



NATIONAL PRODUCTIVITY COUNCIL

Ac. 2157P

Productivity

Vol. 39

January–March 1999

No. 4

Focus : Information Technology

Handwritten signature and date: 7-4-99

Quantification of Payoffs from IT Investment

IT Infrastructure & Electronic Commerce

Electronic Education & Training

Software Quality Assurance & Testing

Supply Chain Management in PC Hardware Industry

Industrial Pollution Control: Regulation Vs Incentives

Drip Irrigation for Sustainable Agriculture

Agricultural Marketing Infrastructure in Gujarat

Cotton Farming in Andhra Pradesh

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<i>Foreign</i>	: Annual Airmail US \$ 80 Annual Surface Mail US \$ 75 Single Copy Airmail US \$ 20
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Productivity will be sent to all subscribers within each quarter. The Journals Division, New Age International (P) Ltd., may be contacted in the event of non-receipt within one month from the quarter.

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Telex : 031-66507 WEL IN
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3288149

ISSN 0032-9924

Productivity

A QUARTERLY JOURNAL OF THE NATIONAL PRODUCTIVITY COUNCIL

Vol. 39 • January–March 1999 • No. 4



PUBLISHING FOR ONE WORLD

NEW AGE INTERNATIONAL (P) LTD., PUBLISHERS

New Delhi • Bangalore • Calcutta • Chennai • Guwahati
Hyderabad • Lucknow • Mumbai • Pune

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NEW AGE INTERNATIONAL (P) LIMITED, PUBLISHERS

NEW DELHI : 4835/24, Ansari Road, Daryaganj, New Delhi 110 002
BANGALORE : No. 36, Mallikarjuna Temple Street, Basavangudi, Bangalore 560 004
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ISSN 0032-9924

Published, on behalf of the National Productivity Council, by H.S. Poplai for New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi 110 002. Typeset by Pagitek Graphics, 7F West Guru Angad Nagar, Laxmi Nagar, Delhi and printed at Chaman Offset Printers, 1626 Suiwalan, Daryaganj, New Delhi 110 002.

Printed in India.

Production: A. Chakraborty

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Quantification of Payoffs from IT Investment

V.K. Gupta

Payoffs from investments are usually classified as tangible or intangible. In the case of IT investment, there is an additional category of strategic payoffs requiring to be quantified appropriately. In particular, these are long term impacts for organisations such as improved image, staff motivation, customer satisfaction etc. Quantification of these payoffs by IT professionals is a must for demonstrating higher profitability, savings in costs, ensuring effective and committed top management, etc. The present paper enumerates the issues in strategic payoffs commencing with evaluation of alternatives in planned IT investment. These issues encompass all aspects of IT scenario like hardware/software, networking, systems, document imaging solutions, personnel policies, training costs, etc. The author advocates a payoffs analysis model and re-engineering of work functions in an organisation for implementing IT projects. He illustrates efficacy of payoffs analysis with a case study of a typical organisation, viz. modernization of the offices of Registrar of Companies in India, holding huge backlogs of paper records.

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Introduction

Payoffs from investments are generally categorised in terms of tangible and intangible; however, in case of IT investment, it is necessary to have an additional category of strategic payoffs. Strategic Payoffs are long term impacts for organisations such as improved image, satisfied customers, motivated staff etc. Quantification of Payoffs is an opportunity to demonstrate the payoffs in terms of higher profitability, better response, and savings in costs in order to receive top management commitment and support to implement the programme. Getting this commitment requires that IT professionals are skilled in conducting and presenting payoffs analysis, more so when the change in business climate over the past five plus years has resulted in an increased focus on bottom line.

Quantification of payoffs is an opportunity to demonstrate the payoffs in terms of higher profitability, better response, and savings in costs in order to receive top management commitment and support to implement the programme.

Issues in Payoffs

Analysis of payoffs deals with evaluation of alternatives. Each alternative will have its own mix of *resources* and it's own *project life*. Quantification of payoffs is related to new investments. Therefore, the estimate of payoffs from an investment in IT project must project the difference that results from making the investment, specifically the change in cash flows as a result of undertaking the project.

Some examples of IT related options are (i) Do nothing; (ii) Implement document imaging solutions;

(iii) Implement document imaging solutions; (iv) Re-engineer existing business processes; (v) Enhance existing network; (vi) Modify existing hardware/software; (vii) Acquire state of art hardware platforms, software products; (viii) Develop new application systems; (ix) Implement E-commerce; (x) Sub-contract development and implementation of new solutions and (xi) Carry out development in house etc.

In any case one alternative that should always be considered is continuing the status quo. For each options it is necessary to identify and itemised costs at a level of detail consistent with the budgetary process in the organisation.

Project Life

For understanding this concept, some definitions are necessary to be understood. Basically this (being sum of economic life and lead time) comprises several aspects (i) *the economic life* i.e., the period over which the savings or payoffs to be gained from the project are available; (ii) period during which a need for the programme is anticipated; (iii) the period during which the facility is available for use; (iv) *Technological life* viz. the period of time before which improved technology would make the facility obsolete and (v) *Lead time*, being the elapsed time period between initial funding and the commencement of the economic life.

Issues which bring complexities in payoffs analysis are varying economic life and lead time among different alternatives. For evaluation of alternatives a common base is necessary.

Issues which bring complexities in payoffs analysis are varying economic life and lead time among different alternatives. For evaluation of alternatives a common base is necessary.

Some of the basic questions which need be asked are: (i) what additional funds (investment) will be required to implement the selected alternative? (ii) what additional revenues will be generated over and above the existing ones? (iii) what improvement in response time and/or customer satisfaction will be achieved (especially relevant to government public interface services)? and (iv) what cost (recurring) will be added or removed as a result of the investment?

Methodology

For carrying out the payoff analysis, it is necessary to understand various cost categories as well as categories of payoffs in an IT investment programme. In particular, the items on which one time costs (investments) are incurred in an IT programme are:

Investment which can be categorised into site preparation (aspects like civil, electrical and furniture).

- Hardware & software products
- Networking
- System development
- Document Imaging Solutions
- Implementation & hand holding
- Redeployment & Retraining
- One-time personnel costs (recruitment, separation, training, travel, etc.)
- Value of Existing Assets Employed

Cost Estimation

A thoroughly reasoned payoffs analysis requires the collection of financial information called cost elements from budget documents along with estimates of proposed IT investment/system costs. The selection of cost estimating techniques depends on the amount and detail of available data and the time and resources available to develop the cost. The required level of effort for the different estimating techniques ranges from extreme analytical detail to intuition.

In developing cost data for a life cycle cost analysis, one should initially investigate possible data sources to determine what is available for direct application to analysis objectives. If the required data is not available, the use of parametric cost estimating techniques may be appropriate. Existing data banks, initial system planning data, supplier's documentation, should all be investigated as potential data sources.

Payoff Estimation

Determining payoffs is the most difficult and interesting part of payoff analysis because it is often difficult to identify all payoffs and accurately quantify and monetise them. IT investment programmes generally result in defining new functionalities and new opportunities for which details are either not available or there is fair degree of uncertainty, in such circumstances it is advisable to attempt to work out cost of operations with

all the functionalities assuming that the benefit of new IT system are not available. Factors which will be predominant in such a comparison are increase in manpower resources, space, communication and travel costs etc. It is also advisable to link the payoffs in quantifiable terms to the programme's goals and needs identified in previous planning stages which are improvements in effectiveness, efficiency, customer satisfaction, image etc.

Determining payoffs is the most difficult and interesting part of payoff analysis because it is often difficult to identify all payoffs and accurately quantify and monetise them.

Evaluation of Alternatives

IT investment alternatives should be evaluated using multiple decisions attributes that include both financial and non-financial criteria.

Net Present Value (NPV) is the discounted value of expected net payoffs, is the standard criteria for deciding whether a programme can be justified on economic principles. It is calculated by assigning values to payoffs and costs, discounting future payoffs and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted payoffs.

Present value is based on the principles that

- (i) Payoffs accruing in the future are worthless than the same level of payoffs that accrue now.
- (ii) Costs that occur in the future are less burdensome than the costs that occur now.

$$NPV = \text{Present value of payoffs} - \text{present value of costs.}$$

If the NPV is negative, the project is not acceptable on economic grounds.

Benefit Cost Ratio (BCR) or profitability ratio

BCR measures the economic desirability of an investment by dividing the present value of its payoffs (cash inflows) by the present value of costs (outflows). The alternative with the highest BCR is the most cost effective because it returns the most payoffs per dollar spent. Return on Investment (ROI), Payback period and Internal Rate of Return (IRR) are the other methods.

Risk Management

Payoffs and cost estimates are typically uncertain. The types of risks in an IT project include:

- (i) schedule and cost risks
- (ii) technical obsolescence
- (iii) dependencies between a new project and other projects or systems
- (iv) monopoly creation for future procurements
- (v) implementation procedures and rules and
- (vi) inadequate funding

Risk management is an organised method of identifying and measuring risk and developing, selecting and managing options of managing risks. It consists of the following elements:

Risk Assessment: Identification of all potential risk areas these are parts of a project having an uncertainty regarding future events that could have detrimental effect on meeting the programme goal. Risk assessment continues throughout the life of the project as previous uncertainties become known and new ones arise.

Risk Analysis: Characterises the likelihood of risk occurrence and the severity of its impact. It results in a watch list of potential areas of risk. Risk analysis also continues throughout the life of the project.

Risk Treatment: After risk has been assessed and analysed a determination is made on how to deal with it; herein alternatives include: (i) risks transfer; (ii) avoidance and (iii) reduction.

Risk management is an organised method of identifying and measuring risk and developing, selecting and managing options of managing risks.

Payoffs Analysis Model

The decision to undertake an IT investment or project is based on the assumption that the business improvements resulting from the system exceed the costs of modifying business operations and maintaining the current IT system (if it exists). Payoffs analysis makes explicit the assumed business rationale that justifies investments in IT/information systems. The major elements of payoffs analysis are total business

and system costs with/without the IT investment/new system.

The decision to undertake an IT investment or project is based on the assumption that the business improvements resulting from the system exceed the costs of modifying business operations and maintaining the current IT system.

The determination of costs and tangible payoffs is based on four basic cost elements:

- (a) Business costs with the IT investment new system (automated).
- (b) Business costs without the IT investment/new system with the current level of automation (perhaps negligible automation).
- (c) Non-recurring costs of the new system
- (d) Cost to continue the current IT system (if there is one).

Technology Issues

For achieving higher payoffs from IT investments, it is necessary that investment be made in the areas: (i) Re-engineering of work functions; (ii) Networking and (iii) Document imaging solutions.

Re-engineering of Work Functions

Existing business processes can be re-engineered based on the following five principles of Business Process Innovation (BPI):

- (i) All routine tasks to the extent feasible will be fully automated.
- (ii) Data capture as much as possible is done only once.
- (iii) Some tasks done serially now, wherever feasible will be done in parallel with other tasks.
- (iv) *Outputs* are centered around *processes* and people are required to have control over processes.
- (v) *Work flow* is distinct from the *task* being performed therefore it can be *redesigned*.

Methodology of Re-engineering

This has the aspects such as: (i) goals, objectives and vision (ii) scope of the study and (iii) priorities (iv) identification of the processes having highest potential for improvement (v) microlevel detailing at milestones level and as per management priorities and perception (vi) organisation of a multidisciplinary study team and (vii) study of existing processes.

