cent at the end of March 1994 to 9.3 percent at the end of March 2000. Likewise the share of artisans, village industries and all other small-scale industries in the total bank credit has declined from 12 percent in 1994 to 10.6 percent in 2000. Put it differently, the share of all institutional categories constituting the 'household sector' (i.e., other than the public sector and private corporate sector) in the total bank credit has significantly declined from 54 per cent in March 1994 to 37 per cent in March 2000. Thus, a decline in the credit-deposit ratio and a change in the structure of credit might have contributed to the industrial recession.

Banks and financial institutions have shown reluctance to lend to sectors such as agriculture.

Conclusions and Policy Suggestions

The recession appears to have been caused by low farm employment, low agricultural production, high food prices, income inequality, large non-farm unemployment, change in the composition of industrial production in favour of consumer durables and against basic and intermediate products, closing down of many small-scale and tiny industries, substitution of capital for labour, trade reforms in general and import liberalisation in particular, and co-ordination failure among the economic agents because of an increase in risk and uncertainty. It is unlikely that interest rate has been a significant causal factor behind industrial recession.

The potential output in the industrial sector can be produced in a sustainable manner if both the farm and non-farm employment opportunities increase to a much greater extent. By encouraging the off-farm activities like agro-based as well as small and medium industries which are highly labour-intensive, employment opportunities can be created for the rural poor to a much greater extent. The agricultural growth potential can be harnessed by undertaking public investment in irrigation, power, transportation, and agricultural research. Similarly, adequate institutional credit needs to be provided to small and marginal farmers. Some institutional reforms like the redistribution of land in favour of the landless and marginal and small farmers are needed as the existing agrarian structure is not conducive to the utilisation and development of productive potential in agriculture in a sustained way. The capital and intermediate goods industries need to be given a priority on account of their large linkage effects on income and employment. There is also an urgent need to improve the state of expectations and confidence (business optimism) by taking appropriate policy measures to reduce the risk and uncertainty so that the co-ordination failure among the economic agents can be minimised.

The interest rate reduction alone cannot revive the Indian economy. In fact, further interest rate cuts may have a number of adverse effects, viz., it may reduce the gross domestic capital formation by reducing savings and net capital inflows, enhance financial instability through portfolio readjustment in favour of speculative financial assets, increase inequity in the returns on various financial assets, have adverse impact on exchange rate management, reduce the purchasing power of medium, low, and fixed income earners, and initiate

the reversal in price stability. It may be remembered that a continuous interest rate reduction in the past four years has had little favourable impact on the performance of the industrial sector in India.

References

Athukorala, P. (1998), "Interest Rates, Savings and Investment: Evidence from India" Oxford Development Studies, Vol-26, No-2, pp. 153-169.

Bhole, L. M. (1998), "Indirect Vs Direct Systems of Business Finance: Theory and Evidence" International Journal of Development Banking, Vol-16, No-2, pp. 13-27.

Bhole, L. M. (1999), Financial Institutions and Markets, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Bhole, L. M. and Dash, P. (2002), "Employment and Unemployment in India During 1970s to 1990s" The Indian journal of Labour Economics (Communicated).

Brahmananda, P. R. (2000), "Washington Consensus-II; Fall out of Interest Rates, Trade Policies" The Business Line, October 28.

Chaudhuri, S. (2002), "Economic Reforms and Industrial Structure in India" Economic and Political Weekly, Jan 12, pp.155-162.

Cooper R. W. (1999), Coordination Games Complementarities and Macroeconomics, Cambridge University Press, Cambridge.

Dhanraj, P. P. (2001), "Impact of Trade Unions, Employment and Technology on Wages", Economic and Political Weekly, December 29, pp 4846-4850.

EPW Research Foundation. (2001), "Structural Deterioration of Banking Development" Economic and Political Weekly, November 24, pp. 4330-4336.

Fan, S. et. al. (1999), "Linkages Between Government Spending, Growth, and Poverty in Rural India" Research Report No. 110, International Food Policy Research Institute, Washington D.C..

Gangopadhya, S. (1994), "Some Issues in Interlinked Agrarian Markets" in Kausik Basu (Eds), Agrarian Questions, Oxford University Press, New Delhi.

Goyal, A. (1997), " Financial Reforms: Why Interest Rates Must Be Kept Low", International Journal of Development Banking, Vol-15, No-2, July 1997, pp. 15-26.

Government of India, Economic Survey, Various Issues.

Gulati, A. and Bathla, S. (2001), "Capital Formation in Indian Agriculture" Economic and Political Weekly, May 19, pp. 1697-1708.

Gupta, K.L. (1986), "Financial Development and Economic Growth in India and South Korea" Journal of Economic Development, Vol-11, No-2, pp.41-62.

Gupta, S. P. (1999), "Trickle Down Theory Revisited: The role of Employment and Poverty" V. B. Singh Memorial Lecture, 41st Annual Conference of the Society of Labour Economics, IGIDR, Mumbai, Nov. 18-20.

Haberler, G. (1964), Prosperity and Depression, George Allen and Unwin Limited, London.

Keynes, J. M. (1936), General Theory of Employment, Interest and Money, Macmillan, London.

Koyck, L. M. and Maria J' t Hooft-Welvaars (1966), "Economic Growth, Marginal Productivity of Capital, and the Rate of Interest" in F. H. Hahn and F. P. R. Brechling (eds), The Theory of Interest Rates, Macmillan, New York.

Lanyi, A. and R. Scacaglu (1983), "Interest Rate Policies in Developing Countries" Occasional Papers, No-22, IMF, Washington D.C.

Matthews R. C. O. (1960), "The Rate of Interest in Growth Models", Oxford Economic Papers, Volume 12, pp.249-268.

Nambiar, R. G. et al. (1999), "Is Import Liberalisation Hurting Domestic Industry and Employment?" Economic and Political Weekly, February 13, pp.417-424.

Patnaik, P. (1994), "Disproportionality Crises and Cyclical Growth: A Theoretical Note" in Deepak Nayaar (Eds) Industrial Growth and Stagnation, Oxford University Press, Bombay.

Patnaik, P. (1999), "The Performance of the Indian Economy in the 1990s" Social Scientists, Vol-27, No. 5-6, May-June, pp. 3-16.

Radhakrishna, R. (2002), "Agricultural Growth, Employment and Poverty" Economic and Political Weekly, Jan 19, pp.243-250.

Raj, K.N. (1994), "Growth and Stagnation in Industrial Development" in Deepak Nayaar (Eds) Industrial Growth and Stagnation, Oxford University Press, Bombay.

Rangarajan. R. (1988), "Agricultural Growth and Industrial Performance in India" Research Report 33, International Food Policy Research Institute, Washington D.C.

Reserve Bank of India, Handbook of Statistics on Indian Economy, 2000, Mumbai, 2001.

----------Monthly Bulletin, Various Issues.

---------- Private Corporate Business Sector in India Selected Financial Statistics from 1950-51 to 1997-98, Mumbai, 2000.

Sen, A. K. (1971), "Interest, Investment and Growth" in Amartya Sen (eds), Growth Economics, Penguin Books, Harmondsworth.

Sen, Abhijit. (1996), " Economic Reforms, Employment and Poverty: Trends and Options", Economic and Political Weekly, Vol-31, Nos. 35, 36, and 37, pp. 2459-2477.

Sundaram, K. (2001), "Employment-Unemployment Situation in the Nineties" Economic and Political Weekly, March 17, pp. 931-940.

Vaidyanathan, A. (1994), "Constraints on Growth and Policy Options" in Deepak Nayaar (Eds) Industrial Growth and Stagnation, Oxford University Press, Bombay. □

Feature

Knowledge Management in Bio-Pharmaceutical R&D

Mohan R.K. Nimmagadda & B.V.L.S. Prasad

The Post merger industrial behaviour of the Biotechnology & Pharmaceutical industries, which are characterised by high-end Research and Development activities, is playing a pivotal role towards Bio-Pharmaceutical sectoral growth and development. Synchronisation of Systems & Processes with the available organisational Human resources and Intellectual capital would be an ideal attempt to collectively bring out the best knowledge sharing practices, which are of prime importance for the industry's productivity and profitable sustenance. This paper attempts to understand and estimate the importance of R&D based knowledge in Bio-Pharma organisations and use of knowledge sharing as a strategic option in minimising research risk and enhancing organisational growth. It also tries to identify and design people supportive KM systems and processes, towards long term productivity and organisational sustenance.

Mohan R.K. Nimmagadda is Centre Director, CBABM-Siva Sivani Institute of Management and B.V.L.S. Prasad is Director and Chief Technical Officer for Helix Genomics Pvt. Ltd.

Coupled with the existing Informatics initiatives for Knowledge Management lies the impact of science that is the heart of any R&D in Biotechnology & Pharmaceuticals. Post Human Genomics stands to revolutionise and further fragment the industry. The multifold developments in knowledge management would support and drive the activities of Biotechnology & Pharmaceutical R&D towards sustainable productivity.

Introduction to Industry – Trends & Status

Indian Biotechnology & Pharmaceuticals industry is currently being rated as the most promising sector for growth and industrial development. Operating currently at Rupees 13 billion per annum turnover and growing at 12% - 15% per year, with the introduction of the Indian Patent Act (IPA) and Drugs Price Control Order (DPCO) major Indian Bio and Pharmaceutical firms have shown tremendous growth and potential to future development through Research and Development.

India has the inbuilt advantage of producing drugs through Biotechnology & Pharmaceuticals at competitive cost but accounts for only 1.3 per cent of the global Bio-Pharmaceuticals production markets. There are about 26,000 Biotechnology & Pharmaceutical companies operating in Indian presently and this vast manufacturing base has an output of 300 to 500 bulk drugs and about 15000 to 20000 formulations every year.

Emergence of Life Sciences based technologies, processes and products have changed the way Bio-Pharmaceuticals are produced – from Chemical Process & Reverse engineering to making them by picking up proteins whose functions are already known. Increased investment in Research & Development, alliances, joint ventures and biomedical applications by the Indian companies in R&D account only for 3-4% of the sales.

Most of the Biotechnology based activities in India are concentrated within the rigid fences of the Pharmaceuticals or Agricultural companies. Indian Biotechnology firms are moving towards joint ventures and collaboration efforts in areas like R&D, Manufacturing, Field-testing, Clinical trails and Marketing.

With the opening up of Human Genome Map (HGM), it is expected that the companies, which can use the genetic knowledge for new drug development, and those, which can control microorganisms for drug production, will dominate the future of Biotechnology & Pharmaceutical industry. It is to be noted here that the Biotechnology & Pharmaceutical companies could leverage this to take a greater slice of the future global market for the post human genome-based drugs.

Commercial Product Development-Advantage in India: Though most of the human resources have been trained in research areas, highly skilled Techno-scientific Professionals are require for supporting the commercial product development and for accurate monitoring of the field and clinical data. Typically, the commercial Biotechnology & Pharmaceutical activity is Knowledge, Research, Capital and Human (KRCH) resources intensive, whereas the Product development Life Cycle (PdLC) undergoes uncertainties, and involves battles over patents and intellectual property issues.

Regulatory guidelines and Product Safety compliance, acceptance of Product and other related issues pose very high Field-Entry Barriers and make it one of the Key areas of Management focus for improvement. It is estimated that the Cost of Innovation for the therapeutic Biotechnology & Pharmaceutical Products in India is much lower in comparison, about US$250 million or even lower. The industry while developing its capabilities should decide whether to invest in developing newer technologies and products or provide development based services so as to collaborate in clinical trials for Biotech medicines or field studies for Agri-Biotech products.

Regulatory guidelines and Product Safety compliance, acceptance of Product and other related issues pose very high Field-Entry Barriers.

Project-Product Knowledge: A successful project to discover and develop a new Biotechnology & Pharmaceutical molecule may take 12-15 years of Productive innovation and involve large number of people from both inside and outside the organisation like Contract Researchers, Hospitals, etc. And for every project that is successful, there may be a hundred that were dropped at various stages of lab research and industrial scale up for commercial development.

The Decision Support systems or the expert systems would enable data interface according to the functional groupings within the organisation that has generated the data. Obtaining information on all aspects for a single project, especially the decisions that were made and conclusions that were reached, are often difficult or impossible. Knowledge Management practices integrate Data trafficking across an organisation which would increase the volume of the generated data and its availability, but often can reduce the accessibility of project specific information and knowledge from the Information Jungle.

Knowledge Management practices integrate Data trafficking across an organisation.

Biotechnology & Pharmaceutical projects cut across the functional groupings within a company where in the project is managed in a complex and matrix relationship. Some companies have implemented corporate intranets to make information available to their staff. While these efforts work at first, the results typically spiral out of organisational control and the benefits perceived by users are quickly swamped.

Lack of networks and/or disfunctioning of collaborative networks and inflexibility towards the changing environment, and more importantly, lack of incentive based structure for conducive exploitation of laboratory research are the major bottlenecks for R&D growth and development. Generation of Combinatorial pediatrics and vaccines for various infectious diseases have the world's largest demand markets along with the various recombinant-DNA based proteins.

The business of Biotechnology & Pharmaceuticals involve identifying potential research areas, product targets, and long-term investments in R&D, Basic drug discovery research, Intellectual property development, Knowledge management, Technology transfer and Product scale up for commercialisation. The strategic approach in effective management of Bio-Pharma business in India would be to invest in appropriate research areas, Intellectual assets and Knowledge management technologies and practices.

Drug Research and Development

The success of the large-scale Biotechnology & Pharmaceutical companies in bringing Drugs to Market (D2M) and growing revenues have generated high stakeholder expectations for the future. For R&d leaders, this has meant rising pressure to deliver more, higher-value compounds to the market. Research in this area indicates that to maintain a leading position in the industry, companies will soon require four to six New Drug Applications (ANDA) per year to be convertible to Blockbuster drugs at the end of the Development cycle time (Fig. 1). It is, however, becoming increasingly difficult to meet this objective by scaling up traditional approaches.

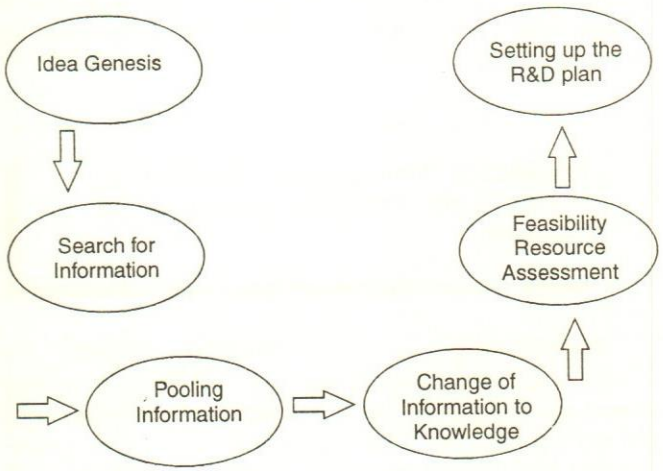


Fig. 1. The Drug/Product Development Life cycle

Competition and uncertainties in the markets present both opportunities and threats to Biotechnology & Pharmaceutical companies. This discontinuity makes it impossible to predict accurately what the business environment will look like even in the near future. However, competition to dominate in the emerging Healthcare, Biotechnology & Pharmaceutical sectors of the world is already fierce with mergers and acquisitions. Research and Development is offering new opportunities by the Rising Technological Discontinuity.

Nevertheless, opportunities for success are there for companies prepared to think otherwise about the 3C's - namely Capacities, Capabilities, and Consumers. There is an expanding mass of credible scientific data available on the Internet, to those with the ability to use it. Knowledge Sourcing (K-Sourcing) for capabilities will become the organisational assets of the future, which Biotechnology & Pharmaceutical companies must now look at and try to create Knowledge Strategies (K-strategies) for owning and trading them. The drug discovery process would be transformed dramatically in the post human genome-sequencing era and would occupy the central state in the modern Biotechnology & Pharmaceutical research world.

> **Knowledge Sourcing (K-Sourcing) for capabilities will become the organisational assets of the future.**

This most spectacular advancement in molecular genetics has been closely associated with Information Technology. The challenge of unraveling the functional meaning of the encrypted human genetics data set will be the most daunting task. Further, the rising Healthcare costs, Mergers and Strategic partnerships, along with high expectations from the markets, have forced most of the multinationals the world over to cut down their R&D costs. On the other hand, Indian Biotechnology & Pharmaceutical industry have increased their R&D expenditure over the years and could do a lot of research in the field of Genomics, to lead discoveries of medicines for genetic diseases.

Scientific collaborations will be initiated and organisations that trade in specific aspects of scientific information and tools to analyse data will emerge in the Biological Markets. Most Biotechnology & Pharmaceutical companies recognised this potential as "data mining" and often used to describe the effort to capitalise on it.

Now, Researchers and Scientists will gain a competitive advantage with respect to the speed and breadth of their research and their increased ability to analyse rather than merely mine information. The challenge lies in improving database design, developing software for database access and manipulation, and data entry procedures to compensate for the varied computer procedures and systems used in different labs.

> **The challenge lies in improving database design, developing software for database access and manipulation.**

Practical Approaches to KM for R&D Environment

Let's consider the typical research environment in a Biotechnology & Pharmaceutical industry, wherein Individuals/Teams of Non-technical and Techno-Scientific workers, work to generate raw data and analyse it.

Biological Drug/Product Target selection requires the collection and analysis of wealth from diverse information containers beyond DNA sequence, and protein structures.

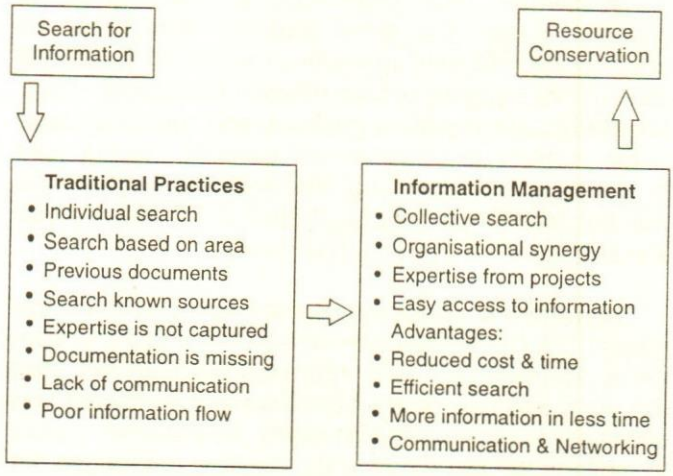


Fig. 2. Basic Information Flow Chart Designing for R&D based KM System

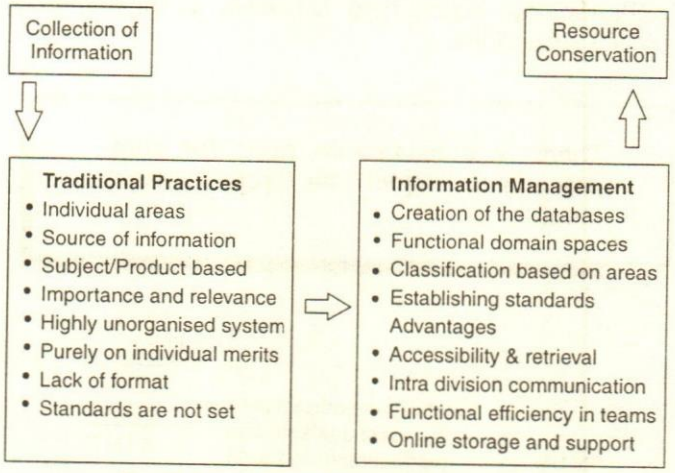


Fig. 3. Search characterisation flow chart for Bio-Pharmaceutical Projects

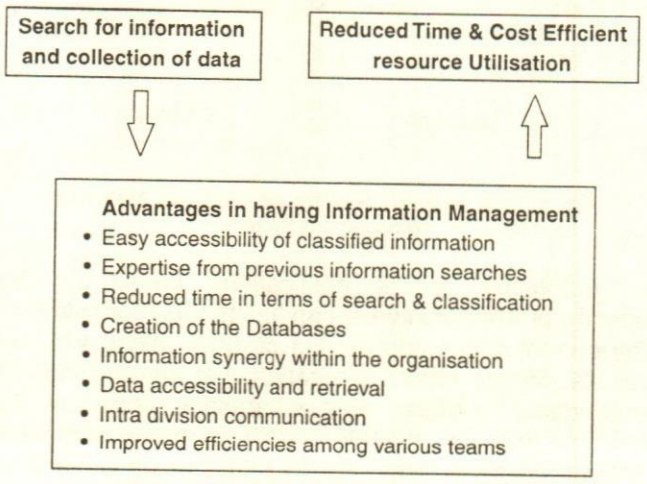


Fig. 4. Information Collection Flow chart

Fortunately, advancements in the Knowledge Platformatics (K-Platformatics) and decision support technologies would enable rigorous and effective business decision processes to be implemented. These processes can provide the much-needed cost effectiveness and efficiency benefits to control the burgeoning costs of new product discovery and development.

There has been much discussion recently of the rapid growth in both quantity and variety of biological data generated in the drug discovery process. In large measure however, the emphasis has been on the capture and storage of data, rather than its application in support of decision-making. Since the data explosion is being driven by automation and new technologies, staff will increasingly concentrate on data analysis rather than its generation. There need to be methods in place to capture the live results of their analyses, and to share those results with colleagues and collaborators, and to use them in support of decision-making. The application of knowledge sharing methods (K- Share) will change the overall discovery process and will be the key to improved efficiency and speed, without which the discovery pipeline will be blocked by accumulated and underutilised data.

The application of knowledge sharing methods (K-Share) will change the overall discovery process.

The re-engineering of the clinical development process over the last decade has set a precedent for what we will see in Product discovery re-engineering. At its core, the Biotechnology & Pharmaceutical Product development is centred on the management of regulatory submissions at each stage and in each country. In contrast, the discovery process is centred on the selection of promising candidate compounds targeted to the most significant markets.

An 'information bin' and decision-support technology approach is required rather than document management system. The BIN should be able to contain files of all types: of not only text documents, but also non-text files such as molecular structures, gene sequence alignments, images, results tables, entry forms, etc. It should also contain links to key internal and external resources, discussion items, key e-mails, external search results, status and summary reports, etc.

The key is managing 'actionable' information: Knowledge management technologies (K-Technologies) would provide the tools required to support the dis-

covery process. To illustrate the need, consider the cancellation of a typical product discovery project. If Data management systems, (DMS) are in place, data generated during the course of the project will still be retained in the organisational/corporate databases.

It is not unusual for a project to be restarted, perhaps after a competitor's lead fails in the clinic trails. However, the project is usually set back substantially because of the important knowledge lost during the hiatus. Similarly, new projects in closely related areas cannot benefit from the 'lessons learned'. However, what the team members in that particular project did with that data would generally be lost as they discard their own paper and electronic files and concentrate on other projects, and as key members, especially the project leaders, may subsequently leave the organisation.

Majority of the times within the R&D divisions in organisations multiple projects keep overlapping. For the team members keeping track of these projects along with cross learning applications from one project to other becomes more important.

The Knowledge Management Assessment here concludes with identifying

- Organisation need for Knowledge and its Management.
- Identification of information flow centres and Capture points.
- Knowledge generation by the individuals & teams and relevance.
- Knowledge storage in Databases and Architectural design.
- Knowledge utilisation by the organisation at a strategic level.
- Knowledge updates and K-Portal for internal K-Management.

Managing the Organisational Knowledge

Most companies pursuing Biotechnology & Pharmaceutical research employ matrix management methods. One dimension of the matrix is comprised of the functional groups (Departments) of scientists and researchers with similar skills, while the other dimension is made up of the projects that cut across the departments and are at different stages. Generally, the generation and storage of data is the responsibility of individual departmental members (e.g. members of the medicinal chemistry department all use and add to the same compound registration database, while the genetics and molecular biologists contribute to a sequence database).

In contrast, most knowledge is generated during projects. Indeed, the same analytical data might be used by two different projects to reach very different conclusions because of their different therapeutic goals. Knowledge management methods add the most value to the projects. In many ways knowledge management in product/candidate drug discovery is synonymous with the Total Organisational Project Life Cycle Analysis and Management Systems (TOPLAMS).

And there is considerable need for comprehensive Project Life Cycle Management—PLCM (Figure 5) from the conception of a new approach, through the drug discovery and new product development, to market and eventually to product market expiry. This need is not just to manage the historic records, but also to facilitate the conduct and management of the current project cycles. Several features of advanced KM systems like TOPLAMS can clearly help, especially as they support project summaries.

There is considerable need for comprehensive Project Life Cycle Management.

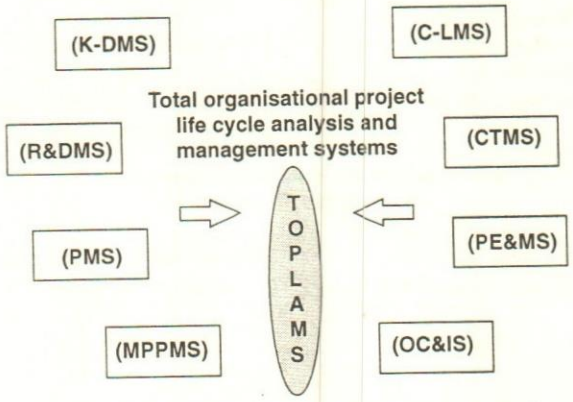


Fig. 5. Total Organisational Project Life Cycle Analysis & Management Systems

Automated e-mail notifications based on the specific profiles of interest can 'push' the information on the current status and project progress along with key results. Simple report generation that automatically or on-demand captures key information from all the projects (e.g. the monthly project executive summary) and produces a single report that can be printed for later review is very helpful. These concepts can be well

integrated with the existing data ware housing protocols and software tools.

KM systems can also bring other useful tools to laboratory management. With the increasing industrialsation of the discovery process, the task and workflow for the management tools are becoming essential. Their value is further increased when they handle not only the assignment of tasks to team members, but also integrate with the experimental systems.