Innovation Analysis and Redesign

This is based on the study of the existing processes and available technological options. It requires application of following principles:

- (a) Outcome driven: Organisation of around outcomes, not tasks i.e. have one person (or section) responsible for all the steps in the process (in case possible).
- (b) Empowerment: Re-engineering of tasks so that individual who need the results of the tasks or processes can do it themselves.
- (c) Modularity: Separating of tasks from the management of the workflow.
- (d) Parallelisation: Allowance for work to progress in parallel wherever possible and in the locations that makes the most sense.
- (e) Definition of performance and control measures
- (f) Design optimisation
- (g) Gap analysis: Identifies the gap areas as per the desired level and existing current status.
- (h) Plan and Schedule: Identification of the steps and activities needed to be accomplished for moving from the present status to the proposed status.

It may not be out of place to mention here that major productivity gains are possible if and only if IT investment programme is backed up by re-engineering of existing work functions. For a multi-location organisation cost of carrying out such a study may vary between US \$ 50,000 to 1.0 million based on the level of detailing and complexities involved.

Networking

Networking is a key area wherein issues which need focus are: LAN, technical aspects relating to Intranet such as Mail Server, Web Server, Data Security, IP addresses, Networking on heterogeneous plat-

forms, strategy on conversion of existing non-client server based (applications to Client Server) based systems.

The needs and objectives of implementing networks in organisations are:

- (i) To share common files and data among different divisions, branches and sections in an organisation so as to reduce the paper movement and to improve productivity.
- (ii) To provide a shift from existing communication mechanism such as post and fax to E-mail.
- (iii) To create capabilities so that data is captured from the point of origin and gets constantly updated during its life cycle.
- (iv) To provide required mechanism so that data is organised in retrievable form to meet the needs of efficient record management and the needs of transparency in an organisation functioning.
- (v) To provide Internet access for improving the analytical capabilities in various functional areas.
- (vi) To create facilities so that (a) systems/networks within the multi-location organisation can access each other for avoiding duplication of information (b) systems/databases in different divisions have inter-operationality and (c) for the open systems/databases customers have equitable access.
- (vii) To create facilities so that in a gradual manner applications such as (a) documents management systems (b) Internet white board and (c) group-ware applications get implemented.
- (viii) To create facilities so that it is feasible for organisations (having large public interface applications) to perform their public interface functions in network mode in accordance with the applicable National Cyber Laws.

For establishing LAN component of Intranet, it is necessary to have network compatible client nodes, database server, RDBMS, structured cabling system, etc. Cost variations are quite significant based on organisation needs. The cost per existing client node can vary between 150 US \$ to 2000 for a typical 100 node Intranet.

Implementing Document Imaging Solutions

Organisation's productivity is also dependent on an efficient record management system, as this provides

the ability to retrieve information in the desired manner with minimal efforts. The technology in the area of document imaging solutions provides answers to the problem of record management. While devising an IT investment plan for improving the organisation's effectiveness, this area of technology need be considered, as availability of hardware and reliable software systems are no more an issue of concern. However, as all the countries have not evolved and implemented Cyber Laws, therefore, still for various business transactions, paper record may be considered necessary. A judicious application of document imaging can solve the problem even for the countries who are in the process of evolving and implementing cyber laws. The technology provides a mechanism to save substantial cost by storing paper records at cheaper offsite locations and improving the productivity of the workers by providing them on their desk electronic files either on-line or on CDs.

Organisation's productivity is also dependent on an efficient record management system, as this provides the ability to retrieve information in the desired manner with minimal efforts.

The IT programme must emphasise on creation of scanning facility as an integral part of the modernisation endeavour. For past records, it may be advisable to take the option of sub-contracting the document imaging work to an agency vendor. As imaging is essentially a labour intensive exercise, therefore costing is likely to be vary from country to country. In case of India, scanning cost including OCR conversion is less than 0.1 US \$ per page.

Case Study

The concepts defined in the present paper are illustrated by a case study on modernisation of the Offices of Registrar of Companies and re-engineering of their work functions in India. They are essentially concerned with the incorporation of the companies/firms and such offices are essential to the corporate sectors functioning and may be known in different countries by names such as a company house, registry of companies etc. These offices are multi-locational offices and are located at 20 geographical locations in the country. The staff strength in these offices vary from 50 to 500 personnel.

The major functions of these offices relate to

incorporation of companies, i.e., title clearance, incorporation/registration of new companies, overseeing the functioning of already incorporated companies by seeking periodic inflow of company records to these offices such as balance sheets etc. Maintaining details on the current status of companies such as address, details on directors etc. In India there are 500,000 companies registered with these offices and on an average 1.4 million documents are filed annually by these companies. The Indian corporate sector is growing at a compounded growth rate of 16 per cent.

This case study illustrates in terms of the impact of modernisation which has already been realised in Phase-I. The Phase-II is a futuristic phase and has already gone through the approval process where Quantification of Payoffs analysis has played the major role. Both the phases are discussed below:

Phase-I

This phase of the project has been concerned with computerising the receipt of documents, networking these offices and implementing systems relating to title clearance. As a result of the Phase-I implementation, the processing time was reduced from 6 months to 2 to 3 days and the annual revenue of the offices got enhanced from US \$ 9 millions to 60 millions. Table 1 below gives the relationship between investment in IT and the increase in revenue of these offices:

Table 1: Relationship between Investment in IT and Revenue Generated

Year	Investment in Computerisation (\$ millions)		Name Applications Processed (Nos)	Revenue Generated at ROCs (\$ millions)
	Yearly	Cumulative		
91-92	Nil	Nil	80859	8.75
92-93	0.44	0.44	84058	27.00
93-94	0.44	0.88	93700	28.00
94-95	0.19	1.07	132400	59.00
95-96	0.20	1.27	118000	59.50

Phase-II

Herein the issues such as lack of adequate office space, registering large pending documents (2 millions), growing pendency of 56 per cent every year, 5 year registration period, virtually non-existent public inspection facility, inefficient working procedures and human resource constraints are dealt with.

Major components of this phase are re-engineering of working procedures (public service function to be counter based, pre-scrutiny of documents and acceptance of only completed documents), record room management (storage of documents on CD-ROMs, rearrangement of documents-yearwise, weeding out of records), work procedure manual, work flow layout and infrastructure development, human resource development and training. Payoffs analysis details are summarised in Tables 2 to 7.

Table 2: One-time Costs of New System

Items	(Amount in US \$ Millions)			
	Ist Year	IInd Year	IIIrd Year	Total
Hardware (Computer Systems)	Nil	1.25	0.31	1.56
Document Imaging Hardware	0.13	0.20	Nil	0.33
Software (Purchase)	Nil	0.24	0.06	0.30
Software Development	0.03	0.12	0.15	0.30
Site Preparation	0.21	1.88	Nil	2.09
Furniture	Nil	0.45	0.11	0.56
Document Imaging (one time)	0.09	2.07	2.16	4.32
Communications	Nil	0.32	0.33	0.65
Training and Travel	Nil	Nil	0.10	0.10
Project Management	0.04	0.64	0.30	0.98
Total	0.50	7.17	3.52	11.19

Table 3: Annual Recurring Costs of New System

Items	Ist Year	IInd Year	IIIrd Year	Total
Operation and Software Maintenance	0.05	0.15	0.15	0.35
Communications	Nil	0.09	0.09	0.18
Maintenance (Hardware)	Nil	Nil	Nil	Nil
Supplies (Consumables)	Nil	0.09	0.19	0.28
Software Upgrades (Purchase)	Nil	Nil	Nil	Nil
Training and Travel	Nil	Nil	Nil	Nil
Project Management	Nil	0.01	0.02	0.03
Total	0.05	0.34	0.45	0.84

Table 4: Associated Payoffs

<i>More Effective Customer Service</i>	
(i)	Availability of latest status of their applications at any time
(ii)	Availability of Name Search at Public Counter
(iii)	Availability of Co. Documents for inspection and certified copies at the counter
(iv)	Procedure/guidelines will also be available to public for know how
<i>Management Monitoring and Control</i>	
(i)	The pendency can be spotted on individual tables and remedial action can be taken such as increasing terminals/tables for particular type of application (deployment of more manpower, computing resources etc.)
(ii)	Workload can be monitored and reassigned to new desk
(iii)	Statistical profiles and information on performance of functioning of ROCs will be available online through network.
<i>Timeliness</i>	
(i)	Disposal of application will be much quicker than in existing system as in existing system of processing areas such as defaulting, prosecution, defunct companies, weeding out of records,
(ii)	Investigation and Inspection are rarely given the level of priority these activities deserve as most of the time is spent on New Registration, Document Registration and Register of Charges.
(iii)	ROCs will be able to perform most of the functions without neglecting any other activity
<i>Quality of Work</i>	
(i)	With scanned documents and database the quality of search will improve enormously
(ii)	More accuracy and efficiency will be achieved in re-engineered system
(iii)	Paper work will get reduced
(iv)	Movement of paper from desk to desk will reduce drastically
<i>Identification and Action against Defaulting Companies</i>	
(i)	ROCs will be able to identify defaulting companies and prosecution can be launched against such companies with diversion of manpower from scrutiny cells.
(ii)	With close monitoring from ROCs of the functioning of Cos., Investor grievances/complaints will reduce
<i>Quality of Public Search</i>	
With the availability of scanned documents and Company database online at the counter, the quality of service will certainly facilitate public to a great extent and their confidence in ROCs will increase.	

Table 5: Payoffs of New System

(Amount in US \$ Millions)				
Items	Ist Year	IInd Year	Illrd Year	Total
Savings on Reduction in visits of the members of public by 40% II yr. 60% III yr. @ \$ 3 per visit (1 million visits per year)	Nil	1.20	1.80	3.00
Enhancement of revenue collection due to inspection of documents and increased filing fee @ 20% II yr and 30% III yr of total revenue collection (annually US \$ 62.5 millions)	Nil	12.50	18.75	31.25
Savings due to filing of documents on magnetic media @ 0.5 per page (1.4 millions documents/4.5 millions pages per year)	2.25	2.61	3.02	7.88
Total Payoffs	2.25	16.31	23.57	42.13

Table 6: Cost of Operation without New IT System

(Amount in US \$ Millions)				
Items	Ist Year	IInd Year	Illrd Year	Total
<i>Cost of IT System already operational</i>				
Operation and Software Maintenance	0.10	0.11	0.12	0.33
Communications	0.05	0.05	0.05	0.15
Maintenance (Hardware)	0.06	0.09	0.11	0.26
Supplies (Consumables)	0.05	0.06	0.08	0.19
Software Upgrades (Purchase)	0.01	0.01	0.01	0.03
Training and Travel	0.01	0.01	0.01	0.03
Project Management	0.01	0.02	0.02	0.05
Total	0.29	0.35	0.40	1.04
<i>Cost of Additional Manpower (@ \$ 6,000 per man-year) To clear the backlog within 3 years and to handle additional workload getting added every year.</i>				
Cost of Additional Manpower	0.6	5.00	6.00	11.60
	(100 man-years)	(835 man-years)	(1000 man-years)	
Cost of Additional Space required to place pending documents - \$ 1.71 million (for 72,000 sq. ft) and cost of space required to place additional documents being submitted every year - 0.42 million (for 18,000 sq. ft.)	1.71	2.13	2.55	6.49
Total	2.60	7.48	8.95	19.13

Table 7: Payoff Cost Analysis

Items	(Amount in US \$ Millions)			
	1st Year	11nd Year	111rd Year	Total
IT investment in New System	0.55	7.48	3.97	12.00
Operational cost without new IT system	2.60	7.50	8.90	19.00
Operational Cost with new IT system	0.05	0.30	0.45	0.80
Savings in operational Cost (B-C)	2.55	7.20	8.45	18.20
Payoffs of New IT System	2.25	16.31	23.57	42.43
Total Payoffs (D + E)	4.80	23.50	32.00	60.30
Present Value Factor (based on 7% discount factor)	0.93	0.87	0.82	-
Present value of cost of new IT system	0.51	6.53	3.24	10.29
Present Value of Total Payoff	4.49	20.52	26.12	51.13
Net Present Value (I-H)	3.98	13.99	22.88	40.84
Benefit-Cost Ratio (I/H)	-	3.14	8.06	4.97

Conclusions

(a) Payoffs analysis is essential to obtain top

management commitment on IT investment programme.