Notification of the completion of an experimental run, automated analysis of results and result-dependent task assignments are few other examples. Classic laboratory information management systems do a reasonable job of managing experimental data but are not designed to provide notification in a way that flexibly 'recognises' organisational structure—in other words, who needs to know what and when. Interfaced with a powerful KM system, these shortcomings can be effectively addressed.

We have identified through KM assessments the components in TOPLAMS are

- Knowledge based Data Management Systems (K-DMS)
- Reporting & Documentation Systems (R&DS)
- Project Management Systems (PMS)
- Molecule research-Project-Product Management System (MPPMS)
- Complete Lab Management Systems (C-LMS)
- Pre clinical/Clinical trails Management Systems (CTMS)
- Performance Evaluation systems - based on project tracking/product roll outs/contributions/ innovation % (PE&MS)
- Organisational communications and intranet solutions. (OC&IS)

These findings can be used to Measure the Knowledge Metabolism i.e., the Knowledge Contribution (K-Anabolism) and Knowledge Consumption (K-Catabolism) for different organisational units which includes:

Knowledge management processes with benchmark ratings to indicate current levels of performance.

- Key business issues critical to future performances.
- Significant assessment findings related to key business issues.
- Specific areas for improvement opportunities that may be used as the basis of action planning or more detailed assessment.

Competitive advantage through Knowledge Management

Companies need to develop multipurpose Biological platforms like TOPLAMS for the seamless integration and transfer of data; information and knowledge to achieve knowledge management for an enterprise-wide informatics based decision support system. The system must facilitate both horizontal and vertical integration of Biotechnology & Pharmaceutical research tools. TOPLAMS system can be used, for example, to capture and disseminate data and information involved in target identification, assay development, screening and lead optimisation, and preclinical development.

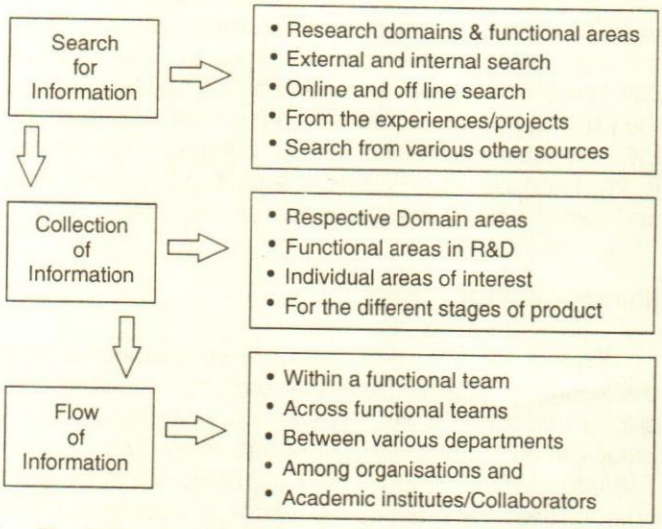


Fig. 6. Benefits of IT Interface in Bio-Pharmaceutical Project

Future success depends on how good a job a company does in selecting targets, developing assays, optimising new drug candidates, and getting them to the clinics before its competitors. The two biggest issues for Biotechnology & Pharmaceutical Companies are knowledge management and the Drug discovery research/development interface. The problem with the discovery/development interface is that what people know in the discovery phase isn't being passed on to the people doing development.

What people know in the discovery phase isn't being passed on to the people doing development

When scientists and companies see the power of data integration and dissemination of information across an organisation, the imperative to get data into an electronic form will be understood. The integration of data allows one to make decisions that must feed back into the design of experiments. So, the next step is to use data integration to drive experiments in a seamless fashion. On the research side of the business, companies are investing in advanced computing technology in order to streamline drug discovery and speed clinical compliance. As competition increases, speed to market becomes more important.

Accelerate the drug development process

Collaboration is going to be the key to a fast and effective drug development process. Today's drug discovery and development teams often span different sites and time zones. But information, insights and data must be exchanged, decisions reached, tasks assigned, and resources allocated and managed in a 24/7 fashion. Full Project Lifecycle Management-TOPLAMS captures the proliferation of information in the context of keeping the intellectual capital within your company. Information is the lifeblood of all projects and, together with data and documents, forms the corporate memory.

Increase in Productivity

Project leaders form the Core of successful drug development teams. Directing projects will require a strong leader with a versatile set of skills and tools. Companies need to integrate the efforts of all their projects and departments. Making the right decisions at the right time for the right reasons will lead to a blockbuster new drug. Decision makers need to have access to relevant information in the proper context. Putting information into context requires many people working together, sharing a common goal and repository of information. It's a new development based on an age-old business principal – if you can't measure it, you can't manage it.

Knowledge – The new leader in business performance

As the genetics of the Humans and Pathogens are well described, target identification is becoming less a process of identifying novel targets and more of identifying important characteristics about those targets before competitors do so. The need for rapid identification of these characteristics and implementation of subsequent discovery efforts make effective target selection the 'front-end' of the on-going industrialisation of drug discovery and development efforts.

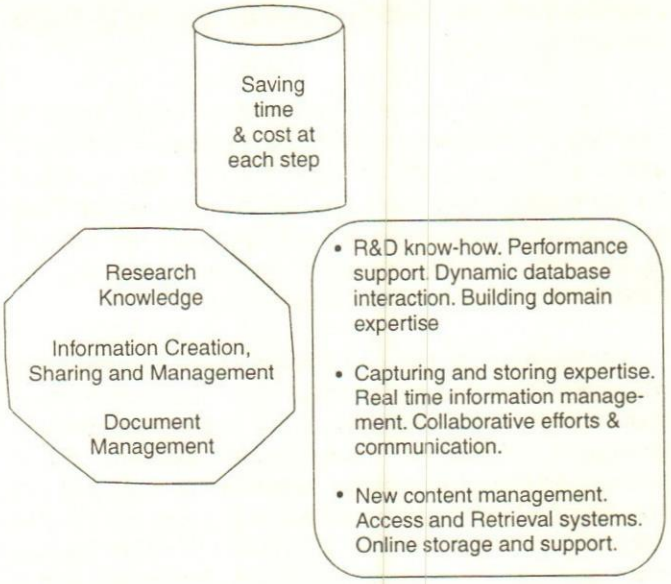


Fig. 7. Organisational Bio-KM Value Chain

The amount of data, information and knowledge that confronts us grows exponentially as the developments in information and communication technology increase their impact on organisations. The ability to capture and utilise information and knowledge enables the creation of improved work techniques, improved processes for delivering value to customers, and increased efficiency. At the same time they magnify the importance of how these assets are leveraged to improve business performance and the risk to competitive advantage if they are neglected.

This is reflected in the value placed on these assets. So called "intangible assets" such as brands, customer "goodwill" and intellectual capital accounted for only 17% of the total market value of corporations in 1978, the remainder being made up of fixed assets such as property, plants, and equipment. By the year 2000, the value of intangible assets had risen to 80%.

Such a dramatic change reflects the fact that after decades of optimising other important business drivers, Management of Knowledge Assets prove by far to be the most powerful lever for increasing performance. Organisations' competitiveness is dependant on how well it manages its "intangible assets" – knowledge about customers and their needs, experienced and well-

Management of Knowledge Assets prove by far to be the most powerful lever for increasing performance.

trained employees and the innovation rate of the organisation itself. Knowledge is driving the Unique Selling Proposition-USP for today's organisations.

Our challenge is to capture, protect, optimise and utilise this unique and valuable asset. The average business experiences a continual loss of knowledge when opportunities to generate and capture this knowledge are missed, or when key employees are lost to the competition. This represents a constant drain on future competitive advantage and profitability. The duration of an assessment depends on the size and the complexity of the organisation, but can generally be completed within a few days for one organisational unit.

KM is an emerging discipline, which would deliver early benefits and also substantial returns in the long term. With the current changes sweeping globally across the Bio-Pharma sector, managing organisational knowledge will be a great challenge and effective management of the same will give individual firms the necessary competitive advantage in the coming years.

Organisations would require managing the knowledge effectively towards improving the functional efficiency. Accountability and the government support for private sector investments in R&D activities, effective collaboration between academia and industry, involvement of industry in policy decision making by the government, focusing on "development", integration of biotechnology into the Biotechnology & Pharmaceutical industry and creating a collaborative long-term competitive agenda. KM is the art of creating core competencies from intangible assets.

Acknowledgement

We sincerely acknowledge the support and encouragement extended by the Management of Helix Genomics Pvt. Ltd and Siva Sivani Institute of Management. We would like to acknowledge our teachers and mentors Prof. Arif. A. Waqif, Dean, School of management Studies, University of Hyderabad and Prof Mohan C Vemuri of Thomas Jefferson State University, Philadelphia.

References

Davenport, Thomas, H., and Laurence Prusak (1998), "Working Knowledge: How Organisations Manage What They Know", Harvard Business School Press, Boston, 5.

Klasson Kirk (1999), "Managing Knowledge for Advantage: Content and Collaboration Technologies", The Cambridge Information Network Journal, Vol. 1, No. 1, 33-41.

Hansen M., N. Nohria and T. Tierney (1999), "What's Your Strategy for Managing Knowledge? "Harvard Business Review, March-April, 106-116.

KPMG, (1998), "The Power of Knowledge", KPMG White Paper & KPMG Knowledge Management Survey Report, KPMG Press.

Teece, David (1998), "Research Directions for Knowledge Management", California Management Review, Vol. 40, No. 3, 289- 292.

Ramesh, Balasubramaniyam and Kishore Sengupta (1995), "Multimedia in a Design Rationale for Decision Support Systems", Decision Support Systems, No. 15, 181-196.

Ramesh, B., and A. Tiwana, "Supporting Collaborative Process Knowledge Management in a New Product Development Team", Decision Support Systems (Forthcoming).

Albert, Steven and Keith Bradley (1997), "Management Knowledge: Experts, Agencies and Organisations", Cambridge University Press, Cambridge, England.

Tiwana, A., and B. Ramesh (1999), "Identifying Knowledge Flow Problems and IT Support Candidates For Process Knowledge Repositories in Product Development Groups", in The Proceedings of SAIS-1999, Atlanta, G.A., 21-24.

Court, A.W. (1997), "The Relationship Between Information and Personal Knowledge in New Product Development", International Journal of Information Management, Vol. 17, No. 2, 123-138.

Nonaka, Ikujiro and Konno Noboru (1998), "The Concept of "Ba"–Building a Foundation for Knowledge Creation", California Management Review, Vol. 40, No. 3, 40-55.

Kaplan, R. and D. Norton (1996), "Translating Strategy in to Action–The Balance Score Card", Harvard Business School Press, Boston.

Von Krogn, G., I. Nonaka and Ichigo (1997), "Develop Knowledge Activists!" European Management Journal, Vol. 15, No. 5, 475- 483.

□

It is best to learn as we go, not go as we have learned.

– Leslie Jeanne Sahler

Feature

E-Commerce: Emerging Trends in India

Ajay Pandit

This article focuses on the role of e-commerce, its application to different areas and the unlimited opportunities it poses for the creation of wealth. Through a survey of eight manufacturing and three service sector firms certain conclusions were drawn regarding the reasons for adopting e-commerce, the problems it poses and the expected role of the government.

Ajay Pandit is Reader, Faculty of Management Studies, University of Delhi. *Paper was accepted for presentation at the XIIth World Productivity Congress 2001, Hong Kong - Beijing.*

E-commerce with its dynamic, rapidly growing, global reach and highly competitive characteristics has thrown open tremendous opportunities for generation of wealth through new on-line businesses. The rate of adoption of internet and its application to diverse areas may, however, enable one to guess a few of the unlimited possibilities for creation of wealth, that can be expected in the near future, through this medium.

The World Wide Web, the multimedia interactive tool of the Internet, is fast becoming as common as the telephone. An estimated 55 million people surf the Web (Green et al, 1998) and on-line traffic has been doubling every 100 days (Ingersoll, 1998). Nevertheless the commercial experience with the Web also continues to be disappointing (Wolff, 1998). The marketplaces that connect buyers and sellers are up and running in many product categories, and are creating value by making trading more efficient. However, according to a study by McKinsey, the experience of early participants suggest that an electronic marketplace can capture savings of 10 to 20 per cent on sales and deliver lower prices for buyers (Barryman et al, 1998).

The impact of internet is also visible in India. In the last few years over $5 billion of venture capital came in for Indian dotcom and information technology firms. With the rise of ISPs like Satyam Info way; portals like rediff.com, indya.com and 123 india.com; e-commerce firms like indiabulls.com, fabmart.com and clickforsteel.com and consumer to consumer sites like bazee.com and bidorbuy.com; the Internet is clearly coming of age in India. Indian entrepreneurs have a once in a life time opportunity to participate in the wealth creation that the Internet has unleashed. However, India still has to go a long way. Not only the e-commerce market is much smaller than in the US and Western Europe, it needs to overcome infrastructure barriers as well [Sawhney & Parikh, 2000]. National Association of Software and Service Companies (NASSCOM) has estimated that the number of Internet connections in India is likely to cross 2.5 million by the end of 2000 [asia.internet.com]. According to the

Confederation of Indian Industry, B2B e-commerce activity in India is expected to increase from Rs. 4.5 billion in the financial year 2000 to Rs. 252 billion in 2005 following the emergence of broadband and improvements in connectivity infrastructure. The total worth of B2C e-commerce activities in India is expected to increase from Rs. 0.5 billion in the financial year 2000 to Rs. 18.82 billion in 2005 (CII, 2001).

In the last few years over $5 billion of venture capital came in for information technology firms.

Several enabling trends suggest that there will be a decisive acceleration in E-commerce over the next few years. They include bandwidth availability and affordability; penetration of modem-equipped PCs; and availability of user-friendly graphical browsers and agent software. In addition, new alliances between gateways, transport providers, financial intermediaries, and Internet access providers are struck every day. With these developments, have come some issues: the adequacy of network speed; transaction security; and billing and payment systems. Internet-based networks have transmission bottlenecks at numerous points that make commercial transactions impractical for many users at present; several transaction security protocols are competing to become the e-commerce standard; and a variety of online payment systems are now being piloted.

Internet-based networks have transmission bottlenecks at numerous points.

Indian firms find themselves in the midst of a new game plan in an arena which is limitless. The way businesses shall be managed has fundamentally changed. Understanding what electronic commerce means, how key technologies will evolve, and what roles players might adopt will be critical to the strategies of companies in a wide range of businesses in the future. The present study seeks to understand the awareness, perception and preparedness of the Indian business community before undertaking an exercise to plot the future of e-commerce in India. The study is primarily focused on B2B e-commerce.

Objectives of the Study

The objective of this survey is to understand the status of e- commerce in terms of awareness and perception of its usefulness. It also attempts to find out what are the facilitators and barriers for adopting e-commerce. Some of the questions which have been addressed in the study are:

- Are Indian businesses aware of e-commerce?
- If so, what do they perceive it as?
- Are they planning to adopt it? If so, when?
- What benefits do they perceive will accrue to them?
- What impediments do they see as hampering this adoption?
- How do they see the role of business partners, industry environment, Indian govt. and the international community in shaping e-commerce?

Methodology

The study followed a survey methodology. A structured questionnaire was developed to obtain the requisite data. Most of the questions had multiple choices. Eight firms, five in manufacturing and three in the service sector (engineering consulting, travel and Non-Banking Financial Company) employing over 100 workers were selected, in and around Delhi. The questionnaires were distributed to the employees representing diverse fields and different positions in the hierarchy. A total of 110 completed questionnaires were received. The study was conducted in January 2001.

Results and Discussions

E-commerce is associated more with accessing new markets.

Businesses associate e-commerce more with accessing new markets, particularly international markets. More than 80 per cent of the respondents were of this opinion. Awareness of e-commerce is still at a rudimentary stage where it is associated more with the internet and new market access. Internationally, B2B transactions have been driving e-commerce markets. Hence concerted efforts need to be made to make organisations aware of potential benefits in conducting B2B transactions like dealing with partners, suppliers, bankers for maintaining accounts, inventory, ordering, invoicing etc. through e-commerce.

E-commerce is a crucial element in strategy.

40 per cent of the respondents rated e-commerce

to be a crucial or substantial part of the company strategy. 39 per cent felt it was not of much significance for the firm's strategy.

Improved customer service is the reason to adopt e-commerce.

Improved customer service, increased productivity/efficiency, access to international markets, were the reasons for adopting e-commerce (82%). It has been perceived that banking, IT and courier/travel/transport will be major adopters of e-commerce in India in the initial stages. Even general manufacturing sectors show good promise for e-commerce usage.

General manufacturing sectors show good promise for e-commerce usage.

Sales/Marketing is the focus area among business functions.

Sales and marketing is the core area for implementing e-commerce across all the industries contacted for the survey (59 per cent). Manufacturing firms emphasise more on Sales/Mktg. while service companies focus more on operations.

E-commerce is happening.

According to 51 per cent of the respondents their firms effected e-commerce transactions every year. 22 per cent said that the rupee value of e-commerce transactions was over Rs. 1,000,000. 49 per cent of the respondents opined that their firms were in the process of gearing up for the show. However most of them were unsure of their future steps despite their beliefs in the advantages of e-commerce. In most organisations, the IT department was the key department in the deployment of e-commerce. This is despite the fact that most organisations had claimed that sales/mktg. functions would be the focus areas for implementation of e-commerce.

The industry feels that the medium is promising.

The industry is optimistic about e-commerce and sees a potential of around 10-12 per cent of their yearly turnover coming from e-commerce over the next two years. Indian businesses are very optimistic about the use of e-commerce and a large proportion considers it as critical to the organisation. On an average, organisations expect 12 per cent returns to be contributed by e-commerce in the next two years. It is currently perceived as a new selling environment which would allow them to access the new/international markets. It is expected to benefit them in terms of improved customer service and increased productivity/efficiency. However, most organisations are not yet clear in terms of the specific returns they wish to get by their usage of e-commerce.

Organisations expect 12 per cent returns to be contributed by e-commerce in the next two years.

Those using IT extensively would take up e-commerce.

Over 82 per cent of the companies feel themselves to be good users of IT. Over 50 per cent of those using or likely to use e-commerce are also amongst those who maintain IT has paid more than expected.

ERP, EDI and Internet are the fastest growing segments today.

25 per cent of the companies surveyed had already implemented the above technologies and 25 per cent were in the process of implementation. 50 per cent do not have security features on their websites.

E-mail, LAN and the company website are present in most organisations covered. Intranet, home pages and ERP have a higher penetration. EDI and extranet are present with only 15 per cent of the organisations. It was also found that those firms that took steps to implement e-commerce or those who had started e-commerce felt that e-commerce had a significant role in their organisational strategy and they also had more than twice the penetration of EDI and Internet than others.

Barriers to acceptance of IT

Lack of skills/training within the company (28%) and lack of funds (24%) are the factors impending the implementation of IT in the industry. This is felt more in medium companies while others complain of lack of vision/thrust from the top. Thus, small companies are often confronted by lack of funds, which hamper the deployment of IT. Medium companies are more bothered by the lack of trained manpower in-house. Large companies tend to be a dissatisfied lot, as they are not getting the expected returns from the usage of IT.

IT is the ladder through which all companies will have to progress to the e-commerce environment. Thus, companies with higher penetration of networking products are more likely to be potential users of e-commerce applications. One of the key barriers identified is the lack of skilled manpower available within the company.

One of the key barriers is the lack of skilled manpower.

Perceived barriers to adoption of E-commerce

The issue, which requires immediate attention, is one of development of a proper commercial and legal system for conducting business electronically (56%). The other key area is the infrastructure (55%). Further, there is an urgent need to cut through the hype and provide a clear picture of what e-commerce can specifically do for a business. Lastly, there is a need to create a more conducive environment with industry initiatives and govt. support.

Expectation from the Indian government

The roles envisaged are as follows:

- Spreading awareness of E-commerce and its benefits.
- Enacting cyber laws.
- Making positive interventions and being a watchdog.
- Developing a strong communication infrastructure.

What role should business partners play?

Concerns on many of the issues were moderate and this has resulted in a middle rating for importance on almost all the issues. However, the concerns are more basic where the partners were requested to use IT in key functions to facilitate e-commerce transactions (45%). Others include efficient delivery systems for products and services and a quality communications system for fast responses.

Emerging Trends

The growth in the B2B segment will be primarily because of the expected increase in Internet based networking companies and an increase in Internet based vendor selection and management activities. The real emerging opportunity in India e-commerce is in providing software solutions and services. The Indian government has already taken key policy initiatives to promote e-commerce in the country. Security for e-commerce is the paramount concern of the Indian businesses. According to the CII, the Indian Internet security solutions and applications market is likely to grow more than 11 times from $6 million to a $68 million by 2005. In light of these emerging trends and future growth potential, it has been stressed that there is need to further strengthen the existing cyber laws under the Indian IT Act. However, to ensure cyber security, Government of India is contemplating a 'National Infrastructure Protection Centre' (NIPC) to keep the vital infrastructure installations including rail and airport reservations, banking and services sectors, electricity and telephones from cyber-crime and attacks [CII, 2001]. Emergence of broadband is likely to increase to the usage of Internet and open new vistas for e-commerce. With the Government allowing foreign direct investment in e-commerce, multinationals are likely to enter the Indian market in a big way. According to the CII-ITC, mergers and acquisitions are also likely to be a significant trend in the short to medium term, which would affect almost all the business categories such as infrastructure providers, website software and service providers and content providers.

Need to strengthen the existing cyber laws under the Indian IT Act.

References

Barryman, Kenneth, Lorraine Harrington, Dennis Layton-Rodin and Vincent Rerolle (1998), "Electronic Commerce: Three Emerging Strategies", Mckinsey Quarterly, Number 1, p. 152.

CII (2001), "Secrets of Electronic Commerce: A Guide for Small- and Medium-Sized Exporters", Confederation of Indian Industry (CII) and International Trade Centre (ITC) UNCTAD/WTO.

Green, Heather, Linda Himelstein and Paul Judge (1998), "Portal Combat Comes to the Net", Business Week, March 2.

Ingersoll, Bruce (1998), "Internet Spurs U.S. Growth, Cuts Inflation", Wall Street Journal, April 16.

NASSCOM: www.asia. internet.com

Sawhney, Mohanbir and Deval Parikh (2000), "The right E-Way, Business World", 25 September, p. 46.

Wolff, Michael (1998), "Burn Rate: How I Survived the Gold Rush Years on the Internet", New York: Simon and Schuster.

□

Feature

Performance Analysis of Opencast Mines – A Heuristics based Approach

Kampan Mukherjee & Chandan Bhar

There exist various performance monitoring parameters or criteria that may represent the performance of a coal mine. The conflicting nature of these parameters makes the performance assessment of coal mines a difficult task. In this paper performance assessment criteria of coal mines are broadly classified as operational and cost parameters. Maximising Agreement Heuristic is used to resolve the conflict among the parameters and to develop a single and consensual rank list of the coal mines. This rank list helps the decision maker to formulate the improvement strategies for mines, keeping in view the best mine as the benchmark. A computer software is developed as a decision aid tool in this performance analysis exercise.

Kampan Mukherjee and Chandan Bhar are with the Dept. of Management Studies, Indian School of Mines, Dhanbad.

With its contribution of nearly 60% in the total commercial energy consumption of the country, coal continues to play a pivotal role in shaping the profile of the national economy of a developing nation like India (Sharma, 2002). Coal is being consumed by a large number of sectors such as power, steel, cement, fertiliser, soft coke, brick, and other industrial sectors, the power sector being the major consumer with 76% share of the total national consumption (Verma, 2002).

More than 90% of national coal production is contributed by two Public Sector Undertakings (PSU) (Bhar, 1994). Unfortunately the performance of Coal India Limited, the largest PSU is not encouraging as per the record of recent past due to poor functioning of some of its subsidiaries (Verma, 2002). This calls for immediate attention on performance analysis issue of PSUs.

Further, in the Indian economy the assessment of a public sector undertaking (PSU) is of utmost importance due its significant contribution to the economy. The assessment of performance of a PSU not only identifies the weaknesses of the organisation but also ensures appropriate action to improve the future performance of the organisation (Bhar and Chattoraj, 2001, and Mathur, 1993).

Thus, in this paper, an attempt has been made to establish a methodology integrating a set of conflicting performance criteria for the opencast mines of a PSU. This assessment of performance will not only improve the performance of each opencast mine but also the performance of the PSU as a whole (Bhar and Chattoraj, 2001). Consensus Ranking Heuristics has been used for comprehensive assessment of performance and the weaknesses of each mine has subsequently been identified. The outcome is expected to contribute significantly to planning, controlling, and benchmarking functions.

Performance Assessment with emphasis on Productivity

The term 'Performance' is generic and its role has been universally accepted in almost all sections across society. The concept of performance can be approached from the viewpoint of the economist, engineer, accountant or manager (Sarkar, 2000). Performance appraisal data set is one of the key ingredients for effective planning and control in any organisation. However domain, dimensions and measurement scales of performance entirely depend on the need and perception of the user/manager/decision maker and also on the object (person, machine, production unit, etc.) for which performance is to be assessed.

Performance appraisal data set is one of the key ingredients for effective planning.

It has been observed that most of the models for performance measurement in mining industry focus only on productivity as the prime index of organisational performance. Zhanxin et al. clarifies that productivity in mining industry depends on the nature of the coal reserves, the degree of mechanisation, management skills, size of work force, environmental conditions and external factors. However, care should be taken to identify some total factor productivity index or its surrogate representation to capture all relevant factors, failing which the measurement would not be a representative performance indicator. For example, labour productivity and cost per tonne, which are the most popular indicators for mining industry represent only partial performance measurements. Ramsay (1989) opines that productivity seems to be one of the key measures of operational performance of an organisation. However Ramani (1989) observes that labour productivity is an indicator of resource utilisation. A rise in labour productivity can be attributed to several factors like high degree of automation, skill development and improved human relation, economies of scale, and unemployment. Kumar and Sadhwani (1992) have described that increased mechanisation in coal industry is reflected by the increased labour productivity measured as Output per Man-shift.