- (b) Pay analysis focus need be on cash flow due to IT investment programme.
- (c) Choice of cost estimating technique is dependent on availability of cost data within the organisation
- (d) Qualitative analysis technique are (i) Net present value (ii) Benefit cost ratio (iii) Return on investment (iv) Payback period and internal rate of return
- (e) Risk management is an integral part of payoffs analysis of IT investment due to higher degree of uncertainties involved in these programmes
- (f) Business process re-engineering, Networking and Document imaging solutions are the components for IT programme which provide return on investment
- (g) Case study on modernisation of the offices of Registrar of Companies in India is an illustrative example of payoff analysis and brings into focus the importance of payoffs analysis in IT investment programme in particular during the approval phase of the project.

□

Re-Examination of Information System Methodology Contributions in Practice

Nimal Jayaratna & Jean-Michel Larrasquet

Information Technology (IT) is seen by many as a major initiator of high productivity. Its introduction to organisations has given rise to a number of methodologies. Some are IT driven methodologies that promote organisational change to maximise productivity through the introduction of IT. Others are focussed on supporting people and their purposeful activities as a way of improving productivity. However, methodology contribution to organisational change is over-emphasised by the advocates and proponents of methodologies. This paper examines some of the 'myths' and 'realities' of methodologies.

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Introduction

During its short period of existence, IT has made considerable impact on organisational life. However, methodologies for maximising IT based solutions have lagged behind the actual development of the technology. Some continue to introduce IT driven change characteristics in organisations (De Marco, 1978; Gane and Sarson, 1979; Jackson, 1983; Yourdon, 1989; Rumbaugh *et al*, 1991; Jacobson *et al*, 1994; and Coad, 1995). In contrast, others have developed methodologies that focus on people with IT playing a supportive role (Mumford, 1983; Mumford, 1991; Checkland, 1997, Checkland and Scholes, 1997; Checkland and Holwell, 1998).

The growth in methodologies has given rise to many research issues e.g., methodology evaluation, models, philosophy, selection etc.

A methodology is simply an explicit way of structuring one's thinking and actions. Methodologies contain models to help with this structuring and reflect particular perspectives of 'reality' based on a set of philosophical paradigms. A methodology should tell 'what' steps to take, in 'what' order and 'how' to perform those steps (methods, techniques) but more importantly 'why those steps should be taken in that order using those techniques.' (Jayaratna, 1994). In this sense, the most important role of a methodology is the intellectual questions it raises for structuring the methodology user's thinking process.

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If a methodology is to assist problem solving then it must contain three distinctive phases, namely:

- (i) Problem formulation (critical thinking)
- (ii) Solution design (creative thinking) and
- (iii) Design implementation (practical thinking).

Problem solving by its very nature implies that the structuring of thinking leads to the achievement of a goal i.e. a problem to be identified and solved. If we are to learn about the success of problem solving then we need to evaluate our activities before, during and after intervention, and focus our evaluation on three significant elements namely the 'problem situation', the problem solving process and the problem solver(s). These form three of the elements of the NIMSAD framework (Jayaratna, 1994). Using this framework one can examine the role of methodology contribution – Fig. 1.

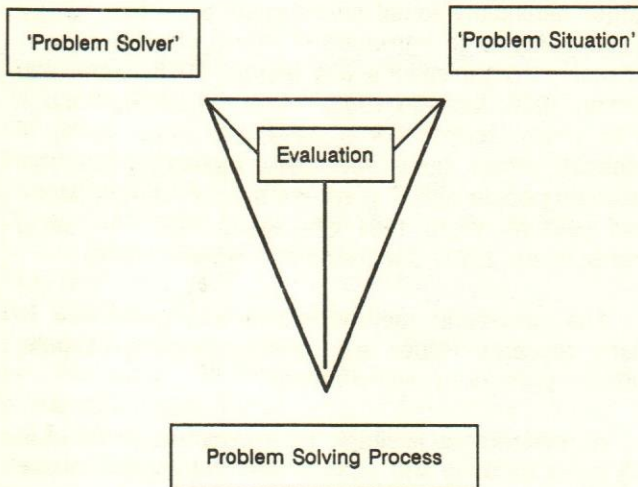


Fig.1. NIMSAD Framework.

Methodology and Problem Understanding

Problem solver(s) need either to have knowledge and understanding of organisations or industry sectors in which they operate (production, local authority, petroleum engineering) or to have general conceptual modelling abilities for gaining understanding of unfamiliar situations. In recognition of this importance, some consultancy organisations recruit and train their partners to specialise in a particular functional domain e.g. Finance and Marketing. In other organisations, the information systems specialists may operate in client departments in order to gain a deep understanding of the operations and the information needs of their users e.g., BAT industries. Both measures help the problem solver(s) to absorb environmental and operational con-

text information and develop models through their experiences in the application environment. However, this is not a viable solution for many organisations because of the one-off development efforts of the particular applications. For example you do not continue to develop order processing, billing etc. The alternative is for methodology users to develop general modelling skills in order to help conceptualise any problem situation. Most methodologies provide limited techniques but not explicit models for structuring the understanding of situation complexity.

Problem solver(s) need either to have knowledge and understanding of organisations or industry sectors in which they operate or to have general conceptual modelling abilities for gaining understanding of unfamiliar situations.

If we examine structured methodologies in general (Yourdon, 1989; Gane and Sarson 1979; De Marco, 1978), one finds that they do not provide any explicit models for understanding the complexity of the 'problem situation'. They provide techniques for the recording of formally recognisable and explicit data flows, stores and processing activities as illustrated in Fig. 2.

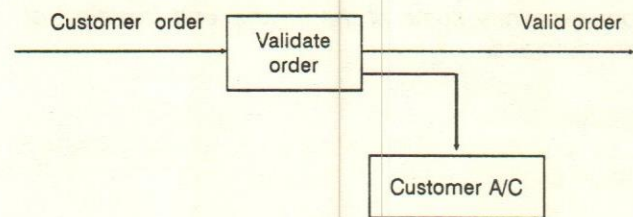


Fig. 2

There is a serious problem with this. As we found in an 'action research' case study, the problem solver failed to recognise most of the informal (yet essential) information flows (Jayaratna, 1986). Problems arise because these techniques do not focus on the development of its users' conceptual reasoning processes. This is also the case when one examines the promotion of new concepts such as 'object' oriented modelling and knowledge management. Objects are defined as 'things' that exist in the world or that it is the natural way humans think!, and knowledge management is defined by who uses knowledge (professionals) or that it addresses the generation, representation, storage, transfer, transformation, application, embedding and protecting of organisational knowledge (Hedlund, 1994).

Knowledge is considered as that which flows! However, 'Soft' Systems Methodology (SSM) (Checkland, 1997; Checkland and Scholes, 1997) provides 'systemic' but evidence suggests that many use the methodology in ontological mode i.e. for describing the 'system', transforming 'the system' (Patching, 1987). SSM's models do not extend to the political or interpersonal dimension even though they have been recognised as important for management.

Methodologies in general do not provide sufficiently complex models to help capture phenomena of the 'problem situations' particularly information of a qualitative nature.

Methodologies in general do not provide sufficiently complex models to help capture phenomena of the 'problem situations' particularly information of a qualitative nature. For instance Larrasquet *et al* (1993) discuss many of the problems associated with extracting information for building multimedia objects.

One of the prime reasons for using a methodology is to learn 'how' to perform the steps. But many fail to show how to perform all the steps they advocate. For example if we examine structured methodologies, we find that they do not provide any techniques for conducting investigations. In fact these methodologies ignore the transformation issues of this important step. What information to extract based on what models? Who should be seen and why? What type of questions to ask and how the relationships should be managed? Instead they rely on the problem solver(s) to devise their own ways of structuring this step prompted by techniques of data presentation. In computer based methodologies as typified in De Marco (1981), there is a considerable reliance on the user's tacit knowledge of the context for developing models of the situations. However, if techniques are not provided by methodologies for performing the steps then it can offer little help

SSM provides 'systemic' models for conceptualising the design activities. For example, the methodology makes its users explicitly consider the *Weltanschauungen* of participants and the roles of problem solving Vs problem context systems.

to its users. Even experienced users need alternative ways of examining their work situations in order to understand or abstract previously unrecognised features of the situations.

SSM on the other hand provides 'systemic' models for conceptualising the design activities. For example, the methodology makes its users explicitly consider the *Weltanschauungen* of participants and the roles of problem solving Vs problem context systems. But it does not give help in the construction of 'rich pictures' or how to manage the critical relationships between problem solver(s) and their clients.

If methodologies fail to provide ways (how) of performing some of the steps they advocate and rely on the methodology user's models and skills, then they cannot claim to structure their user's thinking.

Methodology and Implementation

If we examine methodologies, we note that many do not provide means of structuring the implementation. Given that this is one of the most critical steps for the transformation of any 'problem situation' to desired situations, it is surprising that they do not offer any guidance for structuring this phase. Therefore it is difficult to see how methodologies can claim success for 'problem situation' transformation. They can claim success only to the extent they help to structure the methodology user's perception of the 'problem situation'. If we examine the NIMSAD framework, we note that methodologies do not transform the 'problem situation' but only assist in the conceptualisation of the 'problem situation' by the 'mental constructs' of their users. (For this reason, D'Arcy and Jayaratna (1985) defined the domain of investigation as a 'situation of concern' alerting the problem solver(s) to the artificial boundary composition they generate in problem situations. For example people may eliminate application areas for investigation based on time, cost, social and political considerations which can have a serious impact on the 'systems' they subsequently build. Instead of the transformation of the current situation to a desired situation what they help to transform are *perceptions of current to desired states*. Therefore methodologies can claim success only to the extent they help to structure the users' thinking processes and to the extent of the support they give in the conceptualisation of the transformation from one state to another. The actual transformation depends on the situational characteristics, the client, and the commitment of those in the situation, the 'mental constructs' of the problem solver(s) and their dynamic interactions in the 'problem situation'. Many of the successful examples quoted in

Methodologies can claim success only to the extent they help to structure the users' thinking processes and to the extent of the support they give in the conceptualisation of the transformation from one state to another.

support of methodologies are oversimplifications of situations or familiar and artificial examples.

Methodology as a way of Problem Solving

Most methodologies accept client formulated problems as given i.e. accept 'what' problems are to be solved. There are good pragmatic reasons for accepting clients' expressed concerns or problems as legitimate areas for solving. However, if clients define problems or give specifications then it raises two issues.

First the client has performed the problem formulation phase of the problem solving process outlined above. If, in addition, the methodology also fails to offer ways of implementing the designs, then the only phase it seems to offer the methodology user the solution design phase. That alone is not a sufficient basis for a methodology to claim problem solving status.

Secondly, if the methodology accepts client given problems for solving or the client's requirements for design without understanding the relevance of the requirements to the 'problem situation', then there is no way of knowing how the solutions that are developed at considerable expense are going to resolve the problem situation. For example clients' needs may not be the same as those that need to be performed to solve problems in the situation. The problems that are resolved may be those that clients formulate for satisfying their own personal needs! What this means is that the rationale for the transition from a perceived current state to a perceived desired state will not be well understood. The problem formulation is the area of systemic analysis. In Jayaratna (1991, 1994), the reader's attention was drawn to the missing dimension of systemic analysis in the systems development processes. See also the case study reference that led to the development of the NIMSAD framework (<http://www.cee.hw.ac.uk/~nimal/case.html>).

If one examines structured methodologies in general, it is noted that they use the client requirements as the basis for the transition. Some recognise the process of deriving a specification as a political process

(De Marco, 1978) but do not offer any way of performing it, while others (Jacobson *et al*, 1994; Rumbough *et al*, 1991) try to engage the users of their methodologies on design and design related information search activities. SSM on the other hand is very much directed to the problem formulation phase. It performs problem solving by constructing potentially relevant solutions i.e. 'Root' definitions with their conceptual models and using them as the basis for generating a debate.

Methodologies must offer ways of performing all three phases i.e. problem formulation, solution design and design implementation if they are to qualify as problem solving methodologies. This is the reason why an evaluation phase was included in the framework to be conducted on the three phases at three time intervals.

Methodology and Controlling Costs and Projects

Systems development projects usually involve considerable investments. These investments take place at two levels. First, the project may involve considerable investment in new hardware, software and staff. While the costs are incurred during the development cycle, the returns may be realised only within the systems life cycle. Secondly, costs will be incurred on the development process itself. These may take the form of consultancy fees, costs of systems analysts, designers, and software engineers, project managers and other overheads. Usually, management anticipates the need for investments and therefore may require explicitly considered plans of investments and benefits in order to decide on the project. A methodology with clearly defined steps would certainly help its users to estimate expenditure and would help management to have confidence in the developers. Essentially, a clearly defined methodology may help to reduce risks in investments.

Systems development projects not only involve expenditure but also involve management of those who are involved in the development process. If a systems development project is to be completed on time and within budget, then the project has to be managed on a dynamic basis. A project has to deliver interim results that can be used as a way of ensuring that the project reaches its goals. These outcomes, mostly in the form of documentation (evidence), are known in the field as deliverables. Project leaders find it easier to manage the projects when they can define clear deliverables (what they can expect at what time points) and a methodology by its very nature provides a series of steps helping to produce clearly identifiable outputs. A project management methodology (PRINCE) is different to a systems development methodology such as SSADM (Cutts, 1987).

Systems development projects that involve considerable time and interactions of a complex range of elements, can create huge uncertainty. The adoption and the use of a methodology which helps to structure one's actions can also help to reduce uncertainty whether or not the same planned set of actions are consequently carried out in practice. If uncertainty is to be reduced, then the rationale and not simply the methodology steps, structure or techniques has to be understood with respect to their relevance to the 'problem situation'. In other cases, a methodology that uses familiar knowledge and skills sets (e.g. data modelling, programming language C++) may help to reduce uncertainty whether or not its use is relevant for the situation.

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In any organised set of activities, a group of people coming together can generate a variety of behaviour. According to the Law of Requisite Variety (Ashby, 1956), the variety in a control system must be able to manage the variety displayed in the systems under control. If there is an imbalance, then either the variety in the control system has to be amplified or the variety in the system under control has to be attenuated (Beer, 1988). Methodologies, like agendas at a meeting or procedures in an office or techniques in software engineering, are variety-reducing mechanisms. Strong adherence to a methodology (its guidelines, procedures, techniques, standards) enable management to control and focus the behaviour and the efforts of development teams thereby reducing the diversity of their behaviour. This is a very effective strategy if the strict adherence to methodology steps can help to identify and solve the 'right' problems. In other instances they may help to develop efficient and well managed but irrelevant solutions (Fitzgerald, 1996). It is not simply the methodology steps but the way they are used by project leaders and teams that determine the level of control that can be exercised.

Methodology and Exercising Power

Organisations can be conceived as an interactive set of political systems, which are continuously vying for power and control of others. One of the main ingredients for exercising power comes from the owner-

ship, size and control of resources, the position in an organisational authority structure and the ability to take decisions. Methodologies can be the way to distribute or re-distribute resources thus can be effectively used by systems developers who may wish to maximise their power (Fitzgerald, 1996). Even where resources are not used in this way, the use of a methodology may help to bring about changes to others' tasks, remuneration, relationship networks, job satisfaction and career development thus bringing about power distribution. For this reason, methodologies such as ETHICS (Mumford, 1996), SSM (Checkland and Scholes, 1997) and most Scandinavian methodologies encourage wider participation of users in the design process.

Organisations can be conceived as an interactive set of political systems, which are continuously vying for power and control of others.

Methodology and Providing Security

A methodology with a clearly defined explicit series of steps can provide safety for systems professionals who operate within bureaucratic or authoritarian environments. The fear of risks or failures and associated penalties—for instance, the loss of jobs, reallocation of jobs—may well force people to follow the steps of the methodology without deviation even though they may recognise the futility of the exercise. Fitzgerald (1996) calls these the 'comfort factors'. In large projects it is easy for teams and individuals to operate in this way as methodology steps can clearly disconnect their tasks from those of other groups.

Methodology and Instrument of Learning

There is an increasing recognition among a large number of systems developers that 'problem situations' are far more complex for individuals to manage. Despite their expertise which tends to be in selected sets of change domains (e.g. technical, tasks procedures) they are aware of interventions using methodologies can only achieve limited holistic successes and that they can only gain a better understanding of situations. The epistemological role of using a methodology can be a way of knowledge development and dispersion (Baskerville *et al*, 1992; Stage, 1991). This is the philosophy that underpins SSM (Checkland, 1981; Checkland and Scholes, 1997; Checkland and Holwell, 1998). However genuine learning can only be realised if

methodologies offer ways of evaluating the learning component (Jayaratna, 1994).

NIMSAD Framework

Given that methodology theory and practice differ so much, the effective transformation of situations depends on the clear and unrestricted thinking processes of the problem solvers. In order to consider the effectiveness of a methodology for a particular situation, problem solver(s) need to ask questions about the 'problem situation', the methodology and about themselves. Some of the typical questions are raised below.

Problem Situation

- Why transform the situation?
- Who do I take to be legitimate stakeholders and what are the implications of leaving out others?
- What problems am I trying to solve in this situation?
- What are the essential features and critical aspects of the situation?
- What aspects of the situation are to be transformed and why?
- What are the benefits or penalties of transformation for those in the situation?
- How are failures or successes going to be measured, and what implications?

Methodology

- Which methodology is the most appropriate for identifying 'what' and 'why' (problem formulation) and 'how' and by 'whom' to transform (solution design)?
- What philosophical paradigms are advocated or promoted by the methodology as being relevant to the situation?
- What domain of the 'problem situation' will be covered by the methodology?
- What assumptions are being made by the methodology about the situation? Are they relevant and useful?
- What structure and steps are offered by the methodology?
- What additional methodological steps need to be developed or substituted by those who are planning to use it? And how are these going to

be performed?

- What knowledge and skills are demanded by the methodology?
- What rationale is offered for the steps and the structure of the methodology?

Methodology User

- Why am I intervening in this situation?
- Why transform the situation?
- What benefits am I seeking for myself from this intervention?
- What are the benefits or penalties for me from this intervention?
- What criteria do I consider in selecting a methodology for this situation?
- What skills must or should I have in order to be an effective user of the methodology?

Conclusions

Transformation using methodologies cannot be proved in practice, only their support for structuring the problem solver(s)' thinking or/and action can be demonstrated as relevant and useful. The comprehension of 'problem situations', their transformation to new situations and the management of successful change depends mostly on the dynamic interactions between the problem solver(s), those in the 'problem situation' and other situational dependent conditions. Methodologies can claim success only to the extent they alert or influence the thinking and action processes of the problem solvers.

Also methodology driven transformation can be measured only in an epistemological sense of the term. Problem solver(s) still have to construct considerable and comprehensive levels and number of methodological steps beyond those that are offered by current established methodologies if they are to manage 'problem situation' interactions. The transformation depends not only on the methodology assistance but more so on how well the problem solver(s) manage their situations with explicit or implicit structuring of their thinking and action processes.

While methodologies may be represented as being concerned with the transformation of situations what they being about is a transformation of thinking about the situation. In this context, methodologies do not act as tools. They are brain structuring mechanisms. Methodologies must define the domain of their con-

cerns, the steps, and the rationale for the steps, their structural connection and 'how' the steps are to be performed if they are to be of assistance to the methodology user. Without this level of support, the use of a methodology structure and steps are potentially dangerous to their users and particularly for those living in the 'problem situation'.

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Information Infrastructure & Electronic Commerce: Indian Perspective

A.L. Moorthy & S.S. Murthy

The present paper surveys the overall Information Technology (IT) scenario in India in relation to the current telecom policies and developmental activities projected by the government agencies like DoT, DoE and VSNL. Realizing the essential role of IT in electronic commerce in the forthcoming 21st century, the authors have provided several purposeful policy measures. They have also indicated the dismal growth of IT services in the country in relation to the growth in several South Asian Countries, including Japan. The importance of implementing IT Action Plan without delays is stressed all through. In particular, the value of INTERNET facility for E-Commerce is emphasized.

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Introduction

Information technology (IT) industry and its components including IT-based services have become major contributors to the economy of the developed countries. According to the International Data Centre (IDC), the value of worldwide IT market in 1996 was US\$ 630 billion which is expected to reach 937 billion by the year 2000. The various developments in the IT field have ushered in the 'Information Society'. The information society is characterised by information as the key resource with information (knowledge) workers as main type of employment, research institutions as its base, and computers, electronics and telecommunications as basic technology components. Internet has been the most significant development of the information society, the effect of which is being felt in every walk of human life. And commerce is no exception to this phenomenon. Electronic funds transfer (EFT), electronic payments and Electronic data interchange (EDI) are some of the business activities carried out using Internet (and World Wide Web) for quite some time. The major factors, which made Internet a popular medium over conventional print medium for conducting business, include:

- Enhanced geographical reach
- Unrestricted domains
- Universal applicability to all products, services, vendors, customers in all the subject areas
- Relatively less expensive, provides unlimited space involving low premium
- Easy updation and cheap maintenance
- Non-discriminatory accessibility to all customers 'absolutely free'
- Instant selling of non-material goods (like software)

The advances in telecommunications and com-

puters made it possible to make the home, or even a bed room as 'virtual office' to carry out the tasks assigned to an individual or even supervise the work of team members. Despite drawbacks like visibility, isolation, out of touch with latest developments unless one is in constant touch, it is increasingly becoming popular in the developed countries. This has given rise to the Small-Office-Home-Office concept. In the US, nearly 43 per cent houses possess some form of home office (see Craumer & Marshall, 1997; Hawkins, 1997) and the home-based work force is expected to increase at an annual rate of about 20 per cent.