Sink (1986) recommends that measurement and evaluation systems are extremely critical components of the productivity management process. Sink is of the opinion that there are at least seven distinct, although not necessarily mutually exclusive, measures of performance. These seven measures are: i) efficiency, ii) effectiveness, iii) productivity, iv) quality, v) quality of work life, vi) innovation, and vii) profitability. Gold (1982) expresses productivity through financial and utilisation ratios and defines in terms of five specific elements of performance – i) product prices, ii) unit cost, iii) utilisation of facilities, iv) productivity of facilities, and v) allocation of capital resources between fixed and working capital.

Fabricant (1973) refers to productivity as the ratio of the quantity of goods and services produced and the quantity of resources employed in turning out these goods and resources. This definition stresses only on production function incorporating all production factors. Cahen (1961) proposes the total productivity measurement model for French Coal Mining Industry based on the ratio between production and the means employed to obtain it. The heterogeneous outputs of mining industry have been considered by converting them in monetary value.

Mo (1985) optimises productivity through mathematical programming and defines productivity as the relationship between outputs and the aggregated inputs required to produce those outputs. Data Envelopment Analysis (DEA) approach has been applied by IIMC (Ghose et al., 1998) to analyse production efficiency in coal mining industry. A unit can be said to be 100% efficient, if comparison with other units do not provide evidence of inefficiency in the use of any input. Measuring efficiency in the public sector organisation has always remained an area of attention for management experts across the globe. The inputs in this study report are – i) capacity of equipment, ii) consumption of fuel, explosives, spares in monetary terms, iii) consumption of power in million units, iv) direct and indirect labour in man-shift, v) geological variable. Smith and Mayston (1987) have discussed a method of pursuing efficiency in the public sector by comparing the performance indicators for individual agencies, bringing them together on a uniform platform. This study also uses the methodology of DEA to show how the data underlying performance indicators can be used to generate a single measure of efficiency for an agency.

Slater (1991) says it is possible to identify the most appropriate set of performance measures. The use of too many measures may lead to a loss of focus on the performance, whereas too small a set of measures may fail to address all relevant aspects.

The assessment of performance of coal mines is a significantly complex managerial task due to its multi-dimensionality. There exist varieties of performance monitoring parameters that may represent various

dimensions of coal mining activities. The performance of a mine may vary depending on the parameter/criterion chosen for assessment and this conflicting nature of performance assessment makes the assessment process difficult. Thus, the problem can be viewed as a problem of establishing consensus ranking for a set of mines and an attempt may be made to solve it by the following Consensus Ranking Heuristics.

Criteria for Mine Performance Assessment

The above research and study reports reiterate that the key attention for improving performance of public sector coal mines should be on productivity or efficiency. Moreover recent reports on most of Indian PSUs very often focus on poor efficiency and improper resource utilisation. Efficiency or productivity has been considered the key representation of performance of the coal mines under study.

Efficiency or productivity has been considered the key representation of performance of the Coal mines.

Keeping in view the fact that the management of individual opencast mines are at the lowest operational level in the organisational hierarchy, following criteria have been identified as the major operational parameters for assessing their performance.

- Financial efficiency

Efficiency on utilisation of financial resources by the organisation is indicated by the financial efficiency. The following parameters have been considered for computing financial efficiency.

  - Profit per tonne
  - Return on Asset

- Cost efficiency

It indicates the efficiency in utilisation of working capital and also the expenditure of the organisation. Cost efficiency is mainly indicated by total cost per tonne.

- Operational efficiency

Operational efficiency indicates how efficiently the operations of an organisation are being carried out. In case of a coal mine it is essential that it should be able to meet the target production. Further, labour productivity of the mine also indicates the efficiency of various operations. Thus, the following parameters have been selected for measuring the operational efficiency of a coal mine.

- Labour productivity as Output per man-shift
- Achievement of target production
- Despatch efficiency

It was observed during the Sixth and the Seventh Five Year Plans of India that the pit head stock mounted to over 30 million tonnes during March 1985 (Bhar and Mandal, 1990). There was a lack of coordinated approach to the management of production, movement, consumption and stock of coal (Planning Commission, 1979 and 1985). To measure despatch efficiency coal stock as percentage of coal production is considered.

The above operational parameters are used in this study for assessing the opencast mines on a multi-dimensional scale of performance measurement. This will help in segregating good mines from not-so-good ones and then formulating the guidelines for performance improvement.

Further, cost has always been the central issue, which is more so today as government is withdrawing its earlier policy of restrictions and protectionism. In a situation when high quality and low priced imported coal is adversely affecting sales, reduction of cost seems to be the only way out (Sharma, 2002). So among the above operational parameters, cost parameter needs special attention.

Total cost of a mine may be disintegrated to various cost factors in terms of the activity levels contributing to mine costs. Thus, for cost improvement it is necessary to pin point cost factors which require more attention.

This may be treated as the second level of performance assessment with prime focus on cost reductions. The mine cost is being categorised under the following five cost parameters.

- Salaries cost/ tonne
- Stores cost/ tonne
- Power cost/ tonne
- Other expenses/ tonne
- Fixed cost/ tonne

The fixed cost of a mine includes administrative

overhead expenses, interest, and depreciation of mine assets.

The ranking of coal mines on the basis of the performance monitoring parameters will indicate their relative performance. This will also help in identifying the best performing mine in a year and will help the management to take an appropriate decision to improve the performances of other mines of the PSU.

Heuristics-based Methodology

In the pursuit of ranking of a set of mines, each of which is measured by various performance assessment criteria, decision makers often encounter conflicts or in other words, more than one rank list. The more the varieties of criteria, the more there is chance of conflict, as each criteria measures a specific aspect of mine management. Maximising Agreement Heuristics (Beck and Lin, 1983) seems to be an appropriate approach which logically minimises the difference among the rank lists, each reflecting ranking on the basis of a criterion. The resulting rank list represents consensus ranking keeping in view significant objectivity.

A software is developed on Maximising Agreement Heuristics in C language to convert it to a decision aid tool for mine managers. Algorithm for this software is shown below.

Step 1. Arrange the values of different mines in terms of a performance parameter in ascending or descending order depending on the nature of the performance parameter under consideration. Repeat the process for all the parameters under consideration.

Step 2. Create the Agreement Matrix *A*. Set *n* equal to the number of mines. The value of the element a_{ij} of the Agreement Matrix *A* signifies that *ith.* mine has better rank than *jth.* mine in a_{ij} number of parameters.

Step 3. Compute the entries for the positive preference vector *P*, and the negative preference vector *N*, as

$$P_i = \sum_{j=1}^{n} a_{ij} \quad \text{for i = 1,2,3,.....,n and}$$

$$N_j = \sum_{i=1}^{n} a_{ij} \quad \text{for j = 1,2,3,.....,n}$$

Step 4. Any mine having zero entry either in the positive or negative preference vector is first considered for entry into the final consensus ranking. If zero entry occurs in positive preference vector *P*, enter mine *i* in the next available position at the bottom of the consensus ranking. If, however, the zero entry occurs in the negative preference vector *N*, enter mine *i* in the next available position at the top of the ranking.

In either of the cases, remove the column and row effects of that mine from the Agreement Matrix *A*, and go to step 6.

Step 5. If no zero entries exists in *P* or *N*, then examine the $(P_i - N_i)$ for all *i*. Choose the mine *i* possessing the largest absolute difference. If the difference is positive, enter the mine *i* in the next available position at the top of the ranking. If the sign of the difference is negative, enter the mine *i* in the next available position at the bottom of the ranking.

If at any time a tie occurs, i.e., when more than one mine is eligible to enter the same rank in final consensus ranking, the situation may be termed as Rank Redundancy. The tie may be broken in an arbitrary manner.

Once again remove the row and column effects of the chosen mine from the Agreement Matrix *A*.

Step 6. Set $n = n - 1$

Step 7. If *n* is greater than one, return to *Step 2*. If *n* is equal to one, enter this mine in the next available position at the top of the ranking.

Step 8. Select a performance parameter of *Rank 1* mine. Compare its performance value with other mines and identify the improvements expected for other mines with reference to *Rank 1* mine.

Step 9. This comparison will be repeated for all the performance parameters and the expected improvements for other mines are computed.

Salient Features of the Software

The software has been developed using C language and has been executed in DOS environment of Pentium III computer (Bhar and Chattoraj, 2001). The software is generic in nature and it can be used to assess the performance of any set of mines taking into consideration the operational parameters and also the cost parameters.

The output of the software handles Rank Redundancy situation by producing rank values in two lists –

"Rank" and "Final Rank". "Final Rank" list displays the rank redundancy by showing same rank value for the mines having same rank, whereas "Rank" list breaks tie arbitrarily by showing different rank values for all the mines under consideration.

In addition to consensus rank list, the software output also includes:

a) Parameter-wise improvement expected for all coal mines.

b) Mine-wise improvement expected in different performance parameters.

The software written in C language is very user-friendly and menu driven. Thus to execute the software the user has to type only NCL in DOS environment. The inputs are to be provided by the user through query response mode.

The output of the software is saved in the file OUTPUT.TXT and the output file may be viewed or printed. The output of the software will provide the consensus rank and the information relating to the expected improvements with reference to the best mine.

Case Study on Mine Performance Assessment

The PSU is operating nine opencast coal mines. These coal mines have similar geological conditions and use the same state of coal mining technology. Table 1 and 2 show the mine performance assessment by operational parameters and cost parameters, respectively, as per the record of 1997-98. Table 3 and 4 are the respective rank lists, which also reflect the existence of conflict in the pursuit of evolving single ranking of mines.

Table 1: Performance of Coal Mines measured by various Operational Parameters

Coal Mine	Profit/ tonne (Rs.)	Total cost/ tonne (Rs.)	O.M.S.	ROA	Deviation from target production (%)	Coal stock (% of coal production)
A	234.67	195.16	9.19	0.621	36.74	0.677,
B	212.02	257.12	9.66	0.463	22.73	0.199
C	359.08	309.73	12.38	0.743	4.67	1.688
D	87.54	352.58	6.46	0.115	–15.12	2.121
E	271.18	427.95	8.75	0.229	–22.27	2.462
F	104.28	454.89	7.35	0.068	–9.684	12.879
G	100.12	496.77	3.58	0.1	34.00	7.96
H	158.47	476.55	8.59	0.129	–4.762	3.3
I	27.01	572.51	6.39	0.015	0.714	7.347

Source: Working Results of Northern Coalfields Limited, 1997-98, Singrauli.

Table 2: Performance of Coal Mines measured by various Cost Parameters

Coal Mine	Salaries cost/ tonne (Rs.)	Stores cost/ tonne (Rs.)	Power cost/ tonne (Rs.)	Other expenses/ tonne (Rs.)	Fixed cost/ tonne (Rs.)
A	52.06	75.00	30.80	32.91	67.01
B	39.98	99.38	23.16	42.53	57.61
C	34.31	149.80	44.58	53.17	68.58
D	59.76	126.03	26.37	65.75	96.03
E	43.58	169.75	46.73	46.13	140.53
F	49.59	189.54	53.03	39.33	154.78
G	105.97	137.06	53.85	97.76	92.66
H	42.90	177.80	46.80	79.30	160.52
I	46.47	137.00	37.19	72.60	197.88

Source: Working Results of Northern Coalfields Limited, 1997-98, Singrauli.

Table 3: Rank List by Operational Parameters

Coal Mine	Profit/ tonne	Total cost/ tonne	O.M.S.	ROA	Deviation from target production	Coal stock (% of coal production)
A	3	1	3	2	1	2
B	4	2	2	3	3	1
C	1	3	1	1	4	3
D	8	4	7	6	8	4
E	2	5	4	4	9	5
F	6	6	6	8	7	9
G	7	8	9	7	2	8
H	5	7	5	5	6	6
I	9	9	8	9	5	7

The consensus ranks of the coal mines as per operational parameters and cost parameters during 1997-98 reflect resolution of rank conflict which has been established applying our proposed methodology and software. These are presented in Table 5 and 6 respectively.

Mine A is the best performing mine in terms of operational parameters, whereas Mine B is the best when various cost factors are considered. Now for improvement of other mines, the best mine in the rank list

may be considered as the benchmark. So referring to Table 1 and 2 it is possible to directly measure the improvement requirements for other mines, which in fact should be the expectation in 1999, for improving their performances.

Table 4: Rank List by Cost Parameters

Coal Mine	Salaries cost/ tonne	Stores cost/ tonne	Power cost/ tonne	Other expenses/ tonne	Fixed cost/ tonne
A	7	1	3	1	2
B	2	2	1	3	1
C	1	6	5	5	3
D	8	3	2	6	5
E	4	7	6	4	6
F	6	9	8	2	7
G	9	5	9	9	4
H	3	8	7	8	8
I	5	4	4	7	9

Table 5: Consensus Rank of Coal Mines as per Operational Parameters

Name of Mine	Rank
A	1
C	2
B	3
E	4
H	5
D	6
F	7
G	8
I	9

Table 6: Consensus Rank of Coal Mines as per Cost Parameters

Name of Mine	Rank
B	1
A	2
C	3
D	4
E	5
I	6
H	7
F	8
G	9

The second part of the output reflects the improvement requirements. The following shows the sample output of this second part considering cost parameters for performance assessment.

Projectwise Improvement Requirement (in percentage) in 1999

Project Name: A	
Power_cost	Reduction Required 24.81
Stores_cost	Reduction Required 0.00
Wage_cost	Reduction Required 23.20
Other_cost	Reduction Required 0.00
Fixed_cost	Reduction Required 14.03
Project Name: C	
Power_cost	Reduction Required 48.05
Stores_cost	Reduction Required 33.66
Wage_cost	Reduction Required 0.00
Other_cost	Reduction Required 20.01
Fixed_cost	Reduction Required 16.00
Project Name: D	
Power_cost	Reduction Required 12.17
Stores_cost	Reduction Required 21.15
Wage_cost	Reduction Required 33.10
Other_cost	Reduction Required 37.23
Fixed_cost	Reduction Required 40.01
Project Name: E	
Power_cost	Reduction Required 50.44
Stores_cost	Reduction Required 41.46
Wage_cost	Reduction Required 8.26
Other_cost	Reduction Required 7.80
Fixed_cost	Reduction Required 59.01
Project Name: F	
Power_cost	Reduction Required 37.73
Stores_cost	Reduction Required 27.46
Wage_cost	Reduction Required 13.97
Other_cost	Reduction Required 41.42
Fixed_cost	Reduction Required 70.89
Project Name: G	
Power_cost	Reduction Required 50.51
Stores_cost	Reduction Required 44.11
Wage_cost	Reduction Required 6.81
Other_cost	Reduction Required 46.37
Fixed_cost	Reduction Required 64.11
Project Name: H	
Power_cost	Reduction Required 56.33
Stores_cost	Reduction Required 47.57
Wage_cost	Reduction Required 19.38
Other_cost	Reduction Required 0.00
Fixed_cost	Reduction Required 62.78
Project Name: I	
Power_cost	Reduction Required 56.99
Stores_cost	Reduction Required 27.49
Wage_cost	Reduction Required 62.27
Other_cost	Reduction Required 56.50
Fixed_cost	Reduction Required 37.83

Conclusion

The assessment of performance of a coal mine is essential for designing its improvement strategy. However, it is a complex job due to the presence of several conflicting performance assessment criteria. Maximising Agreement Heuristics has been applied for resolving this conflict originated from the variations in perspective among the criteria. This heuristics aims at achieving consensus and results in establishing a single ranking list The ranks will indicate the relative performance of the mines. A computer software has been developed for application of the Maximising Agreement Heuristics algorithm. Output of this software will also indicate the improvements required in the performance of the mines in terms of different performance monitoring parameters for improving the overall performance of the mine. While designing the strategy for performance improvement, following issues are to be taken into consideration.

- A strategy may be evolved which will improve the performance of a mine simultaneously in terms of more than one parameter.
- An improvement on one parameter may lead to deterioration of value on some other parameter(s). This may call for evaluating appropriate trade-off through cost-benefit analysis.
- Mine specific facts and issues are to be considered in detail during strategy formulation along with all types of resource constraints.

This software may be used as a decision aid tool and will be applicable for ranking the mines which are having similar geological conditions and using almost same type of coal mining technology, otherwise the conclusion in terms of parameter-wise comparison will not be realistic.

References

Beck, M. P. and B. W. Lin (1983), "Some Heuristics for the Consensus Ranking Problem", Computer and Operations Research, Vol. 10, No. 1, pp. 1-7.

Bhar, C. and P. Mandal (1990), "Coal Planning Need for a Systematic Approach", paper presented in the Fourth National Conference of the System Dynamics Society of India held at Tirupati, December.

Bhar, C. (1994), "Long-Range Planning for the Indian Coal Industry - Some Quantitative Approaches", Unpublished Ph. D. thesis of Indian Institute of Technology, Kharagpur, 1994.

Bhar, C. and S. Chattoraj (2001), "Computerised Performance Assessment of Coal Mines – A Case Study of Large Public Sector Undertaking", Computer Applications in Mineral Industry, Oxford & IBH Publishing Company Private Limited, New Delhi, pp. 177-185.

Cahen, M. L. (1961), "Measuring the Total Productivity of a Sector of Industry – The French Coal Mining Industry", Productivity Management Review, No. 25.

Fabricant, S. (1973), "A Premier on Productivity", Prentice Hall of India Private Limited, New Delhi.

Ghose, R., B. K. Sinha, K. C. Krishna, and J. K. Sengupta (1998), "A Study on Application of Data Envelopment Analysis in Coal India Limited", A Research Project submitted by Indian Institute of Management, Kolkata, to Coal India Limited, pp. 21-25, March.

Gold, B. (1982), "Practical Productivity Analysis for Management, Part – I", Analytical Framework IIIE Transactions, Vol. 14, No. 4, pp. 227- 242, December.

Kumar, R. and U. Sadhwani (1992), "Indian Coal Industry : Principal/Issues and Analysis of Trends in Investment", Proceedings of the seminar on Investment in the Coal Industry : Problems and Prospects, Bureau of Industrial Costs and Prices, New Delhi, pp. 1-38, April.

Mathur, B. P. (1993), "Public Enterprise Management", Macmillan India Limited, Delhi.

Mo, D. W. (1985), "Optimisation of Productivity through Mathematical Programming", Proceedings of International IE Conference, IIE, Norcross, Georgia.

Northern Coalfields Limited (1998), "Working Results of Northern Coalfields Limited", 1997-98, Northern Coalfields Limited, Singrauli.

Planning Commission (1979), "Sixth Five Year Plan, 1980-85", Government of India, Planning Commission, New Delhi.

Planning Commission (1985), "Seventh Five Year Plan (1985-90), Vol. II", Planning Commission, Government of India, New Delhi, October.

Ramani, S. (1989), "Managerial Excellence through Productivity", Proceedings of National Seminar on Corporate Communication of Productivity in Public Sector – Roles and Challenges, pp. 6-8.

Ramsay, M. R. (1989), "The Indian Ethos in Productivity", Proceedings of National Seminar on Corporate Communication of Productivity in Public Sector – Roles and Challenges, pp. 34-44.

Sarkar, D. (2000), "Development of Methodology for Improving the Performance of Different Work Units – A Case Study from Large Public Sector Mining Company", Unpublished Ph. D. thesis of Indian School of Mines, Dhanbad, October.

Sharma, N.K. (2002), "Prospects and Problems of Coal Industry", paper presented in the workshop on Problems and Prospects of Indian Mineral Industries, held at Indian School of Mines, Dhanbad, on February 23.

Sink, D. S. (1986), "Performance and Productivity Measurement-The Art of Developing Creative Scoreboards", Industrial Engineering, pp. 86-90, January.

Slater, K. (1991), "Performance Measurement in the Finance Function", Management Accounting, pp. 32-34, May.

Smith, P and D. Mayston (1987), "Measuring Efficiency in the Public Sector", OMEGA, International Journal of Management Science, Vol. 15, No. 3, pp. 181-189.

Verma, S. K. (2002), "Challenges before the Indian Coal Industry", paper presented in the workshop on Problems and Prospects of Indian Mineral Industries, held at Indian School of Mines, Dhanbad, on February 23.

Zhanxin, Wang et al, "Productivity and its Impact on Employment and Labour Relations in the Chinese Coal Industry", Sectoral Activities Program, Working Paper, Industrial Activities Branch, in Productivity, Employment, and Industrial Relations in Coal Mines, edited by Norman S. Jennings. □

Feature

Technical Efficiency of Scheduled Commercial Bank Groups

V. Nagarajan Naidu & Manju S. Nair

Financial Sector Reforms were implemented in India on the basis of the recommendations of Narasimham Committee on Financial System (NCFS) from 1992. With the changing scenario, importance of improved efficiency has assumed tremendous significance for the commercial banks in the country. The examination of technical efficiency levels of public sector bank groups using stochastic frontier production function reveals decline in technical efficiency levels in the post liberalisation period compared to pre liberalisation period. At the same time the efficiency of private sector groups, both domestic and foreign have improved, though slightly. However the disparity of technical efficiency within bank groups over the period has been reduced revealing the fact that liberalisation measures have instilled competition in banking sphere.

V. Nagarajan Naidu is Lecturer, Department of Economics, Government College, Attingal, Kerala. Manju S. Nair is Lecturer, Department of Economics, Christian College, Chengannur, Kerala.

With the changing scenario of the banking industry in the liberalised era, the importance of improved efficiency has assumed critical significance for the viability of commercial banks operating in India. This paper seeks to examine empirically whether the technical efficiency of scheduled commercial banks in India has improved after the implementation of Narasimham Committee recommendations. Scheduled commercial banks in India are grouped into public sector banks, which are owned by the Government of India, and private sector banks. Public sector banks comprise of the State Bank of India and its associates, nationalised banks and regional rural banks. Private sector banks include privately owned domestic banks and foreign banks. To study the impact of policy reform on technical efficiency of bank groups, scheduled commercial banks are classified here into SBI and associates (SBI), other nationalised banks (NB), and other scheduled commercial banks i.e. privately owned domestic banks (OSB), and foreign banks (FB). The period of study is classified into two sub periods – 1968-69 to 1990-91 and 1991-92 to 1998-99. The first period represents the financially repressed phase while the second period represents the liberalised phase.

Financial Sector Reforms

India followed a multi targeted Financial Repression policy since the nationalisation of major scheduled commercial banks in 1969. The effects of this Financial Repression policy, which prevailed till 1991, were very tremendous. Markets were heavily segmented and underdeveloped secondary markets inhibited the competitive pricing of assets (Rangarajan 1994). The presence of non price allocation mechanisms led to an inefficient use of credit, the restrictions on banks' uses of funds and the imposition of branch licensing requirements and a significant negative impact on bank profitability, and the restrictions on bank entry and the dominance of public sector banks greatly inhibited competition and

efficiency in the banking sector. This necessitated the adoption of financial reforms in India.

The initial impetus to reforms in the financial sector came with the submission of reports of two influential committees, the Chakravarthy Committee 1985 and Vaaghul Committee in 1987. Since the mid-eighties, RBI has implemented in a phased manner several key recommendations of the two committees which include the introduction of Treasury Bills of 182 days (1986), rediscounting facility for these treasury bills, institution of Discount and Finance House of India (DFHI) (1988), withdrawing the ceiling on call money rates in money market (1989), introduction of Commercial Paper and Certificate of Deposit (1988-89).

Since the mid-eighties, RBI has implemented in a phased manner several key recommendations.

More radial reforms had to wait till the adoption of the structural adjustment cum stabilisation programme by the Indian government in 1991. The adoption of financial reforms was to fulfill two important preconditions. Firstly with a sharp reduction in the central government's fiscal deficit in the first year of the reforms, there was less of a need to use the banking sector as a captive source of funds. Secondly, the reforms in the real sector to succeed, trade and industrial reforms had to be supported by reforms in the financial sector, so that scarce investible funds could be drawn to the most productive uses.

In November 1991, a committee was set up by the Government of India to study the working of the financial system – the Narasimham Committee on Financial System. The main recommendations of the committee were to bring down the SLR in a phased manner to five per cent over five years, to use CRR as an instrument of monetary policy and not as a means of controlling the expansion of credit brought about by monetisation of the fiscal deficit, to phase out directed credit programmes and to reduce the requirement to lend to 'priority sector' down to 10 per cent of aggregate credit, to bring the interest rate on Government borrowing in line with other market-determined interest rates and to phase out concessional interest rates, to make banks and financial institutions achieve a capital adequacy ratio in relation to risk weighted assets, to permit the more profitable public sector banks to issue fresh capital to the public through capital market, to make banks and financial institution adopt uniform accounting practices with regard to income recognition and provisioning for non-performing loans, to abolish branch licensing and the matter of opening and closing of branches be left to the commercial judgement of individual banks, to liberalise policies towards foreign banks with regard to the opening of offices as branches or subsidiaries, to set up a quasi-autonomous body under the aegis of the RBI to supervise banks and financial institutions etc.

Among the recommendations of the Narasimham Committee that have been implemented by the Government till date are the deregulation of entry of new private sector banks, both domestic and foreign, liberalisation of branch licensing policy allowing banks more freedom to plan branch expansion in response to market needs, subject to certain minimum performance requirements, phase-wise deregulation of interest rates on both deposits and advances, introduction of capital adequacy norm of 8 per cent in line with the norms set by the Bank for International Settlement (BIS), Basle, institution of transparent prudential and income- recognition norms, allowing public sector banks to access the capital market to raise equity and gradual reduction of CRR and SLR.

Measurement of Efficiency

Farrell (1957) defined efficiency as the ability of a production organisation to produce a good at the minimum cost. He dichotomised efficiency into two parts – technical efficiency and allocative efficiency. Technical efficiency, according to Farrell, can be input based measure or output based measure. An input-based measure is calculated as the ratio of best practice input usage to actual usage, holding the output constant. Output- based measure is computed as the ratio of actual output obtained from a given vector of inputs to maximum possible output achievable from the same input vector. A decision-making unit is said to achieve allocative efficiency in production of a given level of output if it could allocate the factors of production at a given set of factor prices in such a way that the marginal rate of substitution between two factors becomes equal to their factor price ratio.