Coupled with the above mentioned benefits, the business companies realised that the competitive edge/advantage of traditional commerce is fast becoming limited and started looking for newer avenues to enhance profitability. They found that Internet provides seamless access to customers, partners, suppliers, and distributors in a networked environment. Thus, Internet has become a medium to achieve corporate competitiveness and profitability.

Internet is holding enormous volumes of information in each and every field of human knowledge. It also holds guides to techno-commercial information covering sources of business information (for example, see Sinha and Tulas, 1998, p. 6). Although Internet contains only a fraction of one per cent of the world's public domain of available data, it is tripling in size each year and in six or so years it will be growing a thousand fold. According to a speculation, in five years from now, 80 per cent of publicly available data will be available on the Net (quoted in Cronin and Mckim, 1996, p. 164). The Web sites maintained by manufacturers, vendors, financial institutions participating in E-commerce and organisations supporting it like Commerce Net, Netscape, Microsoft, etc. will be more useful for those who would like to enter into the world of E-biz (see Appendix for a short list of important players in some of these areas). E-mail distribution lists, manufacturer's and product directories, list-servers, etc. are also available for product marketing.

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Electronic Commerce

Variously known as E-commerce, E-biz, cyber com-

merce, online commerce, Net commerce, etc., electronic commerce is the latest phenomenon of Internet. E-commerce is re-defining the way business is conducted by individuals, institutions and industries. It has provided new avenues for marketing, novel ways for advertising, large customer base for vendors and manufacturers, increased visibility for products, and a variety of alternatives for customers.

E-commerce is profoundly influencing the structure of business dealings and supply chains. It is growing at a rate of more than 30 per cent and facilitating business-to-business and business-to-customer/consumer transactions manifold. This is mainly because Web-based transactions offer low service costs. For example, sending a 40 page document from New York to Tokyo costs an average of US\$ 26 if sent through courier services; about US\$ 30 if sent by fax and a mere 10 cents if sent via Internet (Chasia, 1998, p. 43). Internet facilitates use of a host of electronic payment systems resulting in cheaper operational costs; it costs about 5 cents per transaction for digital currency as against 45 cents per transaction for credit card payments, 75 cents for check payments and US\$ 1 per transaction for paper currency payments (ter Maat, 1997, p. 69). Internet offers online bank transactions costing five paise per transaction as against Rs. 1.50 through a teller (Balasubramanian, 1998, p. 49). Internet follows true socialism—it has no preference or favouritism on any product or firm; it provides the same facilities, opportunities and avenues to all. Thus, right from advertising and automobiles to software and value-added services, all thrive over cyber space. See, for example, the usage of Internet of some of the companies:

- Boise Cascade Office Products, the first office supplier to put its catalogue on the Web to reduce the costs and increase the speed of order processing while improving order convenience for customers not only recouped its investment in this technology, but also saved US\$ 1 million in just one year.
- The AIM Management Group, a mutual fund company, has developed an extranet to provide its customers with up-to-the-minute information, twenty-four hours a day accessible from anywhere. It is able to satisfy all customers and brokers with brochures, literature and financial information all the times.
- Knight-Ridder New Media, electronic publisher, has developed a Web-based application for making financial operations more efficient, and attracting new subscribers and advertising revenue through innovative online publishing for all the company's newspapers.

- The Hongkong Telecom, the largest Internet Service Provider in Hong Kong with an annual sales of US\$ 32 billion (in 1997), developed and deployed an online application on Internet to deliver higher levels of cost-effective service, twenty four hours a day, seven days a week.
- The Internet Commerce of Cisco Systems in 1996 was US\$ 100 million, which rose to US\$ 3.2 billion in 1997.
- The Web site of Amazon.com was visited by 15,10,000 during the fourth quarter of 1997 and 22,60,000 in the first quarter of 1998. The sales during these periods was US\$ 66 and 87.4 millions respectively.
- The daily sales of Dell Computers on Internet in January 1997 was less than US\$ 1 million which rose to about US\$ 6 million daily during December 1997 holiday period.
- Auto-by-Tel, a Web-based automotive market place, had auto sales worth US\$ 1.8 billion (3,45,000 purchase requests) during 1996. By 1997, it rose to about US\$ 6 billion (12,00,000 purchase requests).
- Chrysler Corporation reportedly saved more than US\$ 1 billion in cost of materials in 1997 merely by linking its suppliers through a Web-based network and by the year 2000, the annual average savings estimated will amount to US\$ 2 billion.

Although there is a difference of opinion as to the revenues generated by E-commerce, it is steadily growing. IDC estimated that transactions worth US\$ 10 billion were executed over Internet in 1997 (equal to a mere 0.05 per cent of the global commerce). It estimated the value of E-commerce for 1998, 2000, 2001, and 2010 to be US\$ 45.8, 150, 220 and 1000 billion, respectively (Brand Equity, 1996, p. 4).

The main characteristics of E-commerce is the anonymity it provides to the customers and vendors as well as to the transactions, which take between them. Other problems include privacy, and integrity of messages sent, authenticity and non-repudiation of transactions taking place on the Net. This has given rise to initial hick-ups including insecurity, fraud, money laundering and impersonation (Lakshmana Moorthy and Karisiddappa, 1998). This situation in turn led to the formulation of security protocols like Secure Hypertext Transfer Protocol (SHTTP), Secure Sockets Layer Protocol (SSLP), Secure Electronic Payment Protocol (SEPP), Secure Electronic Transaction Protocols (SETP), and so on. As of today, both material goods

and non-material goods (like software) are available over Internet through vendors. While the latter can be procured instantly (by downloading from the site), in the case of the former, the goods are sent separately by post. Online ordering facilities are available for both the transactions. In the case of instant purchases, the payments are to be made through either deposit accounts or smart/credit cards or any of the electronic payment systems. A host of electronic payment systems like First Virtual Internet Payment System, E-cash, INVERIFY, Net-Cash, Secure Internet Payment System, CyberCoin, MilliCent, Payword, PayNow, NetBill etc are available to choose from. These have been discussed in detail elsewhere (Loshin and Murphy, 1998; and Opplinger, 1998).

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In electronic market place, search costs are heavily reduced, as all the information about an item/product is available at one place. This reduces search time and related costs and enables in locating suppliers matching the needs of the buyers. However, this is not true in all cases. As per study, the average prices of second hand cars sold through AUCNET, an electronic market place for used cars in Japan, were found much higher than that of traditional non-electronic markets. But the higher prices made many sellers list their cars on AUCNET, which in turn attract more buyers as it offered better choices (Lee, 1998, p. 73). It had also created risks of buying inferior quality vehicles as transactions are made without physical inspection.

Web Advertising

Internet advertising (or Netvertising) is another rapidly growing area of E-commerce. As Internet supports audio, video, animation and graphics, this area is gaining more and more attention. As against print media, here the consumer goes to the advertiser. The Web advertising and marketing are generally skewed towards educated, middle and high-income groups. Many newspapers, newsletters, and ad agencies are advertising on the Net. The ad revenues for Web sites during April-June 1998 was US\$ 422.7 million which is almost double when compared to the revenues for the

same period in 1997. According to Active Media, Nevertisements will be earning US\$ 19 billion by the year 2001 (see Kaur, 1998, p. 75, for more details).

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Impact of Internet

Although the benefits of Internet were felt a long time ago, it is only recently that the country is realising its potential and taking necessary steps for popularising usage of Internet among scientific and R&D community. This is because of the policy of the government which made providing Internet services a vital monopoly of Videsh Sanchar Nigam Ltd. (VSNL). Till late 1998, India had only four ISPs: NICNET, ERNET, VSNL and SoftNet of Software Technology Parks. Whereas, smaller countries like Japan, Hong Kong and Korea have 1300, 90 and 15 ISPs, respectively. The number of Internet hosts and subscribers in the country is also very small.

Internet access in India is mostly urban oriented. The communication networks like NICNET of the National Informatics Centre (NIC) and ERNET of the Department of Electronics (DOE) started providing Internet access to the academic and R&D institutions and made Internet popular among the research community. NICNET is the first network in India to establish a Web server to cater the needs of Internet users. It had a target of establishing 30 Web servers by 1995. With its nodes in each and every district headquarters in the country, NICNET has been successful in taking Internet to schools, colleges and polytechnics. Although VSNL launched its Internet. For Masses' programme on 15 August 1995, at present the country has only about 1.2 lakh Internet subscribers which is growing by 10,000 every month. This is because of lack of sufficient Internet nodes and a communication backbone network of adequate bandwidth. VSNL and DoT together operate 30 nodes and another 24 are under various stages of execution. Internet users from places other than those having nodes have to use I-Net of DoT or dial-up and are thus forced to bear extra charges. This situation led some users approach courts for legal redressal (Akila, 1998, p. 48).

Despite these problems, the popularity of and access to the Internet is on the increase. Many academic,

research and commercial institutions both from public and private sectors, and many government agencies have their home pages maintained on the Net. Many more are planning to follow the suit. A number of computer and business magazines and almost all leading newspapers in the country are making their publications available over Internet (see Lakshmana Moorthy and Karisiddappa, 1998 for a detailed discussion). Some of these are even displaying advertisements.

The IT Action Plan recommended withdrawal of the monopoly of VSNL and participation of private industry in providing Internet services. Already Satyam Infoways, a subsidiary of Satyam Online, became the first private sector ISP from November 1998; it is offering Internet access from 12 cities spread over the country. With the government's acceptance of the Internet-friendly measures suggested by the IT Task Force, Internet usage in the country is expected to improve manifold.

India and E-Commerce

In tune with adopting other technologies, India embraced E-commerce late. When the second-generation E-commerce is taking the developed countries by storm, India is slowly but steadily catching up with it. It is also bliss in disguise; for, the initial problems faced in standardising various routines and protocols and the security considerations have not been felt by the country. As per the estimation of the Indian subsidiary of IDC, the value of E-commerce in India was about US\$ 2.8 million in 1997 which is expected to reach US\$ 160 million by the year 2001. Oracle Corporation plans to generate Rs. 300 crore from India through E-commerce solutions by the year 2000. NASSCOM (1997, p. 98) estimates that by the year 2000, the Indian market for EDI solutions and services would be generating over Rs. 500 crore annually.

E-commerce is the new buzzword in the Indian business industry. Observing the successful exploitation of Internet for promoting business across cyber space, many business firms in India are taking interest in E-commerce. Sinha and Tulasi (1998) provide a number of techno-commercial Web sites including those exclusively dealing with Indian scenario. Indian software industry took the lead in establishing Web sites and home pages for marketing Indian software products and value-added services. Many computer magazines and almost all leading newspapers in the country are available over the Net. Publication groups like The Hindu, India Today, etc. are publishing Internet editions of all their publications. In Bangalore and Hyderabad, cinema tickets could be booked over Internet; fresh vegetables are being traded through the Net. MCDNET has been established by Manipal Control Data Electronic Commerce Ltd., a Ban-

galore-based company in collaboration with Control Data Systems of USA to offer E-commerce solutions in the country. Indian book publishers are also joining the race. The Chemicals and Allied Products Export Promotion Council (CAPEXIL) is launching a Web site which will support home pages of its members to display their company profiles and catalogues.

The computer-to-computer business transaction standard, EDI (a part of E-commerce), is gaining acceptance in India for both domestic and overseas transactions. EDI, coupled with bar coding technology and electronic funds transfer, is capable of drastically reducing processing time manifold besides financial savings. It is most suitable in cargo handling systems where a number of players, viz. banks, customers, customs, cargo forwarders, transporters and importing and exporting agents, are involved. With the active support of the EDI Council of Ministry of Commerce, Govt. of India, for adopting EDI technology by all departments in foreign trade, the scenario is fast changing. In India, the current usage of EDI technology by all departments in foreign trade, the scenario is fast changing. In India, the current usage of EDI (among the various Internet services) is only 4 per cent and is expected to grow (NASSCOM, 1997, p. 111). VSNL is the first to start EDI services in the country in 1993 which installed an EDI system in Mumbai with access nodes at New Delhi, Calcutta and Chennai. EDI is being promoted to be adopted by all port trusts; Kochi Port Trust is the first to implement it. Apart from port trusts, the important players in EDI include BHEL, Electronic Research and Development Centre (ERDC, Calcutta), CMC, Customs and Director General of Foreign Trade (from public sector); and Tata-IBM, Satyam Infoway, WIPRO Infosys, etc. (from private sector). The Federation of Indian Export Organisations (FIEO) is encouraging its members for switching to E-commerce as many overseas companies have started demanding that Indian exporters operate through EDI; and already a few cases were encountered where potential overseas clients declined to deal with the companies which do not have EDI facilities. Satyam Infoway (P) Ltd., Chennai is implementing a pilot project for the Indian automobiles industry with an EDI application, which is also aimed at speeding, up the transaction cycle in the industry. Eleven major companies are involved in it along with major automobile associations.

Internet banking has already been introduced in India for the first time an year back by the ICICI Bank, which in collaboration with Infosys Technologies, developed a software Infinity—Internet Banking, a complete online banking solution, wherein Internet can be used as a banking channel for retail and corporate consumers. With this, the ICICI Bank joined a select group of banks in the Asia Pacific region (about 150)

which have banking sites on Internet (Cyber-update, 1998, p. 69).

Apart from these developments, the IT Action Plan recently announced by the government (Govt. of India, 1998), has also identified, among others, information infrastructure and E-commerce as critical areas for national needs. The Plan envisages training citizens in the use of E-commerce, tele-banking, tele-documents transfer, tele-library leading to IT—led economic development. Other salient points of the Plan related to E-commerce include:

- (a) Opening of Internet access points at all district HQrs by 26 January 2000,
- (b) Withdrawing the monopoly of VSNL for Internet access and allowing public/govt agencies to become ISPs,
- (c) Providing Internet access through authorised cable TV by ISPs without licensing fee,
- (d) Meeting data communication requirements for E-commerce and EDI by Department of Telecommunications (DoT),
- (e) Giving maximum flexibility in organising marketing of software packages through Internet, and
- (f) Creating 'Mega Web sites' on Internet servers located in India.

The IT Panel has also urged the Reserve Bank of India to allow use of international credit cards for IT-related purchases (thus enhancing the E-commerce) and also for accessing latest technology as soon as it is available. At present, a few companies in the country are offering Web advertising services. The DSF Internet Services has exclusive advertising rights to two of the most popular Indian sites—the All India Radio and Door-darshan. The Web sites of India World, Khel, Khoj, Dhan and News Asia of India World Network, launched in August 1998 has generated Rs. 5 lakh till November 1998 (Kaur, 1998, p. 76). Rediff On The Net is expecting hoping to sell Rs. 3-5 lakh worth of books, music titles and hotel reservations per day within next six months and Mumbai Mart is targetting Rs. 5-10 lakh per month (Financial Express, 1998).

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Information Infrastructure

The Government of India taking necessary steps to introduce IT Act to amend cyber-related laws and put forth legal amendments for facilitating effective trade on the Net. If the country has to penetrate the cyber commerce and retain a respectable chunk of the global E-business, it has to invest in advanced Internet technologies. This only would allow growth of meaningful Internet-based commerce. The following sections examine the status of the computer and communication infrastructure currently available in the country for doing business over Internet.

Growth of Computers

It can be said that indigenous computer industry had its beginnings in 1973 when the Electronic Corporation of India Ltd. (ECIL) started manufacturing computers in the country. The industry has grown at an annual rate of about 10 per cent during late 1970s and only in 1985 the production of computers had reached Rs. 200 crore. Initially there has been a slow growth in the computer base; the country had an installed base of 120 computers in 1970 which reached a lakh by the end of Seventh Plan (1990). The economic liberalisation policies of the Government during the early 1990s boosted the growth of the computer industry in the country. Further, the computer industry got a shot in the arm from the new Computer Policy announced by DoE, Govt. of India in November 1994. During the past five years, the computer hardware industry has grown at a compound average growth rate (CAGR) of 15 per cent and is expected to grow 46 per cent annually during the Ninth Plan. Table 1 provides details of computer hardware production and exports during 1988-97 (DoE, 1998, p. 70-71).

Table 1: Computer Hardware Production and Exports (Rs. in crores)

Year	Production	Export
1988	486	137.8
1989	700	243
1990	820	297.5
1991	830	177
1992	1205	260*
1993	1342	420*
1994	1775	600*
1995	2015	775*
1996	2500	932*
1997	2700	1250*

* Turnover during financial year.

In the recent years, the production of PCs has registered a phenomenal growth. Table 2 shows the details of PC production in the country during the last four years (Dataquest, 1996-1998). The PCs segment of the computer industry has grown by over 25 per cent during 1997-98 (as compared to 1996-97). About 8,00,000 PCs were sold in the country out of which 6,20,493 were manufactured in the country. The PC/At 286s disappeared from the scene in 1995-96; 386s in 1996-97, and 486s may disappear in the current financial year, if figures are any indication. Pentiums reached their zenith and may go into oblivion in a couple of years as Pentium Pros and PIIs are coming into the scene.

Table 2: Production of PCs in the Country during the last 4 Years

PC type	1994-95	1995-96	1996-97	1997-98
286	6185	-	-	-
386	110859	37510	-	-
486	116049	268091	167028	58570
Pentium	897	53076	277396	441100
Pentium Pro II	-	-	1000	85277
Macs	6310	13000	6003	10000
Total (Desktops)	2,44,800	3,83,006	4,67,387	6,20,493
Non-servers	3074	2990	-	-
Workstations	3483	2548	3676	4582
Servers	17216	28851	66520	17650
Total	2,68,573	4,17,395	5,37,583	6,42,725

Penetration of PCs is an effective indicator of an information society. However, the PC density (PCs per 100 population) in the country is too low to be happy. This figure indicates the usage of PCs in various activities such as business, marketing, information retrieval, electronic messaging, E-mail, file transfer, etc. and the extent of the diffusion of IT and of computer culture in the society. As per the International Telecommunications Union (ITU) data during 1995 India had only 0.1 computer per 100 people or 1 computer for every 1000 population (ITU, 1995). The developed countries have 10 PCs and above per 100 population with USA and Switzerland leading the table with PC densities of 29.7 and 28.8, respectively (see Table 3) (The Observer, 1995). India ranks behind Hungary, Greece, Chile, Malaysia, Thailand, Brazil, China, etc.

The PC density reached to 2 per 1000 now (1998) and it has been proposed to improve this ten fold to bring the figure to 2 per 100 by the year 2008 (Govt. of India, 1998, p. 1). The installed PC base of the country at present at the current PC density works out to be 1.8

million (for a population of 90 crore) which is expected reach 10 million by the year 2000.

Communication Infrastructure

The communication network in India is the backbone for accessing and providing Internet services. The telecommunication network in our country is the monopoly of the government (DoT) till recently although the economic liberalisation has given way to a limited participation of the private sector in some areas. Plans are afoot for the involvement of private sector in the domestic long distance traffic by the year 1999 and international traffic by 2002. However, the quality of telecommunication services is poor and unreliable. Starting from 1991, private sector is involved in areas like telecom equipment manufacturing, value-added services, private networks in industrial areas, radio paging services, cellular services, etc. The announcement New Telecom Policy in May 1994 gave momentum to these efforts. The long distance network in the country has a total of 2,14,858 km of which the coaxial cable accounts for about 14.3 per cent (30921 route km). The microwave/UHF link accounts for 56.4 per cent (121072 route km); and the remaining 29.3 per cent (62865 route km) is optical fibre cable. The proportion of digital lines to the total telephone line network is 66 per cent (the rest being electro-mechanical) as against the world average of 61.9 per cent.

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There were 1.3 million telephone lines in 1970 which almost doubled to 2.8 million lines in 1980 and 3.8 million in 1988. The number of telephone lines in 1991 crossed 5 million (5.07 millions to be exact) and in 1994 it was 8.03 million which rose to 11.98 millions in 1996. In 1995, India with 9.8 million lines ranked 14 in terms of total number of lines behind Spain, Brazil and Turkey. By the end of 1997, the country had about 14.54 million telephone lines and in the next 10 years 67.4 million lines would be added to the existing network (Deccan Chronicle, 1998, p. 4). An estimated 30-35 million lines would be added to the existing lines by the year 2002 making it to be among the six largest telephone networks in the world (Expert Group, 1996). The number of telephone connections grew at an average rate of 19

per cent between 1991-92 and 1995-96. This has resulted in consideration reduction in the waiting time for a telephone line. However, the waiting list still continues to grow; from 1.03 million lines in 1986 to 2.28 million lines in 1996. At present the waiting list corresponds to approximately one-fourth, i.e., for every 100 lines existing, 25 are in waiting.

The number of telephone lines per 100 population (known as telephone density or teledensity) in the country is very small when compared to other developing countries like China, Mexico, Argentina, Brazil, etc. India had a teledensity of 0.4 telephones in 1988 (compared to 75 in the US, 65 in Japan, and 7 in Malaysia). This rose to 0.55 in 1990, 1.07 in 1994 and 1.29 in 1996 (compare this with 14.7 for Malaysia, 8.1 for Brazil, 4.7 for Thailand and 2.3 for China). According to the ITU (1995) report released in October 1995, the average teledensity of the world was 11.57. India had a teledensity of 1.07 in 1994, lower than the average teledensity of the world, 11.57. India had a teledensity of 1.07 in 1994, lower than the average teledensity (1.48) for low income countries (see Table 1; India ranked 39 in both PC density and teledensity. By the end of 1997 India had a teledensity of 1.5 which rose to 1.6 in 1998; less than the neighbouring Pakistan (2.4) or Indonesia (2.4) and China (3.8). The aim of the government is to achieve a teledensity of 10 by the year 2007 (Chowdappa, 1995, p. 6).

While the number of telephone lines is on the increase with considerably reduced waiting lists and marginal qualitative improvements, the prices of the telecom services are extremely high when compared to world standards. A comparative and critical evaluation of local, long distance, leased line costs, personal Internet connectivity charges and international trunk calls has been done by Shah (1997). The high costs makes the Indian telecommunication services egalitarian or elitist and keeps these services away from common users of information. The high prices of leased lines (which is about ten times of international standards), closed user group policy prohibiting interconnection between any two computer networks, high license fee for E-mail providers (which in many countries is at nominal rates

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making individual users to pay literally nothing), the monopoly of VSNL and the DoT in making Internet available in the country are a few examples (Shah, 1997) which are not information user-friendly. These restrict the percolation of computer culture in the information society.