Stochastic Production Frontier Approach

Farrell proposed an output-based measure of technical Efficiency that could be derived by estimating a Frontier Production Function (FPF) with a specific functional form such as Cobb-Douglas. A Frontier Production Function is defined as the locus of points representing the maximum levels of output achievable from the given input vectors. In the framework of a FPF,

technical efficiency is gauged as a ratio of actual output obtained from a given combination of inputs to the corresponding level of output shown by the production frontier. Two types of FPFs, namely, deterministic and stochastic, are estimated by researchers. A deterministic FPF envisages a deterministic optimal relationship between inputs and output, unaffected by random events and statistical noise such as measurement errors. Thus, in the deterministic FPF models the actual level of output of a firm is assumed to lie below the frontier only due to the existence of technical inefficiency in the production process of a firm.

Two types of FPFs, namely, deterministic and stochastic, are estimated by researchers.

The stochastic frontier production function postulates the existence of technical inefficiencies of production of firms involved in producing a particular output. For a given combination of input levels, it is assumed that the realised production of a firm is bound by the sum of a parametric function of known inputs, involving unknown parameters, and a random error, associated with measurement error of the level of production or other factors, much as the effects of weather, strikes, damaged product, etc. The greater the amount by which the realised production falls short of this stochastic frontier production, the greater the level of technical inefficiency.

Since Aigner, Lovell and Schmidt (1977) and Meeusam and Van den Broeck (1977) independently proposed the stochastic frontier production function, there has been considerable research to extend and apply the basic frontier model. Forsund, Lovell and Schmidt (1980) provide reviews of much of this research. Bauer (1990), Battese (1992), Ley (1990) and Beck (1991) give extensive bibliographies of empirical applications of frontier functions and efficiency analysis.

The methodology followed here is that of Cornwell, Schmidt and Sickles (1990), which has been applied in other studies as well—Krishna and Sahota (1991), Fecher and Pesiean (1993) and Wu (1995).

The production function used in the analysis is

$$Y = \alpha e^{\lambda t} L^{\beta 1} K^{\beta 2} M^{\beta 3} e^{\varepsilon} \qquad (1)$$

In log form,

$$\log y = \log \alpha + \beta_1 \log L + \beta_2 \log K + \beta_3 \log M + \beta t + \varepsilon$$

$$\varepsilon = v + u$$

Where

Y = the level of output

L = total number of labourers

K = capital

M = material

t = time

α = the efficiency parameter

$\beta_1, \beta_2, \beta_3$ and *labda* are the elasticity coefficient of output with respect to *L, K, M* and *t* respectively.

ε is the error term comprising a random component, *v* and the component associated with technical efficiency, *u*. The term *u* is assumed to be non positive while *v* follows the usual properties. Technical efficiency of the ith state at time *t* is given by

$$\text{Technical Efficiency } (t) = Yi\ (t)/Yi*\ (t) = \exp\ (ui\ (t)) \qquad (2)$$

Where *Yit* is the observed level of output and *Yi*t* is the frontier level of output.

Differentiation of equation (1) with respect to time, t yields

$$Yi\ (t) = \beta_1 \log L + \beta_2 \log K + \beta_3 \log M + \lambda + TEi\ (t)$$
$$(\text{as } du\ (t)/dt = TEi\ (t) \qquad ...(3)$$

The dotted variables indicate the percentage changes. It is evident from Equation (3) that output growth is equal to the rate of technological change, input growth and the rate of change in TE.

The major worry in this case is regarding the estimation of the efficiency component. In the case of cross-section data, it is estimated by assuming *Ui* to follow one of the one-sided distributions like half normal, exponential and truncated normal. In the case of panel data following the methodology of Cornwell et al, (1990), a two-step procedure is followed to estimate efficiency. First, Equation (1) is estimated by standard panel data approaches and ε are generated. In the second step the values of ε are assumed to be a function of *t* and t^2 and a random error *Vi*(t) i.e.

$$\varepsilon\ (t) = \delta_0 i + \delta_1 it + \delta_2 it^2 + v \qquad (4)$$

The fitted values of ε (*t*) from equation (4) give as estimate of the efficiency parameter *Ui*(*t*) ie

$$Ui\ (t) = \delta_0 i + \delta_1 it + \delta_2 it^2 \qquad (5)$$

In order to be consistent with the concept of a frontier, Ui(t)s are normalised so that TEi(t)s are non-negative with an upper bound of unity, ie,

$$TEi\ (t) = \exp\ [Ui\ (t) - Umax\ ] \qquad (6)$$

Where Umax is the maximum value of *Ui (t)* within the data, assumed to lie on the production frontier.

Data and Variables

The data base for the study is drawn from various publications of the Reserve Bank of India like Statistical Tables Relating to Banks in India, Banking Statistics and Report on the Trends and Progress of Banking in India. The methodological concept to the given dependent and independent variables is as follows.

Output

In banking literature, there exists considerable disagreement on how to define output and inputs for a banking unit. There are two approach. Intermediation approach views banks as collectors of deposits and buyers of funds to be subsequently intermediated into loans and other assets. In this approach, a bank's total value of earning assets or income generated are treated as measures of output and deposits are considered as inputs along with capital and labour. On the contrary, in the production approach, banks are seen as producers of services associated with individual loan and deposit accounts. According to this approach, the number of accounts of each type serviced by labour, capital and other inputs measures the output of a bank.

While defining output, the intermediary approach of banking services is used. Banks collect deposit from various sources and lend to general public. As an intermediary it earns income in the form of interest income, service charges, commissions etc. In this context, the total output of bank is sum total of income earned while acting as intermediary.

While defining output, the intermediary approach of banking services is used.

Capital

The inputs in the analysis have been divided into three categories, namely, labour, capital and material input. Capital can be measured by the annual value of services produced by the fixed assets of a bank. The book value of premises, furniture and fixtures represents the fixed assets of a bank. However, in the banks' balance sheets, book value of premises includes only the value of owned premises to the exclusion of rented premises. As the rented premises are used for performing a significant proportion of the bank's business, the exclusion of rent element from the measure of capital is not desirable.

We adopt a flow measure of capital in our analysis which assumes that a bank consumes every year services worth five per cent of the value of owned premises, ten per cent of the value of furniture and fixtures and full value of rent, insurance and taxes. Thus capital is approximated by the summation of one- twentieth of the value of premises, one-tenth of the value of furniture and fixture and full value of rent, insurance and taxes paid by the bank.

Labour

Labour is measured by the number of employees which comprises of officers, clerks and subordinate staff. However, the banks vary in composition of their employees that in turn may vitiate the regression results. With a view to minimise distortion in the result, we have proposed to use employees by converting them into the homogenous units of subordinate staff. Practically following Swamy and Subramaniyam (1992) we have used the ratio of 1/3:1/2:1 for expressing officers, clerks and subordinate staff, respectively, into the homogenous unit of subordinate staff.

Material

In the intermediation approach, banks act as collectors of deposits to be subsequently intermediated into loans and other assets. In this approach, deposits and borrowings are considered as the material to produce output.

Empirical Estimation of Technical Efficiency

As stated earlier technical efficiency is obtained for the four bank groups using the stochastic frontier production function. Average technical efficiency levels of bank groups in the pre and post liberalisation period is also estimated. Table 1 and 2 below gives the details.

Results reveal the picture that technical efficiency levels of commercial bank groups has not increased significantly after the implementation of financial sector reforms. It was SBI, which had recorded the maximum average technical efficiency in the pre reform period.

Competition among bank groups to enhance efficiency has increased.

However technical efficiency levels of public sector banks (SBI and NB) has declined in the post reform period, the only gainers in technical efficiency levels being OSB and FB. FB is the maximum recorder in technical efficiency levels in the post reform period and the NB was the least efficient bank group. Standard deviation of the average technical efficiency levels for the four bank groups are obtained to understand differences in achieved efficiency level between bank groups. The standard deviation of technical efficiency has declined from 1.752 in the pre liberalisation period to 0.0842 in the post reform era, which means that there has been reduction in differences in efficiency levels of bank groups. This indicates the fact that the competition among bank groups to enhance efficiency has increased.

Table 1: Technical efficiency of banks

Year	SBI	NB	OSB	FB
1980-81	0.934	0.880	0.878	0.822
1981-82	0.930	0.901	0.924	0.992
1982-83	0.935	0.874	0.911	0.959
1983-84	0.849	0.868	0.866	0.925
1984-85	0.866	0.930	0.884	0.864
1985-86	0.868	0.914	0.893	0.832
1986-87	0.868	0.874	0.871	0.866
1987-88	0.862	0.798	0.872	0.863
1988-89	0.948	0.973	0.885	0.904
1989-90	0.808	0.852	0.887	0.892
1990-91	0.937	0.889	0.908	0.900
1991-92	0.953	0.933	0.926	0.952
1992-93	0.859	0.853	0.852	0.772
1993-94	0.833	0.835	0.835	0.860
1994-95	0.827	0.880	0.831	0.989
1995-96	0.923	0.917	1.000	0.921
1996-97	0.945	0.903	0.968	0.851
1997-98	0.846	0.880	0.785	0.824
1998-99	0.897	0.877	0.892	0.920

Table 2: Average Technical Efficiency

Period	SBI	NB	OSB	FB
Pre reform	90.8	88.51	86.51	88.63
Post reform	88.54	88.49	88.62	88.68

Several reasons can be attributed as to why the technical efficiency levels of private banks, both domestic and foreign are greater than public sector banks. Two studies, namely, Keshari (1993) and Nag and Shivaswami (1990) have shown that a large proportion of private sector banks' deposits come from the corporate customers, NRI businessmen and professionals, and most of the advances go to the industrial sector, as a result, advances (or deposits) per account for private banks are much larger in comparison to those of public sector banks. Other notable features of private sector banks are minimal contribution to priority sector lending, a greater involvement in highly profitable activities like bill discounting, portfolio management services, investment in securities, foreign exchange dealings, maintenance of NRI accounts, fee related business, buy-back, ready forward and double ready forward operations. Confinement of private sector banks' activities in metropolitan centres, larger proportion of officers in the total staff, introduction of aggressive marketing of new financial services and greater involvement in real estate and consumer durable financing have also acted in improving the technical efficiency levels of banks.

Conclusions

This paper aimed at examining whether the technical efficiency levels of scheduled commercial bank groups has improved after the adoption of financial liberalisation policy in India. Result showed that technical efficiency levels of both public sector bank groups has recorded a decline in the post liberalisation period, however, the technical efficiency levels of both domestic private sector banks and foreign banks has increased slightly. The decline in standard deviation computed from the mean levels of technical efficiency of bank groups in the post liberalisation period as compared to the pre liberalisation period shows that the differences in technical efficiency levels among bank groups has declined in the post liberalisation period, indicating enhanced competition among bank groups.

Technical efficiency levels among bank groups has declined in the post liberalisation period.

Reference

Aigner, D.J., C.A.K. Lovell and P. Schmidt (1977), "Formulation and Estimation of Stochastic Production Function Models", Journal of Econometrics, Vol. 6 pp. 21-37.

Baueer, P.W. (1990), "Recent developments in the econometric es-

timation of the frontiers', Journal of Econometrics, Vol. 46, pp. 39-56.

Battese, G.E. (1992), "Frontier Productions Functions and Technical Efficiency: A survey of empirical applications in agricultural economics", Agricultural economics, Vol. 7 pp. 185-208.

Beck, M. (1991), "Empirical Application of Frontier Functions: A Bibliography", Mimeo, Joachim-Ringeinatz-Str, 20, W-6200 Wiesbaden, Germany, pp. 9.

Berger A, G.A. Hanweck and D.B. Humphrey (1987), "Competitive viability in Banking: scale, scope and product mix economics", Journal of Monetary Economics, Vol. 20, pp. 501-520.

Cornwell, C., P. Schmidt and R.C. Sickles (1990), "Production Frontiers with Cross Sectional and Time Series Variations in efficiency levels", Journal of Econometrics, Vol. 46, pp. 185-200.

Farrell, M.J. (1957), "The Measurement of Productive efficiency", Journal of Royal Statistical Society, Series A, Vol. 120, part 3, pp. 253-82.

Forusnd, F.R., C.A.K. Lovell and P. Schmidt (1980), "A Survey of frontier production functions and of the relationship to efficiency measurement", Journal of Econometrics, Vol. 13, pp. 5-25.

Fecher, F. and P. Position (1993), "Efficiency and Competition in O.E.C.D Financial Services" in Harold. O. Fried, C.A.K. Lovell and Shelton S. Schmidt (eds), The Measurement of Productive Efficiency, techniques and applications, pp. 374-85, Oxford University Press, New York.

Krishna, K.L. and G. Sahota (1991), "Technical Efficiency in Bangladesh Manufacturing Industries", The Bangladesh Development Studies, Vol. 19, pp. 89-101.

Keshari, P.K. (1993), "Operation of Foreign Banks and Domestic Banks in India: A comparison of their broad characteristics and efficiency", National Institute of Bank Management, Pune.

Ley, E. (1990), "A Bibliography on Production and Efficiency", Mimeo Department of Economics, University of Michigan, Ann Arbor, pp. 32.

Meeusen, W and J. Van den Broeck (1977), "Efficiency estimation from Cobb-Douglas production function with composed error", International economic review, Vol. 18, pp. 435-44.

Nag, A.K. and K. Shivaswamy (1990), "Foreign Banks in India: Recent Performance", RBI Occasional Papers, Vol. 11, pp. 297- 328.

Rangarajan, C. (1994), "Developing the Money and Securities Markets in India", RBI Bulletin April 14, 81-90.

Subramaniyan, G and S.B. Swami (1992), "Bilateral Productivity and Performance Comparisons of Public Sector Banks in India", National Institute of Bank Management, Pune.

□

The brain is a wonderful organ. It starts working the moment you get up in the morning, and does not stop until you get into the office.

– Robert Frost

Feature

Ownership – Does It Matter

Sudhir Naib

Empirical evidence on performance of public and private firms is quite large, with mixed findings about their relative efficiency. In order to provide fresh evidence on the impact of ownership on efficiency of Indian enterprises, micro level study at firm level is carried out in this paper. To study the effect of ownership, efficiency of some Indian public sector enterprises is compared (to the extent possible) with comparable private sector firms. Total Factor Productivity (TFP) measure has been used to measure the efficiency of the firms. The enterprises covered are from diverse sectors viz. steel, aluminum, copper, zinc, fertilizer, engineering, and paper. The period covered for this analysis is from 1988-89 to 1999-2000.

Sudhir Naib is with the Directorate of Standardisation, Defence Production and Supplies.

One of the main reasons for the present drive towards privatisation is a general belief that change in ownership will bring efficiency in State Owned Enterprises (SOEs). However, the current wave of privatisation follows a long period characterised by nationalisation and growth in the size of the public sector in the economies worldwide. These nationalisations took place practically in every area of economic activity in a majority of countries and not merely in the Soviet Union, China, Central and Eastern Europe where Marxist and Socialist thinking had the greatest impact. In Central and Eastern Europe, nationalisations were imposed due to increasing Soviet influence after the Second Work War. In Western Europe – for example – France and Italy – the surge in nationalisation began in the years immediately preceding the Second World War and continued after the war. After the Second World War, many Latin American countries also decided to base their development strategy on SOEs. Similarly, after decolonisation in Asia and later in Africa, Nationalisation movement gained ground where new regimes took control of their assets from foreigners.

In industrialised nations, state ownership was viewed as the remedy for market failures such as externalities and monopoly. In developing nations, these justifications were coupled with arguments that SOEs facilitated economic independence and planned development.

However, during the 1980s, privatisation programmes were launched in many countries throughout the world. Privatisation was given a great push by the collapse of communist regimes throughout Central and Eastern Europe. The prominent reason for the sharp reversal of the nationalisation trend was that SOEs, on a whole, performed poorly. Another important reason for a shift towards privatisation was that most governments found themselves facing deep budget deficits and public finance crisis. The state no longer had the financial resources either to offset the losses of SOEs or to provide the capital necessary for their development. The other reason for such reversal was that technological

and other developments made it possible to introduce competition into activities formerly thought to be natural monopolies, such as telecommunications and electricity generation and distribution, which could earlier justify state intervention. Rapid changes in the international economy have also accelerated the decline of the SOEs. Globalisation of the economy accelerated technological innovation, and growing integration of markets compel businesses to adopt highly flexible strategies. It was argued that SOEs are generally unable to function so flexibly. Many of them, though have managed to survive through favoured treatment such as, tariff protection against competing imports, preferences in public procurement, exclusive rights, preferential access to credit, and subsidies.

Technological and other developments made it possible to introduce competition into activities formerly thought to be natural monopolies.

Theoretical perspectives on the effects of ownership

There are theoretical arguments favouring each form of ownership, that is, public and private. The difference between public and private enterprises starts with the very objectives of the owners in the two cases. In private ownership, it is generally assumed that the motive of the owners is profit maximisation, whereas in public ownership, the assumption is that the objective is to maximise social welfare. This leads to the public interest theory of state-owned enterprise. The public interest theory assumes that if monitoring of management is equally effective under both types of ownerships, public ownership allows the government to achieve distributional objectives and provides it with policy instruments to correct any deviation between the social and private returns. This theory suggests that where private ownership is efficient (i.e. in competitive markets with no externalities), public ownership would to equally well and in case of market failure, public enterprises can do better by correcting the misalignment of the public and private objectives.

Public ownership allows the government to achieve distributional objectives and provides it with policy instruments to correct any deviation between the social and private returns.

However, this theory has not taken into account the enterprise agency problem. The owners of both public and private enterprise face a similar agency problem, that is, how can managers and other employees (the agents) be encouraged to act in ways that contribute maximally to the owners' (the principals') objectives. This is the problem of incentives or of enterprise monitoring.

Here it is relevant to note that competition among firms tends to ease the enterprise agency problem in a number of ways. First, the existence of several competing firms in the market generates information that is of value to enterprise owners (whether public or private) in monitoring performance. Second, competition is capable of establishing direct links between managerial performance and managerial rewards. Therefore, ownership is not the only determinant of incentive structure, and factors like competitive conditions in the market influence commercial behaviour considerably.

The key hypothesis concerning the agency problem at the enterprise level is that private ownership is associated with a more effective incentive structure than public ownership; that is, there will be less scope under private ownership for managers and workers to pursue their own objectives at the expense of owners. The most fundamental argument for the efficiency of private firms is that as residual claimants to firms' revenues, the owners have every incentive to act efficiently. Further, there exist several mechanisms such as signals from stock market, takeover bids and bankruptcy threat in the private sector which constrain agents to pursue their own objectives at the cost of the principals.

A common criticism of public ownership is that the monitoring of enterprises tends to be poor. The principal-agent problem in case of public enterprises seems potentially to be much more severe than that of private enterprises. In the case of SOEs, the full monitoring hierarchy includes voters, elected political representatives, civil servants and the managers of SOEs. This lead to a number of principal-agent problems. The political agency problem associated with the relationships between voters and the political decision-makers is of particular significance. The politicians and/or bureaucrats responsible for monitoring SOEs can themselves be viewed as agents of the wider public (the principals), and it is the welfare of public that is the ultimate benchmark against which performance should be judged. The incentives for politicians to act in the best interests of the wider public will depend upon factors

such as the nature of the relevant political system and the closeness of impending election. In practice, monitoring the performance of SOEs is likely to be just one of the responsibilities of the political decision-maker. Further, performance of a SOE may not have any bearing on the electoral prospects, as election is concerned with a wide range of issues and not merely how an SOE is being run.

Private ownership is associated with a more effective incentive structure.

There are considerable informational asymmetries between politicians and voters. For example, political action to encourage managers to reduce unit costs would be observed adversely by workers who suffer as a consequence; but, the benefits from lower taxes and lower prices which results to the population at large might not be visible to the recipients. Informational asymmetries indicate that an efficiency improvement may sometimes lead to worsening of the electoral prospects. On the other hand, there would be electoral benefits in setting politically sensitive, low prices even below marginal costs, since the direct positive impact on consumers is more visible than the indirect negative effects arising out of giving subsidy to SOEs.

Thus, similar to enterprise agency problem, which leads to managerial discretion, the political agency problem gives rise to political discretion. Bureaucrats and politicians can introduce their own agendas into the process. Bureaucrats, for example, may pursue the goal of expanding their own departments, while politicians will be concerned about their political careers and their individual and party electoral prospects. Bureaucratic agendas may, therefore, result in excessive monitoring and control over SOEs, while political agendas may introduce goals such as redistribution of resources to favoured interest groups (for example, provision of high wages and secure employment to SOE workers) and exercise of patronage. This implies that the objectives of political decision-makers can be expected to deviate significantly from social welfare objectives. Thus the political agency problem tends to weaken any general advantage that might be claimed for public enterprise

The political agency problem tends to weaken any general advantage that might be claimed for public enterprise.

on account of its preferred objectives. It tilts the balance of advantages towards private ownership, and weakens the case for state intervention.

Relative efficiency of public and private firms

The literature on empirical evidence on performance comparisons between public and private firms is quite large but what is perhaps surprising is the divergence in the conclusions.

The relative performance of publicly and privately owned firms with respect to allocative and internal efficiency will depend upon a range of factors that include:

(a) the effectiveness of respective monitoring systems,

(b) the degree of competition in the market,

(c) regulatory policy, and

(d) the technological progressiveness of the industry.

The findings of empirical literature are not so informative as many studies focus almost exclusively upon the ownership variable and fail to take proper account of the effects on performance of differences in market structure, regulation etc. Private firms may be more profitable but this in itself has no direct bearing on the question of economic efficiency. Let us briefly recall the empirical evidence on performance comparison between public and private firms.

Table 1 gives a summary of the empirical results on relative efficiency of public and private firms. The main criteria for inclusion in this table were frequency of citation, and inclusion in highly cited review articles. Secondary criteria for inclusion in this table were the use of statistical tests and sample size. Important Indian empirical studies on the subject are also included in the table. The table is categorised into 'Private Ownership Superior', 'Ambiguous', and 'Public Ownership Superior' based on the balance of empirical evidence presented in each study.

Although, empirical evidence on performance of public and private firms is quite large, with mixed findings about their relative efficiency, it is still possible to make some conclusions. First, when market power is significant (as in the case of regulated or natural monopolies such as electric utilities and water), there in no systematic efficiency difference between public and private firms. Hence there is little empirical justification for a general presumption in favour of either type of

Table 1: Results on Relative Efficiency of Public and Private Firms

	Study	Industry	Measure of Performance	Sample Size	Country 0 = LDC 1 = Transition 2 = Indus-trialised	Market Structure 1 = No competition 2-3 = Intermediate 4 = Full competition
Private Ownership Superior	Davies (1971)	Airlines	Labour prod	2	2	2
	Peltzman (1971)	Electricity	Price	128	2	1
	Kitchen (1976)	Garbage collection	Cost	48	2	1
	Savas (1977)	Garbage collection	Cost	315	2	Mixed
	Crain and Zardkoohi (1978)	Water Supply	Cost	112	2	1
	Edwards and Stevens (1978)	Garbage collection	Cost	77	2	3
	Bennet and Johnson (1979)	Garbage collection	Price	2	2	2
	Funkhouser and McAvoy (1979)	Manufacturing	Cost Profits	99	0	4
	Hill (1982)	Textiles	Capital + Labour prod.	81	0	4
	Pryke (1982)	Mixed	Cost Profits	6	2	3
	Perkins (1983)	Manufacturing	Capital + Labour prod.	300	0	3
	Boardman and Vining (1989)	Manufacturing	Profits Labour prod.	499	2	4
	Boardman and Vining (1992)	Mixed	Profits Labour prod.	370	2	3 4
	Ehrlich Gallis- Hamonno; Liu and Lutter (1994)	Airlines	TFP	23	0 2	Mixed
	Joshi and Little (1994)	Manufacturing	Rate of Return	Industry-wide	0	Mixed
	Majumdar (1995)	Mixed	Efficiency	Industry-wide	0	Mixed
Majumdar (1998)	Mixed	Efficiency	Industry-wide	0	Mixed	
	Dewenter and Malatesta (1999)	Mixed	Profits	1369	2	Mixed
	Ros (1999)	Telecom	Labour prod.	17 countries	0 2	Mixed
Ambiguous Or No Difference	Yunker (1975)	Electricity	Cost	73	2	1
	Kemper and Quigley (1976)	Garbage collection	Cost	90	2	3
	Tyler (1979)	Manufacturing	TFP	38	0	4
	Caves and Christensen (1980)	Railroad	TFP	2	2	4
	Forsyth and Hocking (1980)	Airlines	Labour Prod.	2	2	2
	Feigenbaum and Teeples (1983)	Water Supply	Cost	319	2	1
	Fare Grosskopf and Logan (1985)	Electricity	Allocative + Tech efficiency	153	2	1
	Atkinson and Halvorsen (1986)	Electricity	Cost	153	2	1
	Yarrow (1986)	Mixed	Profits	5	2	4
	Trivedi (1990)	Cement	Public Profitability	14	0	4

(Contd.)

Table 1: Results on Relative Efficiency of Public and Private Firms (Contd.)

	Study	Industry	Measure of Performance	Sample Size	Country 0 = LDC 1 = Transition 2 = Industrialised	Market Structure 1 = No competition 2-3 = Intermediate 4 = Full competition
	Bhaya (1990)	Manufacturing	Working Capital and inventory in relation to Net Value added	Industry-wide	0	Mixed
	Jha & Sahni (1992)	Mixed	Productivity	4 Industries	0	Mixed
	Sharma and Sinha (1995)	Cement	Productivity	16	0	4
	Kole and Mulherin (1997)	Mixed	Profits Labour prod.	17	2	4
	Kaur (1998)	Mixed	TFP	30	0	4
Public Ownership Superior	Meyer (1975)	Electricity	Cost	180	2	1
	Mann and Mikesell (1976)	Water supply	Cost	214	2	1
	Neuberg (1977)	Electricity	Cost	165	2	1
	Pescatrice and Trapani (1980)	Electricity	Cost	56	2	1
	Bruggink (1982)	Water	Cost	?	2	1

Source: Compiled by Author.

ownership in cases where market power is significant. Second, in competitive markets where other allocative inefficiencies associated with market failures are not substantial, often private firms are more efficient than public ones. This does not mean that in competitive markets public enterprises are always less efficient. Relatively efficient public enterprises can and do survive, but, on an average, frequency of this occurrence is expected to be lower than private enterprises. Thirdly, the key factor driving performance is competition. When public enterprises operate in markets where they have market power, they do just as well (or poorly) as private firms operating in similar markets under regulation. When markets are deregulated, the performance of firms-public and private-improves.

In order to provide fresh evidence on the impact of ownership on efficiency of Indian enterprises, the author has carried out micro level study at firm level.

Methodology

In order to measure the efficiency of public and private firms, Total Factor Productivity (TFP) measure has been used. Efficiency is usually defined as the deviation of the actual cost from the minimum achievable cost of production for a given level of output. As efficiency should get reflected in productivity measures, productivity is considered a good proxy for efficiency. Rao (1996a, 1996b) has labelled the estimate of productivity based on gross output and real value-added as 'Total Productivity' (TP) and 'Total Factor Productivity' (TFP), respectively. As long as material inputs are separable from the other factors it does not matter as to which of the two above- mentioned measures of production is used for the measurement of productivity. If material inputs are not separable, TP should be preferred to TFP. The reason for this is that if firms reap economies of scale by combining material inputs with factor inputs, 'material input conversion efficiency' is included along with the 'efficiency in value-added' in the concept of TFP. Nevertheless, measuring TFP is desirable on the grounds that it is the 'final measure of the value of production' (Rao, 1996a). In literature, a preference is exhibited for using real value- added as the measure of production.

To measure the efficiency of public and private firms, Total Factor Productivity (TFP) measure has been used.

Various measures of TFP have emerged over time. These measures differ from each other either on the basis of method which they employ for arriving at weighted combination of inputs or on account of underlying production function. We have used translog Index for calculating TFPG in this study. In Translog Index (an approximation to the Divisia Index) for two inputs, Labour (L) and Capital (K) only the TFPG can be estimated as follows:

$$TFPG = \Delta \ln TFP_{(t)} = \Delta \ln Q_t - \left(\frac{S_{L,t} + S_{L,t-1}}{2}\right)$$

$$\Delta \ln L_t - \left(\frac{(1-S_{L,t}) + (1-S_{L,t-1})}{2}\right) \Delta \ln K_t$$

This equation measures the difference between the rate of growth of real value added and the rate of growth of factor inputs.

Value-added at constant prices has been taken as the measure of output, Gross Fixed Assets at constant prices has been taken as a measure of capital input. Total number of employees excluding casual employees has been taken as a measure of labour input. Factor share i.e. share of labour was estimated as wages and salaries divided by value-added at current prices in line with most acceptable practices.

To obtain real value-added, the yearly current estimates of value added have been deflated by a suitable wholesale price index. Single deflation method has been used because getting suitable deflators for heterogeneous 'materials' is a rather difficult task, Moreover, well known studies (notably Ahluwalia 1991, and Goldar 1986) of the growth of productivity in Indian industry have worked with value added at constant prices arrived at by using single deflation procedures as the measure of output.

The translog index of technological changes is based on a translog production function, characterised by constant returns to scale. It allows for variable elasticity of substitution and does not require the assumption of Hicks neutrality. Hence it is a flexible form of production function. As all TFP growth indexes are based on a methodology, which analyses equilibrium situations, interpretation in disequilibrium situation becomes difficult. However, measure of TFPG over a sufficiently long period is unlikely to be influenced by such imbalances. The long-term trend of TFP growth tends to even out the year to year fluctuations.

Interpretation in disequilibrium situation becomes difficult.

In order to study the impact of ownership on efficiency, comparable enterprises to the extent possible in the public and private sector were selected. The selection was based on product profile, and closest possible market share. The group consists of 13 enterprises in the public sector and 13 in the private sector. The sample consists of a number of sectors such as steel, aluminium, zinc, copper, fertilisers, paper and engineering. In order to compare the performance of public and private enterprises, the total factor productivity growth (TFPG) and total factor productivity index (TFPI) based on the translog production function was estimated from 1988-89 to 1999-2000. This period has been chosen for two reasons. First, CMIE prowess data is available from 1988-89 for private firms. Second, the base of index number of wholesale prices got changed from 1980-81 (=100) to 1993-94 (=100) in the year 2000-2001.

Average Annual Growth Rate (AAGR) has been estimated as average of TFPG and is presented as percentage.

Total Factor Productivity Index (TFPI) was estimated by taking TFPI of the base year [TFPI(0)] AS 1.00 and then computing for the next year [TFPI(1)] as TFPI(0) multiplied by e sup TFPG i.e. exponential of TFPG. Thus, TFPI of a year (t) has been obtained by multiplying TFPI of the previous year (t-1) with the exponential of TFPG of year (t).

Results

At the enterprise level, results indicate that public and private sector enterprises performed more or less in a same way during the period 1988-89 to 1999-2000.

In the Steel Sector, TFPG of four enterprises was computed viz. SAIL and IISCO in the public sector and TISCO and Jindal Iron and Steel Company (JISC) in the private sector. Whereas TISCO and JISC (both private firms) had positive Average Annual Growth Rate (AAGR), SAIL and IISCO (both public firms) had negative AAGR. Although AAGR is highest for Jindal Iron and Steel Company (JISC), it was found that during this period it was purchasing steel billets and converting it into finished rolled products instead of manufacturing steel.

The AAGR (in percent) for these enterprises which has been estimated as average of TFPG is given below in Table 2 and a graphical representation of TFPI is given in Fig. 1.

Table 2

Public		Private	
Enterprise	AAGR	Enterprise	AAGR
Sail	–4.17	TISCO	2.00
IISCO	–13.61	JISCO	6.50

In the Aluminium Sector, the translog index was computed for four enterprises: viz. BALCO and NALCO in the public sector; and HINDALCO and India

Aluminium Co. in the private sector. The AAGR of both public sector enterprises is quite high vis-à-vis private sector enterprises during this period.

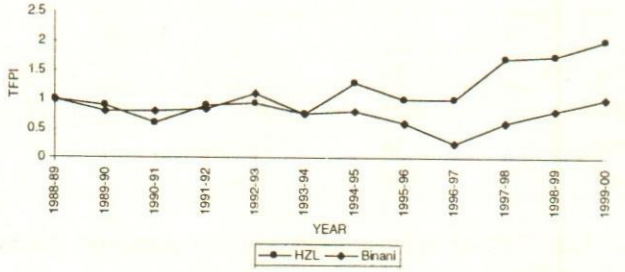


Fig. 1. TFPI of Public and Private Enterprises in Steel Sector

The AAGR (in per cent) for these enterprises which has been estimated as average of TFPG is given below in Table 3 and TFPI is compared graphically in Fig. 2.

Table 3

Public		Private	
Enterprise	AAGR	Enterprise	AAGR
NALCO	7.05	HINDALCO	0.76
BALCO	6.06	Indian Aluminium	–3.70

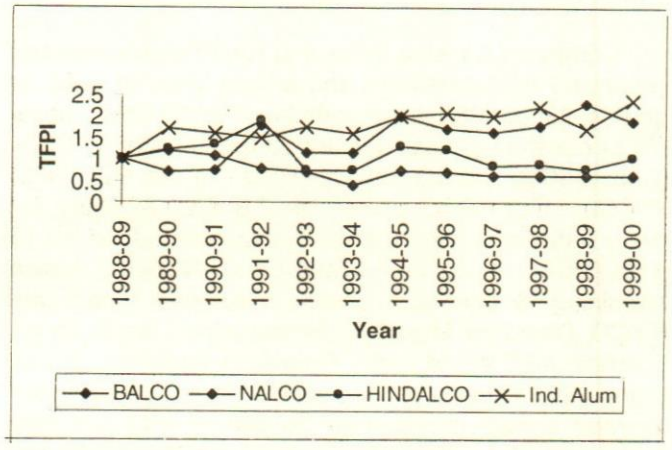


Fig. 2. TFPI of Public and Private Enterprises in Aluminium Sector

Here, the public sector did better than the private sector. Of the four, both enterprises in the public sector viz. BALCO and NALCO experienced a positive AGR, while in the private sector HINDALCO had a positive AGR to a small degree, while Indian Aluminium had a negative AGR. The average AGR of NALCO was the highest, followed by BALCO and HINDALCO.

In the Zinc Sector, TFPG of two enterprises viz. Hindustan Zinc (HZL) in public sector and Binani Industries in private sector was computed. Hindustan Zinc experienced a positive growth rate in TFP of 6.24 per cent per annum, while Binani Industries experienced positive growth rate of 1.17 per cent in TFP.

A graphical representation of TFPI is given in Fig. 3.

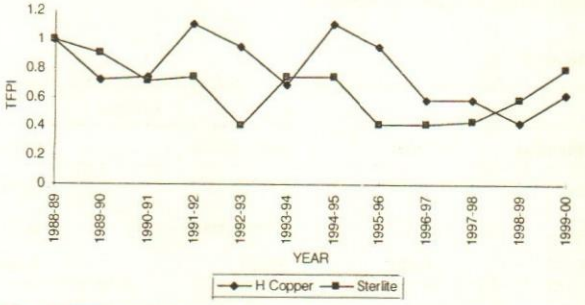


Fig. 3. TFPI of Public and Private Enterprises in Zinc Sector

In the Copper Sector, TFPG of two enterprises viz. Hindustan Copper in public sector and Sterlite Industries in private sector was computed. Results show that both the enterprises experienced negative growth rate in TFP. Hindustan Copper, a public sector enterprise had –4.34 per cent annum growth while Sterlite, a private enterprise had –2.21 per cent of TFP.

The TFPI is compared graphically in Fig. 4.

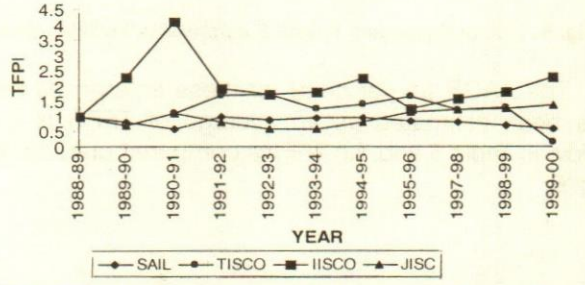


Fig. 4. TFPI of Public and Private Enterprises in Copper Sector

In the Fertiliser Sector, the TFPG and TFPI of six enterprises were computed of which three were in the public sector (MFL, HFL, PPCL) and three in the private sector (Indian Farmers Fertilizers Co-op, Dharamsi Morarji Chemicals and Zuari Agro). The NFL and Indian Farmers Fertilizer Co-operative manufacture urea. Pyrites Phosphates & Chemicals, and Dharamsi Morarji Chemical, manufacture phosphatic fertiliser. Madras Fertiliser and Zuari Agro, manufacture complex fertilizer. Only NFL experienced positive average annual growth rate whereas remaining enterprises had negative growth rate.

The AAGR (in per cent) for these enterprises which has been estimated as an average of TFPG is given below in Table 4 and the TFPI is compared graphically in Fig. 5.

In Engineering Sector, the TFPG and TFPI of six enterprises were computed of which three were in the public sector (BEML, HMT sup 6, BHEL) and three in the private sector (L & T, Widia India, Crompton Greaves). The results show that of the six enterprises, only two i.e. BEML in public sector and L&T in private sector had negative AAGR.

Table 4

Public		Private	
Enterprise	AAGR	Enterprise	AAGR
NFL	2.75	IIFCO	–0.61
PPCL	–47.00	Dharamsi Morarji	–3.21
MFL	–0.60	Zuari	–5.79

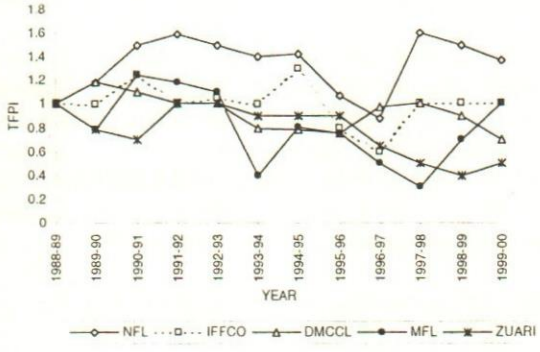


Fig. 5. TFPI of Public and Private Enterprises in Fertiliser Sector

The AAGR (in per cent) for these enterprises which has been estimated as an average of TFPG is given below in Table 5 and the TFPI is compared graphically in Fig. 6.

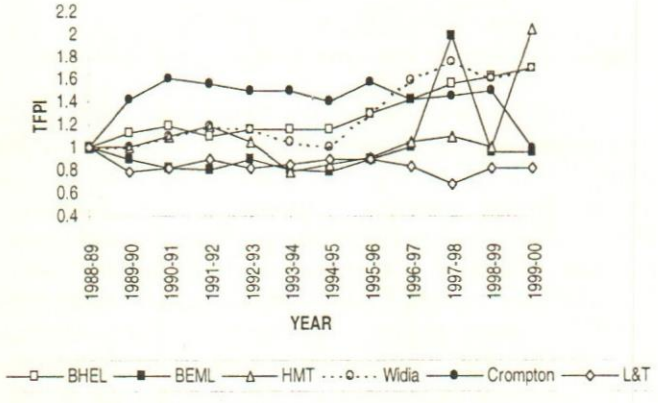


Fig. 6. TFPI of Public and Private Enterprises in Engineering Sector

In the Paper Sector, the TFPG and TFPI of two enterprises viz. Hindustan Paper Corporation in public sector and Ballarpur Industries in private sector was computed. Both enterprises showed positive growth. Hindustan Paper had the AAGR of 14.72 per cent against Ballarpur Industries' 5.72 per cent.

Table 5

Public		Private	
Enterprise	AAGR	Enterprise	AAGR
BEML	–0.18	L&T	–1.65
Bhel	4.69	Cromption	0.32
HMT	6.62	Widia	4.77

The TFPI of these enterprises is compared graphically in Fig. 7.

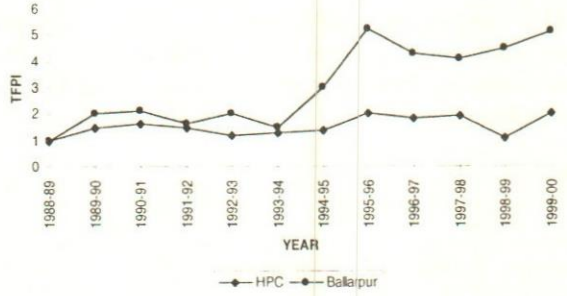


Fig. 7. TFPI of Public and Private Enterprises in Paper Sector

Combined Translog Index and AAGR of Public and Private Firms

Combined translog index and AAGR was computed separately for public firms and private firms. In order to do this, the data on value added and gross fixed capital (All at constant prices) was added together for 13 PSEs (SAIL, IISCO, NALCO, BALCO, Hind Copper, HZL, NFL, PP&CL, MFL, HPCL, BEML, HMT, BHEL). Similarly, for the private firms corresponding data were added for 13 firms (TISCO, Jindal Iron & Steel Co., HINDALCO, Indian Aluminium & Steel Co., Sterlite Industries, Binani Ind, IFFCO, Dharamsi Morarji, Zuari Industries, Ballarpur Industries, L&T, Widia India, Crompton Greaves). It was found that these public sector firms experienced average annual growth rate (AAGR) of 0.41 per cent from 1988-89 to 1999-2000 against AAGR of 0.06 per cent for private firms.

It is surmised that the better performance of the public sector may be due to difference in the protection

Better performance of the public sector may be due to difference in the protection rates between the public and private sectors.

rates between the public and private sectors. Further, there may be other factors which are not being captured by this analysis viz. impact of administered prices, cost of capital etc.

AAGR was also calculated for the sub-period 1989-90 to 1991-92, and 1992-93 to 1999-2000, to see the impact of post liberalisation policies on public and private sector. It was found that for the period 1989-90 to 1991-92 the public firms had an annual average growth rate of 3.64 per cent against negative growth rate of 0.21 per cent of the private firms. Thereafter, from 1992-93 to 1999-2000, i.e. in post-liberalisation period the public firms experienced negative growth rate of 0.81 per cent whereas the private firms had modest positive growth rate of 0.17 per cent.

The fall in growth of public sector firms in post liberalisation period shows that with the earlier protections not available, they could not adjust to the new environment and cope with increasing competition. Prior to 1991-92, public sector firms although operating in competitive environment were protected or favoured. However, after 1991-92, in many cases true competition emerged not only from domestic private firms but also from multinationals.

The TFPG and TFPI of public and private firms in competitive market environment is given in Table 6 and Fig. 8.

Table 6: TFPG, TFPI and AAGR of Public and Private Enterprises (1988-89 to 1999-2000)

Year	Public enterprises (13 enterprises)		Private enterprises (13 enterprises)	
	TFPG	TFPI	TFPG	TFPI
1988-89		1.0000		1.0000
1989-90	–0.00185	0.99815	–0.0296	0.9708
1990-91	0.01046	1.00866	0.0613	1.0323
1991-92	0.10067	1.11548	–0.0379	0.9938
1992-93	–0.01841	1.09513	–0.1824	0.8281
1993-94	–0.09873	0.99218	–0.0609	0.7792
1994-95	0.09355	1.08948	0.2169	0.9680
1995-96	0.01033	1.10079	0.0385	1.0060
1996-97	–0.09687	0.99916	–0.1254	0.8874
1997-98	0.6834	1.06983	0.0433	0.9267
1998-99	–0.06380	1.00371	–0.0159	0.9121
1999-00	0.04117	1.04589	0.0990	1.0071
AAGR	0.41		0.06	
1989-90 to 1991-92	3.64	–0.21		
1992-93 to 1999-00	–0.81	0.17		

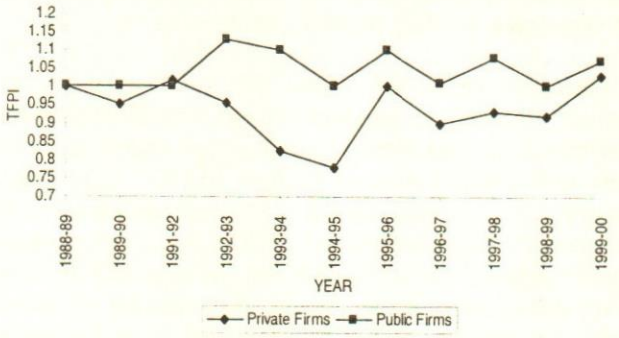


Fig. 8. TFPI of Public and Private Firms in Competitive Sector (1988-89 to 1999-2000)

Conclusion

To provide fresh evidence on the impact of ownership on efficiency of Indian enterprises, micro level study at firm level has been carried out for 13 public and 13 private enterprises. Efforts were made to select comparable enterprises on the basis of market share. The period covered for analysis was 12 years viz., from 1988-89 to 1999-2000. Results showed that both public and private firms experienced modest positive average annual growth rate of 0.41 per cent and 0.06 per cent respectively during this period. Thus, at the enterprise level, this analysis indicated that there is little empirical justification for a general presumption in favour of either type of ownership and a case-by-case examination may be more revealing.

The policy implication of this study is that State Owned Enterprises (SOEs) might not necessarily be an inefficient form of ownership. The SOEs have contributed in several key sectors of economy and this has been done without unduly compromising on efficiency. The SOEs selected in this study have performed equally well in terms of productivity vis-à-vis their private counterparts in several areas. They might not have generated expected financial returns due to number of constraints viz. locational disadvantages, faulty investment decisions, overmanning, burden of taking sick private sector units to protect employment, and social welfare expenditure. This raises the issue of what benefits will emanate from 'change in ownership' from public to private. If improvement in financial performance is the aim, the solution would lie in making SOEs truly autonomous so that decisions on all corporate matters including forming joint ventures are taken by the Board of the company. The major constraint in their present functioning is regarding them as 'State' entities in the Constitution and thus subjecting them to scrutiny by various agencies such as C&AG, CVC, and Parliamentary Committees. All this leads to loss of productive time, delays

and riskaverse behaviour. The need is thus to address this constraint in their present functioning.

However, there are many SOEs which are over manned, making consistent losses, need funds for modernisation, and efforts to restructure them have not borne fruit. Privatisation of a chain of ITDC hotels has brought out the sordid details of mismanagement which ate into the foundations of ITDC. Such enterprises should be privatised at the earliest, as opportunity cost of not doing so is high. Recent privatisation of some enterprises has suggested that this can bring a change in performance.

References

Ahluwalia, I.J. (1991), "Productivity and Growth in Indian Manufacturing", New Delhi: Oxford University Press.

Atkinson S.E. and R. Halvorsen (1986), "The Relative Efficiency of Public and Private Firms in a Regulated Environment: The case of U.S. Electric Utilities", Journal of Public Economics 29(3): 281-294.

Balakrishnan P. and K. Pushpangadan (1994), "Total Factor Productivity Growth in Manufacturing Industry: A Fresh Look", Economic and Political Weekly XXIX (31): 2018-2035 (July 30).

Bennett J.T. and M.H. Johnson (1979), "Public versus Private Provision of Collective Goods and Services: Garbage Collection Revisited", Public Choice, 34(1): 55-63.

Bhaya, H. (1990), "Management Efficiency in the Private and Public Sectors in India", in J. Heath (ed.), Public Enterprise at the Crossroads, London: Routledge.

Boardman A.E. and A.R. Vining (1989), "Ownership and Performance in Competitive Environments: A Comparison of the Performance of Private", Mixed and State Owned Enterprises', Journal of Law and Economics XXXII (1): 1-33.

Boardman A.E. and A.R. Vining (1992), "Ownership versus Competition: Efficiency in Public Enterprises", Public Choice 73(2): 205-239.

Bruggink T.M. (1982), "Public versus Regulated Private Enterprises in the Municipal Water Industry: A Comparison of Water Costs", Quarterly Review of Economics and Business 22(1): 111-125.

Caves D.W. and L.R. Christensen (1980), "The Relative Efficiency of Public and Private Firms in a Competitive Environment: The Case of Canadian Railroads", Journal of Political Economy, 88(5): 958-976.

Christenson L.R., D.W. Jorgenson and L.J. Lau (1971), "Conjugate Duality and the Transcendental Logarithmic Production Function", Econometrica 39(4): 255-256.

Christenson L.R., D.W. Jorgenson and L.J. Lau (1973), "Transcendental Logarithmic Production Frontiers", The Review of Economics and Statistics LV(1): 28-45.

Crain W.M. and Z. Zardkoohi (1978), "A Test of the Property Rights Theory of The Firm: Water Utilities in the United States", Journal of Law and Economics XXI(2): 395-408.

Davies, D.G. (1971), "The Efficiency of Public versus Private Firms", The Case of Australia's Two Airlines", Journal of Law and Economics, 14(1): 149-165.

Dewenter K.L. and P.H. Malatesta (1998), "State-owned and Privately-owned Firms: An Empirical Analysis of Profitability, Leverage and Labour Intensity", Working Paper, University of Washington.

Dholakia B.H. and R.H. Dholakia (1994), "Total Factor Productivity Growth in Indian Manufacturing", Economic and Political Weekly XXIX (53): 3342-44 (December 31).

Dholakia B.H. and R.H. Dholakia (1995), "Total Factor Productivity Growth in Indian Manufacturing", Economic and Political Weekly XXX (28): 1786-1787 (July 15).

Edwards F.R., and B.J. Stevens (1978), "The Provision of Municipal Sanitation Services by Private Firms", Journal of Industrial Economics, 27(2): 133-147.

Ehrlich I., Gallais Hamonno Z. Liu and R. Lutter (1994), "Productivity Growth and Firm Ownership: An Empirical Investigation", Journal of Political Economy, 102(5).

Fare R., S. Grosskopf and J. Logan (1985), "The Relative Performance of Publicly–Owned and Privately Owned Electric Utilities", Journal of Public Economics 26(1): 89-106.

Feigenbaum S. and R. Teeples (1983), "Public versus Private Water Delivery: A Hedonic Cost Approach", The Review of Economics and Statistics LXV(4): 672-678.

Forsyth P.J. and R.D. Hocking (1980), "Property Rights and Efficiency in a Regulated Environment: The Case of Australian Airlines", Economic Record, 56(153): 182-185.

Funkhouser R. and P.W. McAvoy (1979), "A Sample of Observations on Comparative Prices in Public and Private Enterprises', Journal of Public Economics, 11(June): 353-368.

Goldar B.N. (1986), "Productivity Growth in Indian Industry", Delhi: Allied Publishers.

Hill H. (1982), "State Enterprises in a Competitive Industry: an Indonesian Case Study", World Development, 10(11): 1015-1023.

Jha R. and B.S. Sahni (1992), "Measures of Efficiency in Private and Public Sector Industries: The case of India", Annals of Public and Cooperative Economics 63: 489-495.

Joshi V. and I.M.D. Little (1994), "India–Macroeconomics and Political Economy 1964-1991", Delhi: Oxford University Press.

Kaur S. (1998), "Privatisation or Public Regulation–A Managerial Perspective", Unpublished Doctoral Dissertation, University of Delhi.

Kemper P. and J.M. Quigley (1976), "The Economics of Refuse Collection", Cambridge: Ballinger.

Kitchen H.M. (1976), "A Statistical Estimation of an Operating Cost Function for Municipal Refuse Collection", Public Finance Quarterly, 4(1): 56-76.

Kole S.R. and J.H. Mulherin (1997), "The Government as a Shareholder: A Case From the United States', Journal of Law and Economics, Vol. 40.

Majumdar S.K. (1995), "Public, Joint and Private Sectors in Indian Industry–Evaluating Relative Performance Differences", Economic and Political Weekly XXX (7-8): M25-32 (February 18).

Majumdar S.K. (1998), "Assessing Comparative Efficiency of the State-Owned Mixed and Private Sectors in Indian Industry", Public Choice, Vol. 96.

Mann P.C. and J.L. Mikesell (1976), "Ownership and Water System Operation", Water Resources Bulletin, Vol. 12.

Meyer R.A. (1975), "Publicly Owned Vs Privately Owned Utilities: A

Policy Choice", The Review of Economics and Statistics LVII (4): 391-399.

Neuberg L.G. (1977), "Two Issues in the Municipal Ownership of Electric Power Distribution Systems", Bell Journal of Economics 8(1): 303-323.