Table 3: Density of Telephones and PCs of Selected Countries

Country	Telephones	PCs
Sweden	68.3	17.2
Denmark	60.4	19.3
Switzerland	59.7	28.8
United States	59.5	29.7
Australia	49.6	21.7
Britain	48.9	15.1
Greece	47.8	2.9
Singapore	47.3	15.3
Belgium	44.9	12.9
South Korea	39.7	11.2
Spain	37.1	7.0
Czech Republic	20.9	3.6
Hungary	17.0	3.4
Argentina	14.1	1.7
Malaysia	14.7	3.3
Mexico	9.2	2.2
Brazil	7.4	0.9
Thailand	4.7	1.2
China	2.3	0.2
Philippines	1.7	0.6
Indonesia	1.3	0.3
India	1.1	0.1

Telecommunication Technology Vision

Advanced telecommunications offer opportunities and benefits which have a direct bearing on the national economy. It is essential to allow private sector participation for better competition in telecommunication services; offer low-price interconnection privileges; deregulate e-mail, bulletin board and Internet services from the government purview and encourage dial-up services; and to promote Internet connections at low prices (Shah, 1997).

The technology vision for telecommunications for the year 2020 brought out by the Telecom Task Force set up by the Technology Information, Forecasting and Assessment Centre (TIFAC) of the Department of

Science & Technology projects a three-fold increase in the current network size by the year 2002; 70 per cent of the network to be digital by the year 2000—per cent digital network could be expected only by the year 2015; tele-shopping, tele-banking, electronic payments and home banking services via online and videotext networks by the year 2002; wide spread use of broad band for ISDN applications, use of multimedia terminals to support video telephony and video conferencing applications on demand; entire switching system to be digital by the year 2000 with about 2 per cent to support ISDN; 2.5 Gbps capacity transport network backbone in metro cities, 622 Mbps in major cities, and 155 Mbps for international traffic; high capacity and almost synchronous optical network by the year 2015; services of high bandwidth with data applications including Internet; ISDN services including intelligence network services in cities and major towns by the year 2002 (TIFAC, 1997). It has also recommended deployment optical fibre in the national telecommunication network for reliable and high capacity services, evolving a mechanism to provide latest technology information to the R&D including complete information related to standards, patents and indigenous and foreign know-how.

National Information Infrastructure

India has a strong IT base with a CAGR of about 40 per cent over the last five years and accounts US\$ 2.2 billion. About 15-20 per cent of computers installed in the country are connected to local areas networks which is expected to grow at a faster rate in the next 3-5 years. However, the IT diffusion in India is lower than other developing economies. This is because of low IT spending in the country (0.7 per cent as against 3-5 per cent of GDP for developed economies), high costs of technology, lack of inter-connectivity between existing networks making non-utilisation of bandwidth, lack of IT education and training, and absence of a common agenda and thrust by government, IT industry and users. Although the PC density is rather low at present, if the recommendations of the IT Task Force including making computer hardware and software available to the students at Rs. 20,000; providing Internet access through cable TV operators at Rs. 12,000; and production of 20,000; providing Internet access through cable TV operators at Rs. 12,000; and production of vital components like microchips and semiconductors in the country, the situation is bound to improve. The info-infrastructure drive of IT Action Plan targets 30 per cent annual growth rate from the 1998 level of fibre optic back-bone of 75,000 route km. Steps are afoot to connect all the state capitals and the 12 major cities through fibre optic links to facilitate long distance communication. The IT Task Force has made 18 recommen-

dations covering bottleneck issues and promotional measures to improve the info-infrastructure in the country (Govt. of India, 1998). Although the benefits of National Information Infrastructure (NII) initiatives were well known from the experiences of such initiatives taken by developed countries, neither the government nor the industry made efforts in this direction in the country. Wide dispersion of education and training supporting lifelong learning, information network-based economic growth, improved communication links, research applications in engineering, healthcare, science and technology, etc. are some of the major benefits of NII initiatives. Towards strengthening the information infrastructure in the country, the Ninth Five Year Plan (1997-2002) for Electronic Industry (DoE, 1997) suggested an Action Plan and constitution of an NII Commission comprising a Policy Making Board and an Executive Board. While the first two will be headed by the Prime Minister, the Executive Board will be chaired the Cabinet Secretary. Formulation of a National Information Policy and amendments to the existing acts and enactment of new laws encompassing intellectual property rights, IT and EFT are some of the other suggestions. The implementation of NII is proposed in phases, at the Block Level by Ninth Plan, and at the Panchayat level in the following five years, at an estimated cost of Rs. 1000 crore. The Plan also recommends taking a pilot project of about 50 blocks with a budget of Rs. 10 crore to demonstrate the benefits of NII (DoE, 1997).

The existing 22 Mbps bandwidth at major Internet hubs located at Bangalore, Delhi and Mumbai is inadequate to support growing traffic. The NII Action Plan envisages building up of the NII backbone with 2.5 Gbps in phases by 2000. The government is working on this national Internet backbone at an estimated cost of Rs. 85 crore. This is expected to serve over one million subscribers in more than 100 cities. Other salient points of the NII 2000 Action Plan include inter connection of networks, PC penetration, ERNET upgradation, E-commerce and regulatory and legal framework (DoE, 1998, p 37). The Vision for 2020 of TIFAC forecasts that in the next 5-10 years time the technologies like (a) debit cards for EFT at point of sale, (b) smart cards with built-in microchips for electronic cash etc., (c) EDI for EFT at point of sale; smart cards with built-in microchips for electronic cash etc., (d) and EDI for paperless banking transactions, will be introduced in the country (Abdul Kalam and Rajan, 1998, p. 184). All these measures are expected to accelerate the march towards E-commerce.

Conclusions

The IT Action Plan, when fully implemented, is going

to change the existing scenario. The 100 per cent depreciation of IT products and software would further enhance penetration of PCs in the society. Use of cable TV means reaching of over 15 million users without any problem of bandwidth. When DoT meets the data communications requirements for E-commerce and EDI, the implementation of EDI across the country will speed up and exporters would be enthused to shift to E-commerce faster. Use of international credit cards over Internet for IT-related transactions, as and when permitted, by the Reserve Bank of India, for transactions of other goods would definitely have a major impact on E-commerce. Setting up of national level Information Security Agency; formulation of National Policy on Information Security, Privacy and Data Protection Act; and modifications of the Indian Telegraph Act of 1885, the Indian Post Office Act of 1888, and the Indian Wireless Telegraphy Act of 1993, are all would improve the status of E-commerce in the country.

Acknowledgements

The authors thank Smt. K. Shailaja Reddy, B. Dhanunjai Kumar for their secretarial assistance in preparing the paper.

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The following list provides important players in Electronic Commerce. The list is indicative only and is not exhaustive. Some of the firms may be involved in more than one category listed below:

Credit/Smart Cards

Card Service International (www.cardsvc.com)

Icverify Ind (www.icverify.com)

PaylinX Corp (www.paylinx.com)

Mondex (www.mondex.com)

Visa International (www.visa.com)

Electronic Commerce Security

Cylink Corp (www.cylink.com)

NetMarket (www.netmarket.com)

RSA Data Security Inc (www.rsa.com)

Sun Microsystems (www.sun.com)

Terisa Systems (www.terisa.com)

VeriSign Inc (www.verisign.com)

Electronic Currencies/Payment Systems

Checkfree Corp (www.checkfree.com)

Click Share (micro payment system)

CyberCash Inc (www.cybercash.com)

DigiCash bv (www.digicash.com)

First Virtual Holdings Inc. (www.fv.com)

Mondex USA (www.mondexusa.com)

NetCash/NetCheque (gost.isi.edu/info/NetCheque)

VisaCash (www.visa.com)

Financial Institutions

Bank of America (www.bofa.com)

Bank of Montreal (www.bmo.com)

Citibank (www.citibank.com)

Master Card International (www.mastercard.com)

Security First Network Bank (www.sfnb.com)

Visa International (www.visa.com)

Hardware/Software Support

BroadVision Inc (www.broadvision.com)

Hewlett-Packard (www.hp.com)

MegaWeb Inc (www.dynamicweb.com)

Microsoft Corp (www.microsoft.com)

Netscape Communications (www.netscape.com)

Premenos (www.premenos.com)

Online Shopping Catalogues

All-Internet Shopping Directory (www.all-internet.com)

Altavista (www.altavista.digital.com)

America Online (www.aol.com)

Galaxy/WebCrawler (www.webcrawler.com)

InfoSeek (www.infoseek.com)

Internet Shopping Network (www.internet.com)

Lycos (www.lycos.com)

World Avenue of IBM (www.ibm.com)

Yahoo (www.yahoo.com)

Periodicals Published

Electronic Commerce World (monthly)

International Journal of Electronic Commerce

The EM-Electronic Markets Newsletter (quarterly)

(www-iwi.unisg.ch/iwi4/cc/em/emnews1.html)



Impact of Information Technology on Management Control Systems

Thomson S.H. Teo

Rapid advances in information technology (IT) have revolutionized the design of management control systems (MCS). IT has widened the choices available to firms in how they plan and control their daily activities to achieve organisational objectives. This paper examines the impact of IT on each of the four subsystems of MCS: planning subsystem, monitoring subsystem, evaluation subsystem, and reward subsystem. In each subsystem, examples are given to illustrate how IT can be used innovatively to achieve organisational objectives. Implications for leveraging IT to revolutionize the design of MCS are also discussed.

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Introduction

Rapid developments and diffusion of information technology (IT), namely computers and telecommunications have enabled changes in the organisation's strategy (e.g., leveraging IT for strategic purposes), structure (e.g., enabling new organisational forms, reduction of middle management), and culture (e.g., change or modification in existing cultures due to new strategy, structure and technology) in response to competitive pressures. What was not feasible in the past has become feasible today due to technological innovations. For example, dramatic reductions in technology costs (e.g., low cost personal computers compared to high cost mainframes) have resulted in the proliferation of computer power throughout the organisation and a trend towards the decentralization of information resources. This has resulted in new possibilities and opportunities for re-engineering the design of the Management Control System (MCS) to support organisational objectives.

Dramatic reductions in technology costs have resulted in the proliferation of computer power throughout the organisation and a trend towards the decentralization of information resources.

Information Technology (IT)

Keyes (1993, p. 154) defines information technology (IT) as:

"the set of nonhuman resources whose tasks encompass storage, processing, and communication of information. It also includes the manner in which

these resources are organised into a system capable of carrying out a task or set of tasks. Using technologists parlance, this translates to a combination of hardware and software”.

The hardware aspects of IT would include devices such as computers, microprocessors, and communication lines. The software aspects of IT would include operating systems, computer applications like spreadsheet and database management. In a broader sense, IT would include robotics, computer integrated manufacturing, telecommunications, management information systems, and decision support systems.

Management Control System (MCS)

Birnberg and Snodgrass (1988, p. 447) define a management control system (MCS) as “a mechanism designed to limit the decision space of individuals within an organisation so as to affect their behavior. Its purpose is to coordinate the decisions which they make so as to increase the probability of achieving the organisation’s goals.” A control system performs its function by controlling the flow of information, establishing criteria for evaluation and designing appropriate rewards and punishments. The four subsystems within the MCS which are designed to achieve these goals are the planning subsystem, the monitoring subsystem, the evaluation subsystem and the reward subsystem.

The definition of MCS entails the notion of control both as an information mechanism that indicates whether standards are met, and as a behavioural modification mechanism designed to motivate desirable behaviours and discourage undesirable ones.

Thus the definition of MCS entails the notion of control both as an information mechanism that indicates whether standards are met, and as a behavioural modification mechanism designed to motivate desirable behaviours and discourage undesirable ones. The four subsystems of MCS are applicable to all levels of the organisation.