Peltzman S. (1971), "Pricing in Public and Private Enterprises: Electric Utilities in the United States", Journal of Law and Economics XIV(1): 109-147.

Perkins F.C. (1983), "Technology Choice, Industrialization and Development Experiences in Tanzania", Journal of Development Studies, 19(2).

Pescatrice D.R. and J.M. Trapani (1980), "The Performance and Objectives of Public and Private Utilities Operating in the United States", Journal of Public Economics 13(2): 259-276.

Pryke R. (1982), "The Comparative Performance of Public and Private Enterprise", Fiscal Studies 3: 68-81.

Rao, J.M. (1996a), "Manufacturing Productivity Growth – Method and Measurement', Economic and Political Weekly XXXI (44): 2927- 2936 (November 2).

Rao J.M. (1996b), "Indices of Industrial Productivity Growth: Disaggregation and Interpretation", Economic and Political Weekly, Vol. XXXII, 3177-88.

Ros, A.J. (1999), "Does Ownership or Competition Matter?", Journal of Regulatory Economics, 15(1).

Savas, E.S. (1977), "Policy Analysis for Local Government: Public Vs. Private Refuse Collection", Policy Analysis, 3(1): 49-74.

Sharma R.C. and N. Sinha (1995), "Frontier System and Estimation of Productive Efficiency in Intra-Industrial Private and Public Firms", The Journal of Institute of Public Enterprise XVIII.

Solow, R.M. (1957), "Technical Change and the Aggregate Production Function", The Review of Economics and Statistics, XXXIX(3): 312-320.

Trivedi, P. (1990), "Comparative Efficiency of Public and Private Enterprises: Further Evidence", Decision 17(3-4): 177-198.

Tyler, W.G. (1979), "Technical Efficiency in Production in a Developing Country: An Empirical Examination of the Brazilian Plastics and Steel Industries", Oxford Economic Papers, 31(3).

Yarrow, G. (1986), "Privatisation in Theory and Practices", Economic Policy 2: 323-364.

Yunker, J. (1975), "Economic Performance of Public and Private Enterprise: The case of US Electric Utilities", Journal of Economics and Business, 28(1): 60-67.

□

Better to remain silent and be thought a fool than to speak out and remove all doubt.

– Albraham Lincoln

Feature

Livestock & Crop Enterprises in Punjab

P. S. Khattra & Ravinder Singh Harika

Punjab agriculture is at cross roads these days owing to declining profitability of farm enterprises, technological and ecological constraints, besides challenges of globalisation of trade in agriculture. Under these circumstances, it seems pertinent to examine the emerging trends in the production of livestock and crops, along with an insight into their determinants. The trends of time-series data revealed that less productive milch cattle and goats got replaced by more productive buffaloes, machinry replaced draught cattle in the state. The sharp decline in CGR of paddy area and negative CGR of wheat area accompanied by higher CGR in the area of sugarcane, desi cotton, total oilseeds etc. is a desirable movement towards diversification of agriculture in the state. Among the determinants, the temporal variations in productivity, input use, input and output prices were used to explain the trnds in livestock and crop enterprises.

P. S. Khattra and Ravinder Singh Harika are Professor of Agril. Economics and Research Fellow, respectively in the Deptt. of Economics and Sociology, Punjab Agricultural University, Ludhiana.

The sustainability of exsiting agricultural production pattern in the Punjab state is at stake owing to its economic, technological and ecological constraints. The excess production levels of wheat and rice in relation to their effective marketing demand have been causing serious marketing problems which involve prohibitive stock handling costs and it is becoming increasingly difficult for the government to sustain the heavy burden of such expenses. The severity of this economic problem is likely to be aggravated with globalisation of trade in agriculture which would require our domestic farm products to compete with cheap imports from developed countries. The potential yields of these crops have been stagnating far a considerably long period of time. The continuous extensive cultivation of paddy in the state has been depleting the reservoir of underground water at a much faster rate. The persistent predominance of paddy-wheat rotation has caused the deficiency of micro-nutrients in the soil, besides adding to air pollution through burning of straw in the fields.

In view of the above constraints, the existing production pattern seems unsustainable. Under these circumstances, it seems pertinent to examine the emerging trends in the production of livestock and crops in the state.

Most of the researchers have confined their work to the profitability of existing patterns of different enterprises in agriculture (Biswas et. al., 1994, p 37, Ganesau et. al., 1991, p 180, Chaudhary and Narang, 1994, p 41, Singh et. al., 1994, p 42, and Mahyuddin and Dahler, 1997, p 479).

Some research work on the temporal changes in the composition of milch animals was attempted (Gangwar, 1994, p A1) in which yield improvements were suggested for sustaining the maintenance of cows and buffaloes. This study was confined to livestock only and other determinants of temporal trends in this sector were not considered.

Thus, the present study has been conducted to ex

amine the temporal trends in livestock and crop enterprises and their determinants in the Punjab state.

Methodology

Data

In order to achieve the stipulated objectives of the study, the secondary data pertaining to livestock and poultry population were taken from various issues of statistical abstracts of Punjab for the years 1977-78, 1990-91 and 1997-98; as livestock census was conducted during these years only. The time-series data on area, productivity and harvest prices of major crops viz. wheat, paddy, American cotton, desi cotton, maize, sugarcane, gram, rapeseed and mustard, groundnut, total oilseeds, moong and mash were collected from various issues of statistical abstract of Punjab for the years 1977-78 through 1997-98. The data pertaining to the area under fodder crops were obtained from Director, Land Record, Punjab. The data related to input use were also collected for the years 1977-78 through 1997-98. The time series data related to numbers of tractors and tube wells (electrical and engine operated) were ascertained from 'Agriculture in Punjab' published by department of agriculture, Punjab, and data related to fertiliser (N_2, P_2O_5, K_2O) and pesticide consumption were obtained from economic surveys of Punjab and statistical abstracts of Punjab.

The time series data on prices of major inputs viz. tractor, electrical motor, diesel engines for irrigation, fertilisers (Urea, DAP, SP, MOP) and insecticide (Malathion) were procured from various input dealers and agencies for the years 1977-78 through 1997-98. The compound growth rates for all the variables were computed for two period's viz. period I: 1977-78 to 1990-91 and period II: 1990-91 to 1997-98.

Analysis

The growth model adopted was as under

$$Y_t = AB^t$$

Where,

Y_t = Various parameters for which the CGRs for the period 't' were computed

t = Time variable in years (1, 2...n) for each period.

A = Constant.

Log transformation of the above function is:

$$\ln Y_t = \ln A + t (\ln B).$$

Where, $\ln B = \ln (1+r)$, and

$r = [\text{antilog } (\ln B) - 1]$

$CGR\ (\%) = [\text{antilog } (\ln B) - 1] \times 100.$

Student's t-test was used to test the significance of CGRs and tabular analysis was used to analyze the remaining data.

Livestock Enterprises

The extent and nature of dynamic changes in the population of livestock including poultry during the two periods, first from 1977-78 to 1990-91 and second from 1990-91 to 1997-98 have been studied through compound growth rates for these two periods which are given in Table 1. The perusal of this table revealed that buffaloes occupied the predominant position among the livestock after poultry, which was followed by the cattle population. The next in importance is the population of goats which is closely followed by that of sheep.

Table 1: Livestock and Poultry population and compound growth rates for the selected years in Punjab.

(in thousands)

Livestock & Poultry/ Periods	1977-78	1990-91	1997-98	CGRs (1977-78 to 1990-91)	CGRs (1990-91 to 1997-98)
Cattle	3311.8	2832.3	2639.0	-1.196	-1.00
Buffalo	4110.0	5577.7	6170.7	2.370	1.450
Horse & Ponny	75.9	32.9	34.2	-6.23	0.55
Donkey	60.9	36.0	22.5	-3.96	-6.49
Mule	14.8	15.4	17.4	0.31	1.75
Sheep	497.5	507.7	436.0	0.16	-2.15
Goat	722.1	536.6	414.1	-2.26	-3.63
Camel	74.4	43.3	29.7	-4.08	-5.24
Pig	128.7	96.4	93.7	-2.20	-0.40
Total	899.1	9678.3	9857.3	0.56	0.26
Poultry	5539.2	15275.6	11456.8	8.12	-4.03

Further perusal of this table portrayed positive CGRs for the two periods in cases of buffaloes and mules only. The population of cattle, donkeys, goats, camels and pigs witnessed negative growth rates for both the periods. The decline in the population of cattle, donkey and camel can be attributed to the replacement of draught animals with machinery in Punjab state. The reduction in the heads of local cows and goats is due to

their replacement with more productive milch animals i.e. cross-bred cows and buffaloes. The reduction in the pig population is due to the social constraints and relatively less preference for its meat. The highest positive growth rate (8.12%) of poultry birds in the first period followed by negative growth rate in the second period is attributable to the cyclical behaviour of poultry business. It may be inferred from these results that less productive milch animals, i.e. local cows and goats, are being replaced by the more productive milch animals like buffaloes. Draught animals have been replaced by machinery. The poultry business is characterised by the trade cycles which are witnessed by the high growth in the first period and reduction in population in the second period.

The population of cattle, donkeys, goats, camels and pigs witnessed negative growth rates for both the periods.

Crop Enterprises

Area under different crops in thousand hectares in 1977-78, 1990-91 and 1997-98 in the Punjab state has been presented in Table 2 along with its compounded growth rates for the two periods, first period from 1977-78 to 1990-91 and the second period from 1990-91 to 1997-98. It may be seen from this table that paddy in the *kharif* season and wheat in the *rabi* season have been occupying the largest area in the Punjab state. The other important crops in descending order of importance are fodder, cotton, maize, oilseeds, sugarcane, rapeseed and mustard and moong.

It may be seen from Table 2 that sugarcane witnessed perceptible improvement in the compound growth rate of its area in the later period over the previous period. This is the only enterprise which evinced not only growth in area in both the periods but in its CGRs also. Desi, Cotton oilseeds and rapeseed and mustard showed growth in their areas in the later period as compared to the decline in the earlier period. Groundnut and maize witnessed decline in their areas in both the periods but the rate of decline got reduced in the second period. The area under gram witnessed reduction in both the periods and the extent of reduction became sharper in the second period. The areas under wheat, mash and fodder witnessed increments at marginal rates in the first period and in the second period there were declines, though the annual rate of decline was smaller. The growth rates of area under paddy, American cotton and moong got considerably reduced in the second period as compared to the first.

Table 2: Area under different crops and its CGRs for the selected years.

(in thousand hectares)

Crops/ Period		1977-78	1990-91	1997-98	CGRs (1977-78 to 1990-91)	CGRs (1990-91 to 1997-98)
Cereal Crops	Paddy	858	2015	2278	6.02*** (0.476)	1.52*** (0.403)
	Wheat	2616	3273	3301	1.56*** (1.164)	-0.01^{NS} (0.210)
	Maize	444	188	165	-6.05*** (0.294)	-1.93** (0.672)
Pulse Crops	Moong	3.40	50.51	49.30	22.49*** (4.082)	1.18^{NS} (0.915)
	Mash	17.80	8.50	5.20	-6.93*** (0.696)	-4.29^{NS} (2.318)
	Gram	353	60	11	-13.83*** (1.157)	-16.05*** (3.135)
Oil Seed Crops	R & M	137	69	61	-0.96^{NS} (1.664)	0.09^{NS} (3.222)
	Ground-nut	142	11	8	-16.66*** (1.022)	-5.94*** (1.096)
	Total oilseed	287	104	258	-5.18*** (1.035)	9.55* (4.087)
Cash Crops	Cotton (A)	440	637	626	2.61*** (0.838)	0.04^{NS} (1.277)
	Cotton (D)	169	64	98	-9.33*** (1.058)	4.46^{NS} (5.231)
	Sugar-cane	115	101	126	0.31^{NS} (1.059)	5.51^{NS} (4.144)
Fodder Crops		728.99	708.50	671.27	0.26^{NS} (0.495)	-0.17^{NS} (0.904)

***, **,* denote significant at 1, 5 and 10 per cent level respectively.

^{NS} denote non significant

Figures in parentheses are Standard Error.

It may be inferred from these results that though paddy and wheat enterprises are enjoying pre-dominant positions in the cropping pattern of Punjab state there has been drastic reduction in the CGR of paddy area during the later period over the earlier period and CGR of wheat area has turned out to be negative in the second period. This is a healthy trend from the agro-eco sustainability point of view as it gave way to the diversification of agriculture by allowing higher rate of growth in the areas of other crops like sugarcane, desi cotton, oilseeds etc. in the second period (1990-91 to 1997-98). Besides, the rate of reduction in the areas of groundnut and maize also got reduced in the second period. Moong witnessed the highest CGR (22.49) in the first period among all the crops in both the periods but in the second period it became less but remained positive (1.18).

There has been drastic reduction in the CGR of paddy area during the later period over the earlier period

Determinants of Growth in Enterprises

Growth of yield, input use and prices of products may have favourable effects on the expansion of area under concerned crops while the growth in the input prices may adversely affect the growth in the area of different crops.

The association of these parameters with the growth or decline of different crop enterprises is discussed below:

Yield

The yield in kilograms per hectare of the important crops for the years 1977-78, 1990-91 and 1997-98 along with compound growth rates for the two periods (1977-78 to 1990-91 and from 1990-91 to 1997-98) is given in Table 3. The absolute yield levels are not strictly comparable across the crops because of considerable differences in their cost of production and their product prices. However, the temporal changes in the yield levels could be expected to have meaningful association with the temporal changes in the area of different crops, provided the parity between input-output prices remained the same. The strong association between area and yield was noted in case of oilseeds in the two periods. The increase in the CGR of oilseed yield from 1.77 in the first period to 4.20 in the second period appeared to be the major determinant of increase in CGR. The reduction in the CGR of paddy and wheat yields in the second period over the previous period explains the decline in the CGRs of paddy and wheat areas in the later period. The first period witnessed higher annual rate of growth in the yield of American cotton than that of Desi cotton which resulted in the higher positive value of CGR of area under American cotton as compared to negative CGR of Desi cotton. In the second period, the higher negative value of CGR of yield in case of American cotton as compared to that of Desi cotton resulted in the much lower value of CGR of area under American cotton as compared to that of Desi cotton. In case of groundnut and maize, the higher values of CGR of yield in the second period brought about positive changes in the CGRs of their areas in the second period. In other crop enterprises, no systematic relationship was observed between growth rates of area and yield.

Strong association between area and yield was noted in case of oilseeds in the two periods.

Table 3: Productivity and its CGRs of important crops in Punjab, 1977-78 through 1997-98.

(kg per hectare)

Crops/ Period		1977-78	1990-91	1997-98	CGRs (1977-78 to 1990-91)	CGRs (1990-91 to 1997-98)
Cereal Crops	Paddy	2910	3229	3465	1.23** (0.442)	0.51^{NS} (0.607)
	Wheat	2538	3715	3853	2.88** (0.328)	1.08^{NS} (0.609)
	Maize	1527	1786	2094	0.07^{NS} (0.927)	0.91^{NS} (1.487)
Pulse Crops	Moong	529	736	645	1.50^{NS} (1.164)	-2.79^{NS} (1.637)
	Mash	461	424	442	0.50^{NS} (1.139)	0.74^{NS} (2.913)
	Gram	912	744	824	0.19^{NS} (1.810)	3.71* (1.726)
Oil Seed Crops	R & M	503	1003	870	4.95*** (0.951)	0.66^{NS} (2.001)
	Ground-nut	989	816	987	-0.35^{NS} (1.131)	1.19^{NS} (1.227)
	Total oilseed	728	894	1370	1.77* (0.900)	4.20** (1.510)
Cash Crops	Cotton (A)	374	481	213	3.79** (1.729)	-8.93** (3.679)
	Cotton (D)	264	285	264	2.27^{NS} (1.587)	-1.87^{NS} (1.701)
	Sugar-cane	5612	5941	5685	0.92* (0.438)	-0.56^{NS} (0.687)

***, **,* denote significant at 1, 5 and 10 per cent level respectively.

^{NS} denote non significant

Cotton in terms in lint

Sugarcane in terms of gur

Figures in parentheses are Standard Error.

Product Prices

The output prices of different crops for three years i.e. 1977-78, 1990-91 and 1997-98 along with their CGRs in the two periods are given in Table 4. The higher values of CGR of product prices for sugarcane and desi cotton in the second period improved the values of CGR of their areas in the second period (Table 4). In case of Gram crop, the CGR of its price declined from 10.53 in

the first period to 6.6 in the second period which appeared to be the cause of logical change in the CGR of its area which changed from -13.83 to -16.05 in the two periods. This also implied that negative affect of price change on the change in area under gram was stronger than the positive effect of yield. The improved values of CGRs of prices of wheat and paddy in the later period over the previous period as may be seen from Table 4 failed to outstrip the negative affects of reduced CGRs of yield on the CGRs of area under these crops. In case of groundnut, the adverse effect of declining value of CGR of its prices, on the values of CGR of its area was more than off set by the positive effect of increased rate of growth of yield during these two periods. In total oil seeds, the effect of increased rate of growth in the yield was found to have a strong positive effect on the growth of its area and prices.

Table 4: Product prices and their CGRs of important crops in Punjab, 1977-78 through 1997-98.

(Rs/quintal)

Crops/ Period	1977-78	1990-91	1997-98	CGRs (1977-78 to 1990-91)	CGRs (1970-91 to 1997-98)
Paddy	77.95	218.79	439.18	8.36* (0.419)	9.68*** (1.056)
Wheat	114.88	215.36	453.71	4.41*** (0.298)	10.10*** (0.817)
Gram	176.25	749.49	1293.91	10.53*** (0.998)	6.60** (2.228)
R & M	303.20	847.50	1022.70	7.45*** (0.799)	2.93*** (0.688)
Ground-nut	246.96	774.00	1123.38	10.41*** (1.276)	7.44*** (1.864)
Total oilseed	728.00	894.00	1390.00	1.77* (0.899)	4.32** (1.505)
Cotton (A)	378.49	894.30	1992.31	7.52*** (0.918)	12.36*** (3.106)
Cotton (D)	351.61	756.64	1557.52	7.64*** (0.869)	10.21*** (3.235)
Sugar-cane	129.15	447.63	1101.48	9.66*** (1.726)	14.50*** (2.539)

***, **,* denote significant at 1, 5 and 10 per cent level respectively.

NS denote non significant

Cotton in terms in lint

Sugarcane in terms of gur

Figures in parentheses are Standard Error.

Input Prices

Prices in rupees of machinery items per unit, diesel and malathion per litre and of fertilisers per tonne are shown in Table 5 for the three previously mentioned years along with their CGRs for the two periods. Theoretically, changes in input prices are bound to affect inversely the use of inputs. The consequent changes in the use of inputs can be expected to bring about changes in cropping pattern. Before analysing their effects on input use and production pattern, it may be worthwhile to examine the changes in input prices during the periods under study. It may be seen from Table 5 that the CGRs of fertiliser prices witnessed substantial increase in the second period over the first period. Similarly, CGRs of electric motors (5 H.P.) and Diesel oil prices also showed considerable increases in the later period. However, CGR of malathion price evinced marginal increase and CGRs of tractor and diesel engine prices witnessed decline in the later period.

Changes in the use of inputs can be expected to bring about changes in cropping pattern.

Table 5: Prices of Inputs in Punjab, 1977-78 through 1997-98.

	Crops/ Period	1977-78	1990-91	1997-98	CGRs (1977-78 to 1990-91)	CGRs (1990-91 to 1997-98)
Fertilisers (Rs/ tonne)	Urea	1608	2240	3430	2.12** (0.794)	4.77** (1.572)
	DAP	2290	3500	8030	2.92*** (0.767)	13.08** (3.742)
	SP	610	1020	2080	2.81*** (0.761)	4.46NS (5.734)
	MOP	805	1300	4500	6.77NS (4.337)	18.72* (7.941)
Tractor (Rs/unit) International (35 HP)		49854	139610	236000	7.53*** (0.344)	6.95*** (0.829)
Irrigation equip-ment (Rs/unit)	Electri-cal motor (5HP)	1650	5000	11500	8.13*** (0.505)	11.53*** (3.259)
	Diesel engine (7HP)	3760	9276	7100	6.03*** (0.526)	–6.28NS (2.991)
Fuel (Rs/unit)	Diesel	1.42	5.15	10.00	8.01*** (1.089)	11.54*** (1.194)
Insecti-cide (Rs/liter)	Mala-thion	34.50	103.00	186.00	8.13*** (0.685)	9.81*** (0.621)

***, **,* denote significant at 1, 5 and 10 per cent level respectively.

NS denote non significant

Figures in parentheses are Standard Error.

Input Use

The use of chemical fertilszers in thousand metric tonnes; of insecticide in tonnes and numbers of tractors, electric motors and diesel engines are given in Table 6 along with their growth rates in the two periods. The perusal of this Table revealed that rate of growth in the use of fertilizers got reduced substantially in the later period owing to the sharp increase in their prices.

Table 6: Inputs use and their CGRs in Punjab, 1977-78 through 1997-98.

	Crops/ Period	1977-78	1990-91	1997-98	CGRs (1977-78 to 1990-91)	CGRs (1990-91 to 1997-98)
Ferti-lizers (000 metric tonnes)	N_2	331	877	1005	6.82*** (0.792)	1.75** (0.508)
	P_2O_5	105	328	287	7.28** (0.951)	-3.28^{NS} (1.809)
	K_2O	29	15	22	–2.72*** (1.239)	5.23^{NS} (5.760)
	NPK Total	465	1220	1314	6.55*** (0.793)	0.71^{NS} (0.789)
No. of Tractor (in 000)		71	195	245	8.22*** (0.237)	3.52*** (0.133)
No. of Tube well (in 000)	Electri-cal	262	610	735	7.33*** (0.309)	2.68*** (0.145)
	Diesel engine	360	200	175	–4.91*** (0.264)	–2.24*** (0.361)
Insecticide (000 tonnes)		2.20	6.10	7.15	7.65*** (0.165)	1.97* (0.863)

***, **,* denote significant at 1, 5 and 10 per cent level respectively.

^{NS} denote non significant

Figures in parentheses are Standard Error.

Further, perusal oF Table 6 witnessed decline in the number of diesel engines in the state in 1997-98 over 1990-91 and in 1990-91 over 1977-78. However, their annual rate of decline got reduced in the later period. The decreased demand for diesel engines in the state appeared to have depressed their prices in 1997-98 as compared to 1990-91. Contrarily, the increasing prices of diesel engines during the period from 1977-78 to 1990-91 had reduced their demand considerably. The increased number of electric motors in the state with time not only pushed their prices upward but the annual rate of growth in their prices also got enhanced in the later period (1990-91 to 1997-98). The number of tractors and their prices witnessed increasing trend with time. However the rate of increase got somewhat reduced in the second period.

The use of insecticide (malathion) got intensified with time but its rate of increase got slowed down in the later period which may be attributed to the higher growth rate of its price in the second period.

References

Biswas C B, G N Chattopadhya, A Bandyopadhyay, A Ghose and P B Chakraborty (1994), "Resource Management through Paddy-cum-Fish Culture in Coastal Saline Area", Jr. Ind. Soc. Costal Agril Res, Vol 8, No.1, pp. 37-40.

Chaudhry M K and A K Narang (1994), "Integrated Farming System for Sustainable Employment and Income Generation", Seminar on Livestock for Sustainable Rural Employment and Income Generation. (Ind. Soc. Agril. Econ.) at NDRI, Karnal, from April 6-7, pp. A.41.

Ganesan S, K N Chinnaswami, B Chandrasekheran, M N Badhar and M J P Jayaseelan (1991), "Duck-cum-Fish Culture in Rice Farming System in Cauvery Delta Region on Tamil Nadu – The Aduthurai Experiment", Ind. Jr. Agril. Econ., Vol.46, No.2, pp.180-85.

Gangwar A C (1994), "Sustainability of rural employment and income through livestock enterprises", Seminar on Livestock for Sustainable Rural Employment and Income Generation, Ind. Soc. Agril. Econ. at NDRI, Karnal, from April 6-7, pp. A1-A12.

Mahyuddin M D and I Dahler (1997), "Sustainable Dairy Production in Asia in the Context of World Dairy Production", Proceedings of 8th AAAP Annual Science Congress on Partnership for Sustainable Livestock Production and Human Welfare, pp. 479-85.

Singh Kulwant, Raj Pal Singh and R K Patel (1994), "Optimum Combination of Crop Production and Dairy Enterprise for Increasing Income and Employment on Farms in Haryana", Seminar on Livestock for Sustainable Rural Employment and Income Generation, Ind. Soc. Agril. Econ. at NDRI, Karnal, from April 6-7, pp. A.42-44. □

Feature

Total Quality Management in Agricultural Research

Smitha Baby & Joy Mathew

Agricultural research has grown to its present importance in India because of its great contribution to the farming community during the green revolution period. Though a sizeable proportion of our country's financial outlay for agriculture goes for research endeavours, little attention is given to standardise a quality management system in agricultural research. With this view, an indepth analysis of the concept of quality management in agricultural research is attempted in the present study, which may contribute in a big way to the understanding and management of total quality in agricultural research.

Smitha Baby is a Research Associate and Joy Mathew is Associate Professor in the Department of Agricultural Economics, College of Horticulture, Kerala Agricultural University, Thrissur, Kerala.

New ideas, innovations and improved agricultural techniques – the outcomes of research – are the stepping- stones to progressive agriculture. Agricultural research has grown to its present importance in India because of its great contribution to the farming community during the green revolution period. Green revolution, being one of the biggest success stories of India cited globally, enabled the country to convert its nightmarish 'begging bowl' status to that of 'self-sufficiency', with a quantum jump in food grain production from a mere 50.8 million tons during 1950-51 to 209 million tons in 1999-2000. However, there is a growing feeling that in order to accelerate the rate of progress in Indian agriculture, we will have to get a breakthrough in the efforts to increase the quality of agricultural research.

Often the researcher is too busy applying his scientific skills to fascinating problems to leave much time for thinking about the quality of research. Everybody would accept that it would be desirable to improve the quality of agricultural research. But the question is 'How?' What does research quality mean? There is no general view on how to differentiate between good quality and poor quality research.

Quality of agricultural research is often associated with the end results alone. If the results do not have practicability and wide acceptability, the research is often dumped as poor quality. Such as approach can be extremely frustrating and disappointing to the researcher concerned, seriously affecting his morale and motivation. Quality, in fact, could be identified at various stages of agricultural research starting from conceiving a research problem, designing a suitable project and preparing the final report such that even in the absence of a viable end product the researcher could be credited with due merit.

According to Brady (1973), the quality of scientists will determine the quality of research that is done. Suc-

cess in research depends to a very large extent on the abilities and motivation of the individual scientist, as well as the opportunities afforded him for carrying out his work within a favourable environment (Anderson, 1982). This leads to the view that various personal, psychological, job and organisational characteristics may have an influence on quality management in agricultural research.

Various personal, psychological, job and organisational characteristics influence quality management in agricultural research.

The present study was undertaken with the following two specific objectives:

- Identify the dimensions of quality management in relation to agricultural research
- Study the influence of selected personal, psychological, job and organisational characteristics on quality management in agricultural research.

Methodology

Quality management in agricultural research was operationalised for the present study as "excellence in every stage of agricultural research starting from conceiving a research project, conducting it and preparing the final report".

Quality management in agricultural research

Delving into the vast volume of available literature and having threadbare discussions with the resource persons in the field of agricultural research, ten different dimensions of quality management in agricultural research were finalised. These dimensions were then ranked by a group of judges based on their importance in deciding the final quality of agricultural research. Rankings were obtained from 36 judges who were experts in agricultural research in Kerala Agricultural University. Based on these rankings, specific weights or scale values were worked out for each dimension using the Normalised Rank Method by Guilford (1954).

Measurement of the dependent variable

A composite scale was developed based on the above dimensions and was tested for reliability and validity using accepted scientific procedures. The scale was used for quantifying the dependent variables in quality management.

Measurement of the independent variables

Fourteen variables viz. experience, training, technical competence, scientific orientation, achievement, motivation, scope for personal development, attitude towards job, job commitment, job satisfaction, task identity, job autonomy, perceived workload, infrastructure facilities and organisational climate were selected as independent variables for the study. These variables were measured using either adopted scales or schedules developed for the study.

Data collection and analysis

A pre-tested, structured and standardised questionnaire was used for data collection. All the externally aided research projects completed after 1995 in the central zone of Kerala Agricultural University were considered as the sample for the study and the principal investigators of these projects formed the respondents. Finally, 55 scientists constituted the respondents of the study.

Data analysis was carried out using appropriate statistical tools like frequency, percentage, correlation, multiple-regression, step-down regression and path coefficient analysis.

Results and discussion

Table 1 presents the scale values obtained for different dimensions of quality management in agricultural research, which was based on the perceived importance of each dimension in deciding the final quality of agricultural research. It is observed from the Table that among the 10 different dimensions of quality management in agricultural research, research problem identification got the highest scale value, followed by formulation of objectives, research methodology, literature review, data generation, data analysis, results and implications, project title, reporting and bibliography in descending order.

A perusal of the table revealed that research problem identification emerged as the most important dimension of quality management in agricultural research. This indicates that quality can be identified primarily in the innovative, meaningful and imaginative selection of the research problem itself. This finding corroborates the view of Lloyd (1966) that conceiving a research project is the essence of research, a research

Research problem identification emerged as the most important dimension of quality management in agricultural research.

problem is solved in some fellow's head – the thinking step usually comes first and the experiment then follows as a testing of the idea.

Table 1: Dimensions of quality management in agricultural research with their scale values

Dimensions	Scale value
Research problem identification	10.74
Formulation of objectives	9.3
Title of the research project	3.08
Literature review	6.94
Research methodology	8.76
Data generation	6.8
Data analysis	6.02
Results and implications	4.19
Reporting	3.0
Bibliography	0.72

Formulation of objectives was identified as the next important dimension of quality management in agricultural research. It is reasonable to conclude that formulation of objectives could be one of the important dimensions of quality management in agricultural research as the objectives clearly define the focus and direction of research.

As Lloyd (1966) stated, formulation of objectives is so important that the solution becomes evident when the problem is properly stated. Arnon (1975) also emphasised the need for a sound formulation of objectives and considered it as one of the most important yardsticks in the preliminary screening of research projects.

Research methodology emerged as the next important dimension of quality management in agricultural research. It is only logical that a good methodology ensures the technical soundness of the research work. Quality can definitely be associated with the identification and selection of appropriate standardised tools and proven scientific methods for approaching and attacking the problem.

Literature review also evoked a considerably high scale value. It is well accepted that any systematic scientific enquiry has its foundations built upon studies conducted in the past. It provides a firm ground from where to launch your offensive. Hence a quality literature review can certainly be expected to add to the total quality of agricultural research.

Quality literature review can be expected to add to the total quality of agricultural research.

Contrary to popular belief, a comparatively low scale value for the dimension research results may appear strange and misleading, but deserves special attention. While there is a general tendency to associate the quality of agricultural research with the end results, the present finding is a thought provoking one. While this finding never needs to be considered as downplaying the importance of a widely accepted and practicable research result, it projects a new line of thinking that even in the absence of a viable end result, a research work should never be dumped as poor quality.

Table 2: Predictive power of the selected independent variables on quality management: results of multiple regression analysis

n = 55

Variable No.	Selected variable	Partial regression coeff. 'b'	Standard error of 'b'	't' value
x_1	Experience	0.293	0.249	1.268
x_2	Training	–0.011	0.080	1.231
x_3	Technical competence	0.108	0.097	1.445
x_4	Scientific orientation	–0.064	0.110	1.248
x_5	Achievement motivation	–0.058	0.106	1.647
x_6	Scope for personal development	0.217	0.114	2.386*
x_7	Attitude towards job	0.085	0.121	1.865
x_8	Job commitment	0.014	0.171	2.294*
x_9	Job satisfaction	–0.210	0.127	2.060*
x_{10}	Job autonomy	0.005	0.083	1.374
x_{11}	Task identity	0.161	0.078	1.108
x_{12}	Perceived workload	–0.015	0.078	1.849
x_{13}	Infrastructure facilities	0.011	0.095	1.248
x_{14}	Organisational climate	–0.004	0.125	2.133*

R^2 = 0.2931, F = 1.18

*Significant at 0.05 level

A bird's eye view of the Tables 2 and 3 reveal that five independent variables viz. experience, technical competence, scope for personal development, job satisfaction and task identity together contributed 26.74 per cent variation against the 29.31 per cent variation contributed by all the 14 variables included in the study.

However, it may be noted that though the R^2 value of 29.31 offers scope for enough explanation, a sizeable 70.69 per cent variation in the dependent variable lies outside the variables included in the study. Probably other factors like research planning, monitoring and evaluation and some other personality traits of the scientists might be attributed to these aberrant findings. Also, the self-rating method adopted in the study might have caused some inflation on the quality management scores. From the best subset of variables predicting the variation in quality management (Table 3), only two variables, scope for personal development and task identity, showed a positive and significant relationship with quality management, though the other three variables had also contributed considerably to the variation in quality management.

Table 3: Multiple regression analysis of variables selected through step-down regression

Variable no.	Characters	Partial regression coeff. 'b'	Standard error of 'b'	't' value
x_1	Experience	0.253	0.215	1.175
x_3	Technical competence	0.095	0.078	1.218
x_6	Scope for personal development	0.237	0.081	2.919*
x_9	Job satisfaction	–0.167	0.097	1.718
x_{11}	Task identity	0.158	0.068	2.316*

R^2 = 0.2674

*Significant at 0.05 level

Two variables, scope for personal development and task identity, showed a positive relationship with quality management.

In any organisation, organisational facilities such as opportunities to undergo training programmes and exposure to advanced technologies would facilitate the personnel to rise up to the desired level. Scope for personal development refers to the perception of the employees about these facilities and thereby the opportunity for self-growth and the scope to prove their excellence. It is not surprising to see that officials like scientists give much value to this factor. Herzberg's (1966) motivation-hygiene theory also put forth opportunity for growth in the job as a critical motivating factor.

Hence the present finding of a positive and significant relationship between scope for personal development and quality management is quite natural. The finding is in conformity with that of Satapathy and Choudhary (1990) who reported that providing participation in professional seminars, opportunities for self-growth and scope to prove merit were closely related with the output of scientists.

Another important finding is the positive and significant association between task identity and quality management. Task identity refers to the degree to which a job requires completion of a 'whole and identifiable piece of work' viz. doing a job from beginning to end with a visible outcome. According to Turner and Lawrence (1965), when a job is high on task identity, the worker is in a better position to realise that he has accomplished something of consequence. For scientists, the job characteristics like task identity may provide positive emotional feelings that result from good job performance. Job characteristic theory by Hackman and Oldham (1976) states that specific job characteristics like task identity provides psychological conditions that lead to greater motivation and performance. This view holds good in the context of the present study, as George (1996) has already reported a positive and significant association between task identity and work motivation of teachers in Kerala Agricultural University. All these clearly vindicate the above finding.

Experience and technical competence were also found to have contributed to the variations in quality management, though the influence was not significant. It is reasonable to assume that officials with more experience put forth better performance. A similar trend was found in the studies of Poornakumar (1988) and Kalaivani (1999) where experience acted as one of the crucial parameters in explaining job performance. It is also logical to say that a sense of competence in the officials give then more confidence and pride and they become keen to maintain a position of excellence in their field. However, both experience and technical competence showed a non-significant association with quality management, which may be due to poor discrimination of the respondents on these variables.

A negative, but insignificant relationship between job satisfaction and quality is another intriguing finding. This may have several reasons. As Morse (1953) reported, personal characteristics like intelligence, use

Experience and technical competence showed a non-significant association with quality management.

of skills and level of aspiration may influence job satisfaction. People who are more intelligent and competent in their work may find insufficient challenge in their job and it may lead to boredom and dissatisfaction. It could also be assumed that the overall job satisfaction of the employees is strongly related to their higher order needs i.e. self-esteem and self-actualisation. Hence it is likely that the more intelligent and competent scientists in Kerala Agricultural University, who are more ambitious about the quality of their research work may remain dissatisfied in many of the other aspects of their job and organisation in terms of position, respect, compensation etc. Cherrington *et al,* (1971) found that reward structure mediated the relationship between satisfaction and performance i.e., when the performance was appropriately rewarded, the satisfaction-performance relationship was positive and vice versa. Thus there is no reason to accept the notion that only satisfied workers are productive. The relationship may be much more complex and indirect.

No reason to accept the notion that only satisfied workers are productive.

While it is often thought that achievement motivation contributes to work motivation and performance, the poor correlation between achievement motivation and quality management in the study calls for special attention. This finding doesn't agree with the earlier observations of George (1996) that achievement motivation was positively and significantly associated with work motivation of teachers in Kerala Agricultural University. This leads to the conclusion that some other motivational factors have interplayed here. It is reasonable to assume that officials like scientists may value their growth need, which involves more challenge and creativity. Growth needs are major motivational factor in the ERG theory of Alderfer (1969). Growth needs focus on the self such as opportunity for personal growth and development in the job situation. Maslow's self-esteem and self-actualisation needs are said to be equivalent to Alderfer's growth needs. A strong positive association between scope for personal development and quality management elicited in the present study may also support this view. Hence the above finding is justifiable.

Conclusion

The result emanating from the study on the subtle details of the quality management concept in agricultural research would provide deeper insight to policy makers on how to cultivate and foster the quality management principle in the field of agricultural research. The study, it is believed, could probe into the relationships of selected personal, psychological and job/organisational variables with quality management in agricultural research, the results of which may prove invaluable in quality management efforts in agricultural research.

References

Alderfer, C.P. (1969), "Existence, Relatedness and Growth: Human Needs in Organisational Settings", The Free Press, London.

Anderson, P.P. (1982), "Agricultural Research and Technologies in Economic Development", Longman Group Ltd., New York.

Arnon, I. (1975), "The Planning and Programming of Agricultural Research", Food and Agricultural Organisation of the United Nations, Rome.

Brady, N.C. (1973), "Financial resource management and research quality", Proc. National Seminar on Institutionalising Research Management in Asia, Philippines.

Cherrington, D.J., Reitz, H.J. and Scott, W.E. (1971), "Effect of contingent and non-contingent reward on the relationship between satisfaction and task performance", J Appl. Psychol. 55: 531-536.

George, A. (1996), "Work motivation – a multivariate analysis among teachers of the Kerala Agricultural University", Ph.D. Thesis, Kerala Agricultural University, Thrissur.

Guilford, J.P. (1954), "Psychometric Methods", Tata McGraw Hill.

Hackman, J.R. and Oldham, G.R. (1976), "Motivation through the design of work: test of a theory", Organisational Behaviour and Human Performance, 16: 250-279.

Herzberg, F. (1966), "Work and the Nature of Man", World Publishing, Cleveland.

Lloyd, L.E. (1966), "Techniques for Efficient Research", Chemical Publishing Company, New York.

Kalaivani, S. (1999), "Managerial competency, job perception & job performance of extension personnel in Broad Extension System", Ph.D Thesis, Tamil Nadu Agricultural University, Coimbatore.

Morse, N.C. (1953), "Satisfaction in the White Collor job", University of Michigan Press, Ann Arbor.

Poornakumar, V.A. (1988), "Job performance, job satisfaction and problems of assistant professors of Agricultural University", M.Sc.(Ag) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Satapathy, C. and Choudhary S.K. (1990), "Variables for measuring achievements of farm scientists", Indian Journal of Extension Education 26(1&2): 55-60.

Turner, A.N. and Lawrence P.R. (1965), "Industrial Jobs and the Worker", Harvard University, Graduate School of Business Administration, Boston.

□

Feature

Pollution Control in Dyeing & Bleaching Units in Karur, Tamil Nadu

M. Ravichandran, C. Durgadevi & S. Boopathi

The prime aim of this paper is threefold. Firstly, to elucidate the problem of industrial effluents from dyeing and bleaching units in Karur. Secondly, to study the pollution control measures adopted by small scale dyeing and bleaching units. And thirdly, to analyse the cost effectiveness of individually owned effluent treatment plants vis-à-vis Common Effluent Treatment Plants (CETP).

M. Ravichandran is Reader, C. Durgadevi and S. Boopathi are Research Scholars with Department of Economics, Bharathidasan University, Tiruchirappalli.

It is common knowledge, more often than not that large industrial units generate more effluents and the small enterprises cause less damage to environment. This is a myth. The ground reality is whether small-scale units through processing and manufacturing generate pollution and inflict damage to the environment. There is no gainsaying the fact that small-scale units face inadequacy of space and finance towards adopting pollution abatement measures. Emissions/effluents discharged from industrial units, irrespective of whether large or small scale, will cause damage to the receiving media, notwithstanding the variations in the quantity of discharge.

There exist divergent viewpoints in this realm. Mostly small-scale industrial units get situated within the premises of city/corporation. All spin-off effects would naturally be borne by the local inhabitants. Another view is that hazards are due to industries, which produce intermediate rather than final products. Generally, small-scale units use intermediate products like pulp or Kraft etc. rather than produce them. Some would argue that small-scale units have little access to research and development results. This is no excuse for non-adoption of pollution control measures. The whole idea is not to develop a priori impressions on small-scale units, but to highlight the potential damage that the small sector could cause, given the nature of products produced. It is, in this context necessary to identify small-scale units or industries, which pollute air and water or store hazardous material harming the lives of workers and even neighbours.

Material and Methods

The secondary data was furnished from the Tamil Nadu Pollution Control Board (TNPCB), Karur. Details regarding the pollution control measures taken by the select ten units were collected through primary visit to the units. Besides, informal discussion was held with

and CETPs are compared to prove the economies of scale.

The annualised pollution control cost of individual ETPs and CETPs are compared to prove the economies of scale.

Results and Discussion

For over a century, the textile and power loom units were in vogue in Karur and neighbouring areas. Proximity to textile city viz., Coimbatore, enabled the textile owners to procure yarn from there. Existence of textile units promoted the dyeing and bleaching units to come to Karur. Initially, the importance of dyeing units was not felt by the textile owners as they mostly produced dhothis and sarees. Switch over from dhothis and sarees to bedsheets caused the starting of dyeing and bleaching units in Karur. Earlier the textile units had dyeing and bleaching sections as part of their units. But slowly, large units closed down their dyeing and bleaching sections and started to encourage units, which exclusively concentrated on dyeing and bleaching on 'job-work' basis. A few large textile units started their own dyeing units, away from the mother unit, located close to the Ameravathy river.

Mushrooming of dyeing units in Karur is due to the fact that dyeing workers, after having worked and gained sufficient knowledge, came out and started their own units individually. Dyeing and bleaching units are basically water intensive. In Karur, these units are located between Ameravathy riverbank and Puliyur canal. The main purpose of this location is to make easy access to river water on the one hand and easy discharge of effluents into the river through the canal.

Over a period, Karur district became popular for bedsheets, called "jamakalam" in local language. Consequently, buyers from all over the state preferred Karur as a place for bedsheets for bulk purchase. This in turn enhanced the growth of dyeing and bleaching units in Karur.

In this backdrop, the analysis of available information on individual ETP vis-a-vis CETP showed relative cost scenario of treatment plants. Data set out in Table 1 showed the capital cost of the select ten units from which primary data was collected. The capital cost of the units as a whole ranged from 4.5 lakhs to 39 lakhs. The capital cost on pollution control was found to be 3 to 5 lakhs among all units. Importantly, the capital cost of pollution control as percentage of total capital cost ranged from 15.0 to 88.9 with a mean value of 44.14. Such prohibitive cost of pollution control is the precise reason that small-scale units refrained from adopting pollution control measures. The same was the case with other parameters also. The area covered for installation of effluent treatment plant as percentage of the total area of the unit showed a mean value of 22.8. The manpower of the pollution unit was 13.9 per cent of the total employees in the units. The ratio of power consumed to the total power consumption registered a high mean value of 70.85. In the case of chemicals consumed and the total wages paid for pollution control, the mean percentage values worked out to be 5.34 and 13.2 respectively. The maintenance cost of pollution control as percentage of total maintenance cost worked out to be 7.33 per cent, while the annualised PCC as percentage of annual turnover showed a mean value of 7.5. The foregoing description of pollution control costs and its ratio with area, power, chemicals, turnover, O&M cost and the total production cost facilitated a better understanding of the measures adopted by the units. There is no gainsaying that small-scale units find pollution control burdensome.

Prohibitive cost of pollution control is the precise reason that small-scale units refrained from adopting pollution control measures.

Data presented in Table 2 showed O&M cost of select ten units. The annualised total cost of each unit was calculated by summing up the depreciation on total cost, interest on total cost and O&M cost for one year. Similarly the annualized pollution control cost was calculated by adding up the depreciation on pollution control cost, interest on P.C.C. and O&M of pollution control per year. Finally, the percentage of annual P.C.C. to the annual total cost was found to range from 5.3% to 13.55%.

The above empirical evidences on pollution control costs and its influence on economic variables would only pave the way to discuss whether or not small-scale units find it easy to adopt the effluent treatment process individually. Conversely, collective participation by the units through CETPs is yet another tenable alternative that will be discussed in the following paragraphs. A comparison of the CETPs with the individual owners may reveal the relative advantage of the treatment methods.

In Karur, during 1999-2000 there were eight

Table 1: Details of dyeing and bleaching units that adopted individual ETPs

Name of the Units	Capital cost of select units (Lakhs)	Capital cost on PC (lakhs)	Capital cost of PC as % of the total capital cost	Area of ETP as % of total area of the unit	No. of persons employed for PC as % of total workers	Power consumed for PC as % of total power	Chemicals consumed for PC as % of total chemicals used
Malar	15	5	33.3	30	6.7	50	7.7
Vinod	30	4.5	15	16.7	12	66.7	10
Arulrani	6	4.5	75	20	14.3	50	2.9
Arasi	39	4.0	10.3	15	3.3	50	8.9
Southern	15	4.5	30	15	6.7	50	2.5
Jeevan	4.5	4.0	88.9	10	25	53.3	3.3
Anbalaya	4.75	3.7	77.9	12.5	28.6	90	5.0
SPS	10	3.0	30	38.7	20	62.5	8.0
Attick	6.25	3.5	56	50	12.5	95	1.3
Abirami	20	5.0	25	20	10.5	50	3.8

Table 2: Operation and Maintenance cost (in lakhs)

Name of the Units	Depreciation total cost 10%	Interest on total cost 12%	O&M cost full unit	Annualised total cost	Depreciation on PC cost	Interest on PC cost	O+M cost (PC)	Annualised PC cost	Annual PCC as % of annual TC
	1	2	3	1+2+3	5	6	7	5+6+7	
Malar	1.5	1.8	28.08	31.38	0.5	0.6	2.34	3.44	10.96
Vinod	3.0	3.6	18.95	25.55	0.45	0.54	2.34	3.33	13.03
Arulrani	0.6	0.72	12.64	13.96	0.45	0.54	0.70	1.69	12.11
Arasi	3.9	4.68	23.09	31.67	0.4	0.48	2.34	3.22	10.17
Southern	1.5	1.8	36.50	39.8	0.45	0.54	1.33	2.32	5.8
Jeevan	0.45	0.54	22.00	22.99	0.4	0.48	1.37	2.25	9.8
Anbalaya	0.475	0.57	15.29	16.335	3.7	0.444	1.40	2.24	13.55
SPS	1.0	1.2	18.90	21.1	3.0	0.36	1.87	2.53	12.0
Attick	0.625	0.75	30.89	32.265	3.5	0.42	0.94	1.71	5.3
Abirami	2.0	2.4	46.80	51.2	5.0	0.6	2.34	3.44	6.7
			25.314				1.697	2.617	

CETPs under operation. In order to promote collective action and to enable small-scale units to participate in pollution control programmes, the Centre, the State and the World Bank extended subsidies for installing CETPs. On an average the Centre and State gave subsidy to the extent of 25 per cent of the total cost of CETPs. The World Bank, albeit not extended to all the CETPs, provided subsidy up to 30 per cent of the total cost. The contribution made by the respective members of CETPs ranged from a minimum of 17.7 per cent to a maximum of 50 per cent. The total cost of CETPs ranged from Rs. 169 lakhs at current prices to 244 lakhs (Table 3).

The capacity and cost details of CETPs showed a range of 47 member units in one plant (Karur Karuppampalayam Enviro Tech Ltd.) to 150 member units in another plant (Karur Sellandipalayam pollution control units). The capital cost of each facility worked out to be Rs. 210 lakhs on an average. The O&M cost was Rs. 1.80 lakhs per

The Centre, the State and the World Bank extended subsidies for installing CETPs.

Table 3: Sources of Finance of CETPs in Karur (1998-99) (Rs. in lakhs)

Name of CETP	Members contribution	Central govt. subsidy	State govt. subsidy	Loan under World Bank	bank line of credit
Karur Thiruvai Dyeing Enviro Ltd.	40.00	52.00	52.00	64.00	208.00
Amaravathi Pollutech Ltd.	44.00	60.00	60.00	80.00	244.00
Karur Taluk Dyeing Ltd.	38.60	48.25	48.25	57.90	193.00
Karur Andankoil Pollution control Ltd.	45.60	50.00	50.00	82.40	228.00
Karur Vanchi Dyeing Enviro Ltd.	108.00	54.00	54.00	–	216.00
Karur Sukkaliyar CETP company Ltd.	30.00	50.00	50.00	39.00	169.00
Karur Sellandipalayam Pollution Control Ltd.	112.50	56.25	56.25	56.25	–
Karur Karuppampalayam Envirotech Ltd.	40.00	50.00	50.00	60.00	200.0

Table 4: Capacity and Cost Details of the Common Effluent Treatment Plant

Name of the CETP	No. of Dyeing units	Capital Cost (Rs. in lakhs)	cost Rs. in lakhs					
			Chemical	Power	Man power	Others	Maintenance cost/Month	Quality of Effluent (KLD)
			a	b	c	d	a+b+c+d	
Karur Thiruvai Dyeing Enviro Ltd.	62	208	0.60	1.00	0.05	0.10	1.75	2100
Amaravathi Pollutech Ltd.	53	244	0.70	1.25	0.05	0.10	2.10	2400
Karur Taluk Dyeing Ltd.	48	193	0.40	0.75	0.05	0.10	1.30	1500
Karur Andankoil Pollution control Ltd.	47	228	0.40	0.90	0.05	0.10	1.45	1900
Karur Vanchi Dyeing Enviro Ltd.	58	216	0.60	1.00	0.05	0.10	1.75	1150
Karr Sukkaliyar CETP Company Ltd.	80	169	0.70	1.35	0.06	0.10	2.21	1400
Karur Sellandipalayam Pollution Control Ltd.	150	225	0.34	0.87	0.23	–	1.44	2600
Karur Karuppampalayam Envirotech Ltd.	47	200	0.73	1.50	0.13	0.02	2.38	1300
		210.37	0.56	1.08	0.08	0.09	1.80	1793.7

month with chemicals worth Rs. 0.56 lakhs, power Rs. 1.08 lakhs, and manpower Rs. 0.08 lakhs on an average for the eight units (Table 4).

Similar to individual treatment plants the annualised pollution control cost for each CETP unit was calculated by taking the sum of depreciation on capital cost, interest on capital cost and annual O&M cost, then dividing it by the number to member units in each CETP facility. The annualised pollution control cost was found to range from a minimum of 58.06 lakhs to a maximum of 78.88 lakhs for the CEPTs. The cost incurred by individual member units was calculated, it worked out from 0.45 lakhs to 1.54 lakhs. When compared to the cost incurred by individual ETPs this cost is economical. This also proves the theory of economies of scale (Table 5).

Table 5: Proportion of Annualised pollution control cost to the capital cost

Capital cost	Depre-ciation	Interest	O&M cost	Annua-lised PCC	APCC as % of CC	Member unit
208	20.8	24.96	21.00	66.76	1.07	62
244	24.4	29.28	25.20	78.88	1.48	53
193	19.3	23.16	15.60	58.06	1.20	48
228	22.8	27.36	17.40	67.56	1.43	47
216	21.6	25.92	21.00	68.52	1.18	58
169	16.9	20.28	26.52	63.70	0.79	80
225	22.5	27.00	17.28	66.78	0.44	150
200	20.0	24.00	28.56	72.56	1.54	47
Total			21.57	67.85		

Table 6: Details of CETPs in operation

Primary	Karur Thiruvai Dyeing Ltd.	Karur Sukkaliyur CETP Company Ltd.	Karur Karupampalayam Enviro Tech Ltd.	Amaravathy Pollutech Ltd.
No. of units	62	7	47	48
Quantity of effluent treated per day	2400	1700	1200	2400
Capital cost (in lakhs)				
(i) Land	3.00	3.00		6.00
(ii) Building	57.25	79.00		77.00
(iii) Plant & Machinery	77.75	72.00		103.00
(iv) Others	70.00	69.29		54.00
Total	208.00	223.29	169.00	300.00
Area (in acres)	0.96	1	1	2.50
No. of workers per day	5	4	9	8
Operation & Maintenance cost/M (in lakhs)				
(i) Power	0.80	6800	40000	1.00
(ii) Chemical	0.60	2805	90000	0.50
(iii) Manpower	0.25	500	–	0.15
Total	1.85/m	10205/d	145000/m	2.00/m
Waste disposal medium	Sanapiratty channel	Amaravathy	Amaravathy	Amaravathy
Chemicals used	Lime Alum & Polyelectrolyde	Lime Alum & Polyelectrolyde	Lime Alum & Polyelectrolyde	Lime FeSo4 & Polyeloctrolyde
CETP Sludge (Kgs/d)	2500	771	200	400

Out of the eight proposed CETPs in Karur, four were commissioned on 14-6-1999 and the other four are under various stages of construction. Information regarding the cost structure, space, manpower, electric power, fuel and O&M cost for the four operational units are given in Table 6.

The quantity of effluents treated varies in relation to the number of units in the CETPs. The sludge produced in the CETPs range from 200 to 2500 kgm/day. The waste disposal media is Sanapiratty channel or Amaravathy River. The characteristics of the effluents before and after treatment shown in Table 7 denotes a marked reduction in the value of total dissolved solids, total suspended solids, COD, BOD, chloride and sulphate. This treated effluent let off into the water channels will not cause any health hazard as compared to the untreated effluents. The official claims notwithstanding, the so-called treated effluents continued to inflict damages on the households living close to the dyeing units.

The sludge produced in the CETPs range from 200 to 2500 kgm/day.

Households living in and around dyeing units are exposed to effluents from the dyeing units. Skin disease is a major health hazard, which affected most of the residents. In addition, lung diseases owing to constant handling of chemicals are reportedly affecting the workers of dyeing units.

Table 7: Characteristics of Raw Effluents

Parameters	Value	After treatment
Colour	1800-2100 pt.co	80 pt.co
PH	8.5	7-8
Total suspended Solids	1200-1800 mg/L	65
Total Dissolved solids	2500-3500 mg/L	1200
COD	450-600 mg/L	230
BOD	150-200 mg/L	25
Chloride	1500-2500 mg/L	600
Sulphate	250-750 mg/L	200

Another major problems in Karur is ground water pollution. The Total Dissolved Solids (TDS) level exceeded the tolerance limit, and the leaching of chemicals underneath caused the ground water to be polluted. Consequent to degradation of ground water the drinking water source became unsafe in Karur town. The situation now is very grave and the peopled have started agitations. Unlike surface water the ground water sources once polluted, is difficult to treat.

The onslaught of dyeing effluent was felt by the agricultural sector too. Most of the agricultural land on the bank of Amaravathi River became redundant due to industrial effluents. Consequently the agricultural land owners took to dyeing and bleaching activities. Effluents from dyeing and bleaching units caused both depletion and degradation of ground water resources. The water quality was seriously affected owing to effluents and the people of Karur resorted to agitations and demonstrations. The drinking water situation at present is deplorable.

Agricultural land on the bank of Amaravathi River became redundant due to industrial effluents.

Besides cost aspects, the CETPs have certain other advantages. The CETPs are eligible for subsidy to the extent of 50 per cent of the total investment on plant and machinery. Of the total subsidy, the state shares 25 per cent and the rest 25 per cent by the centre. In addition, CETP operations can save labour, space and facilitate easy management of pollution control. However, CETPs are not free from some bottlenecks. In the event of machine failure of CETPs production will stop and there by reduce the generation of effluents. Besides, individually operated ETPs can function through out the week, even on Sundays the effluent treatment process can be carried out.

Conclusion

Major problem with studies on pollution control is that polluting units seldom share information with researchers. There is a lot of resistance from many of the polluting units to divulge information regarding pollution and pollution control technology adapted by them. In the case of dyeing and bleaching units in Karur, there is compulsion for the units to take some measure of pollution control because they would face closure in case of non-compliance to the rules set out by Pollution Control Board. In Karur, most of the dyeing units discharge their effluents into the Amaravathy and Sanaipiratty channel leading to contamination of all drinking water and agricultural wells. The CETP treated effluent does not contain any heavy organic load and so they form the most innovative, cost-effective, factory-specific pollution control technology in the present situation.

CETP confirms the theory of economies of scale in pollution abatement when compared to ETPs installed individually. The capital cost of individual ETP works out to be a high 44.14 as percentage of total cost of the unit as compared with CETP where the individual member units need only invest 0.5-1.0 lakh since State government, Central government and World Bank provide subsidies upto 80 per cent. For O&M cost the individual ETPs need Rs. 1.70 lakhs annually on an average but for CETPs the member unit need only pay Rs. 30,000 to 50,000 per year. Finally, if we consider the annualised pollution control cost for each unit, it is about Rs. 2.62 lakhs on an average for the ETPs maintained individually, for CETPs the cost comes upto an average of Rs. 67.85 lakhs for a single unit but when we share it among the member units it comes up to Rs. 1.15 lakhs on an average.

The Government of Tamilnadu has now made it mandatory for individual units to link with CETP to treat their effluents. This may even facilitate the enforcing authority to monitor the pollution control operations better.

The Government of Tamilnadu made it mandatory for individual units to link with CETP to treat their effluents.

Acknowledgement

This paper is an outcome of a Minor Research Project funded by the Bharathidasan University, Tiruchirappalli, under the UGC unassigned grant. The authors are grateful to the Research Committee, Bharathidasan University, for the same.

References

Gazetteer of Tamilnadu (1998), 'Tiruchirappalli District – Volume-1', Chennai printers, Industrial Cooperative Society Ltd., Chennai.

The World Bank (1984), 'Environmental Guidelines', Office of Environmental Affairs.

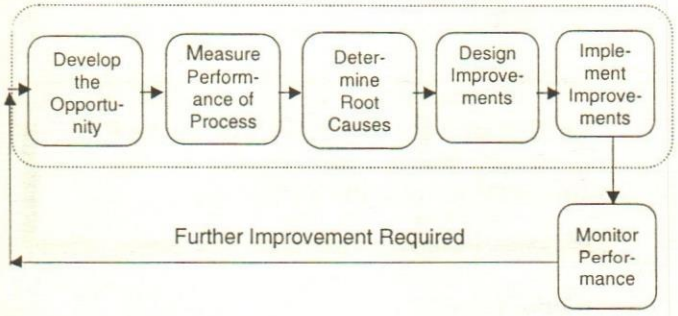
□

News & Notes

FAQs related to Six Sigma

Six Sigma, what is it?

Sigma (σ) is the statistical term used to denote the amount of variability in a process, product, or service. Six sigma is the statistical representation of zero variability (in reality, a variability of 6s represents 3.4 defects per million occurrences or opportunities for defect). Thus, the six sigma methodology is a performance improvement and work flow design methodology which can be applied to manufacturing, or service industries to improve operational (i.e. manufacturing) or business processes (i.e. work processes) by removing sources of variability.



Six sigma can be used to improve existing processes, or develop processes where none exist. All six sigma work begins with a thorough understanding of the market in which the organisation operates. This is then used to develop critical customer requirements (CCRs). One could think of these CCRs as the specifications for a product (e.g. viscosity, colour, thickness, etc.). The actual performance of the process is then measured against these CCRs. Under performing CCRs are then used to target improvement areas. Targeted improvement areas are then attacked utilizing a simple 5 step problem solving process (see the map above):

- Develop the Opportunity
- Measure Performance of Process
- Determine Root Causes
- Design Improvements
- Implement Improvements

Six Sigma, why use it?

Because it works. Companies like GE, Allied Signal, and Penske have found the proven techniques of six sigma invaluable in achieving world class performance levels. In its annual report, GE attributes approximately $ 2 billion of its annual profit to six sigma projects.

Six sigma helps an organisation easily develop a work process approach to their key activities. Once a process engineering approaches (like the tools used in a six sigma project) to continuously improve the process.

Factors that make six sigma attractive:

- *It is very customer focused.* This prevents organisations from utilizing resources in ways that do not matter to the market.
- *It is very much a team-based approach.* This will reduce barriers to implementation and facilitate the cultural change necessary to ensure a lasting benefit is realized by the organisation.
- *The methodology is a gated process.* This provides a lever for management control of the effort.

Implementing Six Sigma: A financial decision or a strategic one?

Implementing a company-wide initiative like Six Sigma is best accomplished when it becomes part of a

strategic plan. A strategic plan is a long-term (3-5 Years) business plan, which defines the long term goals and resources required to achieve the goals. More than likely it is also a financial decision that led to selecting Six Sigma as the long-term initiative. Most organisational long-term plans are financially focused. Goals do not become part of a plan unless they will achieve some financial benefit for the company. So it seems that you cannot have one without the other.

Although Six Sigma projects can and are, completed in a few months, creating a customer focused, Six Sigma focused company required multiple projects over a number of years. Without management on board with a long-term plan, the implementation of Six Sigma could be derailed too early to gain the true benefits. Benefits such as enhanced customer loyalty, reduction in costs of poor quality, improved profitability, and greater shareholder value, will not occur in the short term (less than one or two years). To achieve these benefits management must be able to devote resources long enough to gain the results. Only initiatives that are part of the strategic plan will survive long enough to reap these benefits.

What should a company interested in deploying Six Sigma look for a Six Sigma consulting company?

When selecting a consulting firm one should look at the firm's history, credibility, integrity and the ability to transfer knowledge.

For history: understand how the consulting firm originated, what kind of experiences have they had, who were their customers.

For credibility: check to see if the firm is well written about in the journals, frequently invited to speak at conferences, and if they sustained a good track record of results for other clients.

for integrity: ask the firm's competitors what they think about the firm they want to select. Good firms are not only liked by their clients, but also by their competitors. A firm speaking badly of a competitor most likely lacks the integrity needed to develop good relationships with.

Transferring knowledge is an important aspect of a successful consulting firm. One should evaluate if the firm gives you the tools, techniques, and materials necessary to operate without the consulting firm after the initial implementation.

Who should Champion the Six Sigma deployment within a company?

Champions at all levels are key to deploying and sustaining a Six Sigma initiative. However, to gain a credible start the Champion should initially come from top management. The candidate must be well regarded in the organisation and understand the key business drivers in the company. Most of the Six Sigma Champions come from operations, finance, quality or office of the CEO. In most cases a senior executive is assigned the task of leading the initiative.

For projects a good Champion is one who will lead the way for a Black Belt. Challenge the system, remove obstacles. These Champions are usually mid to upper level executives willing to challenge the status quo and have the authority to do so.

In a small company the owner may be the Champion and the executive staff may be the Black Belts. So it is important to not make a generalization as to what makes a good champion.

Can all companies – large and small – save money by implementing Six Sigma?

All companies can save money by reducing the causes of defects in products, deficiencies in services and processes, and by improving sales through greater customer satisfaction. However, a small company (less than 100 employees) will have fewer resources available than a larger company (1000 employees) to complete projects. The magnitude of improvement will be different between large and small companies. A small company also may have a lesser need to improve than a larger company. Small companies have fewer employees wearing "multiple hats" when carrying out tasks in a process. With fewer employees involved there may be fewer deficiencies to improve on. A larger company will have multiple employees and functions involved, creating complexity and possibly a greater amount of deficiency in the processes.

The main difference between small and large companies will be how to train employees in the tools and techniques of Six Sigma. The short term costs for training and the length of time to complete projects may take longer than in a large company. This mainly occurs because smaller companies cannot free up too many individuals in a short period of time to make the improvements.

Are there other reasons to look to Six Sigma besides financial ones?

If an organisation's Six Sigma effort is only focused on costs savings it will be missing a valuable oppor-

tunity. Institutionalising Six Sigma means having an organisation become so knowledgeable about its customers it can create a competitive advantage. Knowledge of what is critical to customers becomes the focus of improvement projects. By focusing on customers and eliminating problems for customers an organisation it should be able to reduce costs and enhance customer satisfaction. By having products and services designed with the customer in mind should lead to improved sales. The combination of the two will provide a solid financial return for the organisation. Focusing on the cost side will be a short-term benefit.

Compiled by
D. Jagannath Rao
Economic Services Division
from www.qualitydigest.com &
www.sixsigma.com
□

When I give a lecture, I accept that people look at their watches, but what I do not tolerate is when they look at it and raise it to their ear to find out if it stopped.

– Marcel Achard

* * *

If you put garbage in a computer nothing comes out but garbage. But this garbage, having passed through a very expensive machine, is somehow ennobled and none dare criticize it.

– Anonymous

Book Reviews

The tome is "Towards Personal Excellence" authored *by Seema Sanghi,* Published by Response books, New Delhi; Price Rs. 300/- (soft-bound).

Some Laws/principles have been accepted by the organisations of the day as we have accepted the Taylor's Principles, Einstein's Theory, and Newton's Law etc. A few of these have such an extensive application that they are called the Guiding Laws/Principles of the Economic and Social Systems Today. A few of these having the widest of applications are:

- the only thing that is constant today is "Change" and only those can sustain who can withhold the pace of the Change
- the real worth of any organisation is the HR, the more adaptive it is, the more worthy the organisation is
- what gets measured, is what gets improved
- the understanding of customers' expectations is the prime objective of the organisations, etc.

These Guiding principles have not only realised the importance of two hidden nodes but also thrown exalted stress on both of them to not only improve performance but also perform at Par- excellence. They are—the Innovative Technology and the Human Resource. The effect of the same is visible from the increasing concern of the organisations to their requirement w.r.t. the Application of Capability Maturity Models (CMM), Mapping of Individual Skills, Training or retraining, Multiskilling, Empowerment of employees through SGAs or QCs etc. All over it is attempted to improve the performance of both of these strong nodes. However, research shows that they are intermingled in each other in such a way that their interdependence can be visible with 'the naked eye' in terms of 3 outputs called 3Cs i.e. Competence, Confidence and Commitment. Similar inferences can be drawn from the statement made by Sir Henry Ford, *"If 'I' am given only the Manpower and nothing else I could be able to build a new Ford Corporation in just 5 Years",* and also supported by the Policy of Toyota Motors where they claim that they believe *to serve their own Employees than to serve their customers,* because it is their employees only who are the first hand interfaces of the Toyota Motor, to provide complete customers satisfaction.

One of the major constraints with this is the "Measurement" of HR Skills, Competence aptitude, Motivation etc. in an organisation. This is also defined by the rule "what gets measured is what can be improved". This attempt to design and compile the instruments for measuring the Managers for their Technical, Human and Conceptual Skills is of immense importance in line with the discussed requirement.

The whole tome is broadly divided in Six Sections each dealing with the brief and Instruments for each type of skills namely—(1) Managerial Skills, (2) Communication Skills, (3) Group Dynamic Skills, (4) Environment Management Skills, (5) Self Enhancement Skills and (6) Career Planning. All the given skills are important for managers from the point of view of Organisational Development and Future-oriented growth.

The first Section on Managerial Skills provides Assessment tools on Knowledge, aptitude and ability to use and/or allocate Time, Finance, HR and other resources efficiently. This section dwells on various self-assessment tools to assess the Planning, Leadership, Supervisory Competence, Delegation Ability, Conflict Resolution, Creativity and Innovativeness.

The Second Section on Communication Skills provides Assessment tools to speak, write and understand the usage of supporting Body Language which will help in communicating properly. This section dwell various self-assessment tools to assess the knowledge about art of communication & Presentation, the importance of Body Language and Listening to the communication.

The Third Section on Group Dynamic Skills provides Assessment tools on knowledge, aptitude and

ability to work with people and handling adverse situation to achieve goals. This section deals with various self-assessment tools to assess the ability to interview, hold meetings, deal with People and handle difficult Bosses.

The Fourth Section on Environment Management Skills provides Assessment tools on ability to sustain in the changing external environment, influence and Politics towards achieving organisational goals. This section deals with two self-assessment tools one to assess the adaptability to globalisation and second for the ability to cope and sustain the organisational politics.

The Fifth Section on Self Enhancement Skills provides Assessment tools on ability and aptitude to develop oneself to sustain or meet the expectations of all stakeholders with the changing external environment. This section develops self-assessment tools to assess oneself for his Positive Attitude, Constructive approach, Self Control, thinking about himself, self-monitoring and stress level.

The last section on Career Planning provides tools to see one's preparedness to plan and manage a successful professional career. This section deals with self-assessment tools to assess oneself for the preparedness to take new responsibility as Boss and what are the career aspirations.

The beauty of the tome lies not in the extent of coverage w.r.t. managerial functions and responsibility, rather in the way it is presented. Each Test is bifurcated into 3 parts. First part is to collect the response as Mirror Image, second part gives key or guidelines to infer the state of an individual in line with his response at that point of time while the last part provides small and useful tips to improve the individual's performance for the defined character. All the sections have comparable supplementary sheets to respond twice – once now and once later, after the adoption of the given tips in each section.

Since the direction and quality of the attempt is commendable, there is a strong reservation towards the validity of the findings/inference because each factor is judged based on only 10-15 Questions. This only increases the Subjectivity of the finding. The number of questions should be increased to atleast 20 so that the observations could be revalidated in-between the instruments and the sharpness of objectivity could be inculcated into the instruments. There exists ample scope in terms of improvement of Tests in terms of validity & re-validity of each response in the test itself that the scholars or users can easily form by moulding, expanding or changing the language of the question if once an idea is found. This tome is recommended to all Behavioural Scientists, Psychologists and all those who are working in the field of OD/HRD in their respective organisations.

Rajneesh Dalal
Assistant. Director
Business Development Group-HRM
National Productivity Council, New Delhi

Gender & Community in the Social Construction of the Internet *by Leslie Regan Shade,* Published by Peter Lang Publishing, New York, 2002.

In *Gender & Community in the Social Construction of the Internet,* Leslie Regan Shade, an assistant professor of communication at the University of Ottawa, states her mandate early on: "If, indeed, cyberspace is a metaphor for community, if it constitutes a network of varied relationships, and if digital citizenship is a prerequisite for participation and engagement in society, then we need to look closely at who is being included, and who is being excluded". Taking up the task, although a bit too modestly, Shade explores women's access to and participation in Internet society, in both "developed" and "developing" countries, using a critical feminist, political economy, and social constructionist approach. Shade views women (who constitute a diverse category, she admits) as active media users, whose empowerment through Internet technologies is often pitted against their incorporation by capitalist interests. To elaborate her argument, Shade specifically juxtaposes feminist uses of the Internet (specifically, women's online communities centering on feminism, political activism, democratic action, and girls' homepages and e-zines) against efforts to "feminize" the technology in the form of commercial portals targeted to women, which encourage consumption and not the opportunity for production and critical analysis that are provided by women's and girls' online spaces.

At the outset, Shade lays out four objectives: (1) provide an overview of how communication technologies such as the telephone, radio, and TV have been gendered; (2) discuss women's Internet spaces, or communities, focusing specifically on feminist, activist, and democratic ones; (3) examine the implications of digital capitalism for incorporating women as consumers by using a critical feminist and political economy approach; and (4) provide a framework and specific suggestions for examining women's access to and participation in the Internet. Shade limits the focus of her book to exclude rhetorical analyses of gendered CMC, the construction of women's identities in communities, explorations of technoscience or cyborgian formulations of gendered subjectivity, and practices

such as sexual harassment, privacy, anonymity, identity, free speech, and pornography.

In chapter two, Shade examines the literature on women's uses of communication technologies, specifically, phone, radio, and television, areas that have been unequally researched. The section on the phone is (perhaps surprisingly) the most interesting. Here, Shade cites several case studies that examine women's uses of the telephone for communication and social belonging and their concurrent exploitation as low-paid labour (e.g., telephone operators) for the telephone industry. Two studies are particularly interesting: Rakow's (1992) ethnographic field work examining "women's talk" in the small Midwest American community "Prospect" and Moyal's (1992) study commissioned by the Australian government examining the implications for women consumers of a proposed pricing change. For the two broadcasting technologies, Shade explores, very briefly, how women have been active users (both as amateurs and as professional) and, at the same time, target audiences. Although richly descriptive, this chapter would benefit from better synthesis and contextualization. The literature review contains the elements necessary to outline the argument that Shade will later touch on: that women's relationship to communication technologies has historically been paradoxical, potentially a source of pleasure and community-building but also signaling their enslavement in capitalist enterprise. Furthermore, two areas that Shade claims as "blind spots" in research—women in media institutions and women's activist uses of communication technology—may have been further developed by other researchers. I am thinking, in particular, of Creedon's (1991) work. With Shade's focus on radio, television, and rich area of feminist filmmakers is left unexamined, unfortunately.

After providing an overview of the gendering of this "old media," Shade proceeds, in chapter three, to examine women's uses of Internet technologies (as "cyberagents"). She focuses on four areas in which women and girls have made use of IT: (1) mailing lists for feminist academics and health-related support groups; (2) the use of the web by the women's movement to engage in global cyberactivism; (3) cyberfeminism involving artistic expression and political critique; and (4) e-zines and web homepages created by Riot Grrls' and teen girls. The second section on global cyberactivism ("globalization from below"), is nicely detailed. Here, Shade describes how women (both Westerners and non-Westerners) used IT in two specific examples: (1) work surrounding the Fourth World Conference on Women in Beijing and (2) the "social netwar" (41) waged to build favorable public opinion and media discourse of women in the Zapatista movement. The concept of the netwar is very provocative and could have been elaborated on further. The third section of this chapter, the discussion of cyberfeminist uses of the Net, is similarly engaging, with rich descriptions of such groups as VNS Matrix and The Old Boys Network.

Having examined a variety of feminist uses of IT, the fourth chapter now explores digital capitalism's overtures to female consumers. Shade provides a brief overview of market research on women consumers that focuses on several commercial portals targeted to middle-class North American women: Women Central, iVillage, Women.com Networks, and Oxygen Media. She also examines sites targeting girls, such as gURL, Voxxy, and Smart Girl Internette, as well as a new Mattel computer called Barbie PC. With their narrowly-defined target markets and use of advertising, efforts such as these further promote class and geographical inequities, the author argues. Still, commercial interests, as exemplified by entrepreneur Evelyn Hannon's journeywomen.com, can also improve women's lives.

Shade commences her policy analysis in chapter five by arguing that, although a digital divide still exists on gender, the category has been little researched, despite it being central to digital inclusiveness (i.e., ensuring universal access and service) in the promotion of the public good and democracy. The author nicely explores usability issues and, at a more macro level, policies to ensure gender equity. Still, "issues of substance and content", such as etiquette, privacy, harassment, pornography, and free speech, need further elaboration. More discussion of free-nets would also have been helpful. In addition, a stronger linkage could have been made between the gendered aspects of IT telework, which she asserts redomesticizes women.

In chapter six, Shade explores access for women in developing countries by focusing again on the Fourth World Conference on Women in Beijing, specifically, the secondary findings stemming from its five-year review. Results from an online forum and regional meetings show mixed results in terms of information access, freedom of expression, and representation in new communication technologies. Shade argues that policy recommendations are needed in three areas to ensure gender equity: access to user-centered design; training and education; and employment and workplace issues. The successful South African venture Women's Net was very intriguing and could have been elaborated. In addition, more emphasis could have been made of consumer efforts targeting women in developing countries. In addition, the brief section exploring the politics of knowledge dissemination seems key and should have been developed.

In her conclusion, Shade argues for a critical stance in examining the role of the Internet to promote women's rights and citizenship. She briefly discussed the possibility for instituting a universal Right to Communication, which would encompass access to technology and information as a vital part of citizenship. The author suggests seven areas for future research: governance, labour, women in technopoles (i.e., "smart communities"), qualitative studies, civil discourse, design, and representation.

A quick read and with clear writing, *Gender & Community in the Social Construction of the Internet* is a good primer on gender and technology. I wish that the work were more provocative and bold, though. Though Shade notes her critical feminist and political economy focus, she does not fully conceptualize these. Bourdieu, Castells, and Habermas are barely mentioned. Though the author briefly discusses Escobar's (1999) work, it would have been interesting to have applied his concept of meshworking to a study of Internet activism. In addition, extended discussion of Web advertising and the commercialization of search services (Hargittai, 2001) would have enriched the study. Also, the inclusion of illustrations could have made the work more tantalizing and easier to process.

C. Vijaya
ICM
Bhubaneswar
□

The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires.

– William Arthur Ward

Just Released !

IMD's
THE WORLD COMPETITIVENESS YEARBOOK 2002

The world's most authentic report on the competitiveness of nations

Partner Institute from India
National Productivity Council

- ★ Leading analysis of world nations' competitiveness
- ★ Cover 200 competitiveness criteria for 49 countries
- ★ Data from International, national, regional organizations and Executive Opinion Survey

Designed for Top Decision Makers from Business, Government & Academia

Price: Swiss Frank 900/-.
Limited copies available in Rupee terms at 20% discount.

Contact

Dr. N.K. Nair
Director (Research) & Secretary
National Productivity Council
Lodhi Road, New Delhi-110 003
Phone: 011-4618840/4690331-2-3
Fax: 91-11-4615002
E-mail: npcresearch@hotmail.in

Registered with Registrar of Newspapers REGD. NO. 4757/59

Productivity

Announces

a

Special Issue
(October–December, 2002)

on

'Energy'