Figure 1 shows that IT can influence the design of each of the four subsystems of MCS. Conventionally, a change in the planning subsystem will affect the other three subsystems in the sequence as shown by the clockwise arrows linking the four subsystems. However, changes in any one subsystem can also have direct implications on other subsystems (as shown by the

dotted lines inter-linking the four subsystems). For example, changes in the monitoring subsystem not only influence how evaluation is carried out but can also have implications on how rewards are administered. In addition, changes in evaluation subsystem can affect how monitoring is carried out and how rewards are administered.

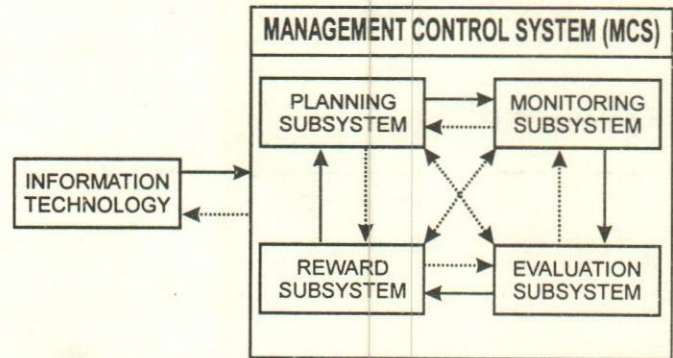


Fig. 1. Impact of Information Technology on MCS

In turn, a change in any of the four subsystems can have implications for the acquisition and deployment of IT (as shown by a dotted line from MCS to IT). For example, the decision to use IT to support and re-engineer each of the four subsystems of MCS is likely to influence whether IT will play a major role in the firm, and consequently also influence the present and future acquisition and deployment of IT.

Planning subsystem

This is concerned with the setting of objectives and the establishment of standards for each objective. More broadly, planning is concerned with the determination of an appropriate organisational strategy. Since the planning subsystem helps to direct or guide individual or group actions, it can be considered as a form of *ex ante* control (Flamholtz, Das & Tsui, 1985).

In order for planning activities to be carried out, relevant information needs to be collected, organized and stored. This information is used to make predic-

IT can be used to facilitate the acquisition, organisation, and storage of information as well as provide support for planning activities such as problems diagnosis, brain-storming and forecasting.

tions, delineate alternatives, set objectives and strategies. IT can be used to facilitate the acquisition, organisation, and storage of information as well as provide support for planning activities such as problems diagnosis, brainstorming and forecasting. In addition, IT can help to reduce environmental uncertainty through information gathering and dissemination by enhancing the information processing capabilities of planners so that they can better understand the impact of their decisions.

Information required to support planning activities are made available through Management Information Systems (MIS). MIS provides information reports on financial and accounting matters, sales and production operations, demographic profiles of customers, and inventory stocks. A branch of MIS, known as Executive Information Systems (EIS), cater to the information needs of top managers. Basically, EIS enables top managers to access concise information with an option to access more detailed information if necessary. Concise reports help to prevent information overload, save time and help top managers to focus attention on more pertinent issues.

In addition, integrated corporate intelligence databases provide information on the general business environment, competitors, customers, suppliers, etc. These databases which promote data integrity and data sharing enable more consistent and reliable data to be available for planning activities, while providing opportunities for flexible access to information, data manipulation and data sharing. In the event of drastic environmental changes such as new governmental regulations, the ability to quickly harness and reshuffle data becomes important in enabling the organisation to respond more quickly. Timely response to such changes may assist the organisation in maintaining its survival or averting its decline. Furthermore, the reshuffling of data can create new information which can result in new solutions or new insights to old problems and new opportunities.

In addition to providing information, IT can be used to facilitate individual and organisational learning by providing support for problem solving and decision making. Different Decision Support System (DSS) models can be used to test various assumptions, evaluate scenarios and assist managers in anticipating future contingencies. Computer models have been used by Hertz Car Rental to assist in fleet scheduling, and by Avis Car Rental to plan its fleet purchasing. The airline industry makes use of computer models to assist in decisions regarding the pricing of airline tickets. Similarly, computer models are utilized by the hotel industry in its allocations of rooms to customers. DSS can also

provide support for planning processes such as objectives identification, problem diagnosis, generation of alternatives, brainstorming and forecasting. Generally, IT can be used to expand our cognitive limitations by augmenting the abilities of the human mind through the enhancement of information processing capabilities. In the event of a crisis, DSS can support decision making under time pressures by enabling various scenarios to be mapped out explicitly for evaluation.

IT can also make the choice of a particular organisational strategy more feasible by increasing the flexibility of production systems. Instead of catering to mass production of a commodity, flexible manufacturing systems with the aid of IT can produce customized products at cost equivalent to mass production. Customization is becoming more important due to customer demands for more "unique" products and the need for firms to be more responsive to customer needs. Planning for customized products to cater to various niches is made feasible through integration of IT with manufacturing systems.

IT can also make the choice of a particular organisational strategy more feasible by increasing the flexibility of production systems.

The use of IT can also help managers to plan and coordinate the purchase and distribution of goods. For example, sales information that is necessary for planning purchases and distribution of goods can be captured with the use of electronic scanners as part of the computerized inventory control system. The computerized inventory control system has enabled some retail companies like Benetton to capture product information (e.g., size and color) whenever a sale is made. This information is analyzed daily and is used to adjust ordering, production, inventory and sales strategies. Fast selling items can be easily determined. The information that is captured by the control system can also be sold to suppliers to generate revenues or discounts for goods. The control system has enabled the company to better plan inventory to cater to the changing needs of customers.

Wal-Mart uses IT on an organisation-wide basis to plan and control its logistics. In this control system, goods are bought in large quantities which are delivered to warehouses where they are selected, repacked, and dispatched to stores, with minimal time spent as inventory in the warehouses. Hence, the usual inventory and handling costs are reduced. All Wal-Mart stores have a video link to corporate head-

quarters and to each other. Store managers are therefore able to frequently hold videoconferences in order to exchange information on which products are selling, which sales promotions are successful, etc. This enable managers to better understand, anticipate and cater to the needs of their customers.

Monitoring subsystem

This is concerned with observations of behaviors and measurements of outputs to ensure compliance with standards. Its behavioral or process function (i.e., act of monitoring) is a form of *ex ante* control since the act of monitoring can influence behavior. Its informational function (i.e., measurements) is both a form of *ex ante* control since intermittent measurements can be used to anticipate performance outcomes as well as a form of *ex post* control since measurements provide the information necessary for corrective actions (Flamholtz et al, 1985). At a broader level, the monitoring subsystem includes the monitoring of the general business environment to ensure that organisational objectives are attainable.

Since monitoring is usually labor intensive, the use of IT to support monitoring activities can reduce management levels by enabling greater span of control, thereby minimizing misinformation and omission of information caused by information filtering through too many management levels. However, Pinsonneault and Kraemer (1993) found that the use of IT can either reduce or increase the number of middle managers depending on the degree of centralization of decision making. Hence the use of IT can have differential impacts depending on organisational contingency factors such as structure and degree of centralization. IT enables the firm to better manage interdependence between business units and along its value chain through electronic links within and outside the firm. Furthermore, with increasing globalization, IT makes it easier for top management to monitor the performance of subsidiary units around the world through the use of worldwide telecommunications systems. Intermittent measurements can be used to anticipate performance outcomes and can provide necessary information for corrective actions. With the aid of IT, strategic issues (defined as issues that are likely to have a profound effect on present strategies and objectives, e.g., deregulation, new business laws), can be easily identified, monitored and stored in a strategic issues database. As continuous environmental scanning of all possible strategic issues is not feasible in terms of costs or manpower, semi-directed scanning is usually carried out. Basically what this means is that only key strategic assumptions in addition to selected sources of information are monitored constantly.

IT enables the firm to better manage interdependence between business units and along its value chain through electronic links within and outside the firm.

By monitoring these issues for weak signals, the organisation minimizes the likelihood of strategic surprises and has more time to plan its responses in the event that the issues become a reality. For example, certain signals might indicate impending deregulation of the industry. By monitoring these weak signals, the organisation in effect has more time to plan an effective response strategy before the issue(s) become critical. Without the use of IT, storage and retrieval of relevant information for rapid dissemination and evaluation of alternative courses of actions would not be feasible.

IT enables better control of resources through its use in Just-in-Time (JIT) manufacturing systems. Without electronic integration between the suppliers and manufacturers, JIT manufacturing systems would not be feasible. IT can therefore help to reduce costs by reducing the need to carry large amounts of inventory (slack) during the manufacturing process. In other words, the use of IT can enable managers to make more efficient and effective use of available resources since less inventory through JIT implies that less manpower is needed to keep track of inventory.

The use of IT in factory automation often produces significant increases in productivity in terms of economies of scale. With the use of robotics, computer integrated manufacturing system and computerized quality control system, there is less need to monitor and worry about variations in workers' performance. With the use of IT to monitor and control deviations, automated manufacturing has produced products which conformed strictly to the desired quality standards. Less emphasis is therefore placed on the skills of the individual worker since the tasks are being routinized. The use of IT can therefore result in an increase in quality and productivity. Further evidence is provided by Mukhopadhyaya *et al* (1997) who found that IT does impact on process output and quality through automation of work processes.

The use of hand-held computers by Frito-Lay sales representatives not only reduces the time required to process a transaction, but also provides management with a powerful monitoring tool. The system allows management to record when each sales representative begins his/her day, interarrival times between stores,

and even the number of cardboard boxes returned each day. This information can be used by management not only to evaluate and reward sales representatives' performance, but also better plan and evaluate marketing strategies. Similarly, hand-held computers are also used by distributors at Pepperidge Farms to keep track of inventory and shorten the time between order and delivery, thereby resulting in improved freshness and quality of products. With the use of real-time information as a result of hand-held computers, Pepperidge Farms is now better able to introduce new products and respond to competitors' imitations.

Better monitoring or tracking system can also help firms to achieve their objectives of high customer satisfaction. For example, Federal Express has a computer-based tracking system that enables packages to be tracked anywhere around the world. The tracking of any package is carried out with the aid of a hand-held scanning device called the Supertracker. The Supertracker scans the bar-code on each package some 10 to 15 times as they move to their final destinations. Hence, at any point in time, the location of any package is known. Although most customers do not use this service, having it enables the company to build relationships with customers. Customers trust the company more, knowing that the package is in safe hands since its location can be tracked anywhere around the world. The success of this system has motivated other mail delivery companies to develop similar systems.

The benefits of real-time monitoring with the aid of IT is evident in the case of American Airlines who developed the SABRE system in response to the need to match passenger names to seats. The SABRE system enables real-time monitoring of seats availability as well as the pricing of air fares of major competitors. The system has drastically changed the way airlines compete and has become a necessary part of doing business in the airline industry.

In addition to real-time monitoring, IT also makes remote monitoring possible. For example, each Otis elevator has a computer chip that sends a warning signal to corporate headquarters of impending breakdown. This enables the company to send service representatives to undertake preventive repairs even before the elevator breaks down. The system has greatly enabled the company to achieve its objectives of increased customer satisfaction since the elevators very rarely breaks down.

Evaluation subsystem

This is concerned with assessment of the performance of individuals or groups against pre-established goals and standards. It is a form of *ex post* control since

comparisons are made against pre-established goals and standards (Flamholtz et al, 1985). In a broader sense, the evaluation subsystem also includes the evaluation of changes in the general business environment to determine the feasibilities and the effectiveness of current strategies.

Management needs to evaluate not only the effectiveness of current strategies but also the changes in the business environment that can influence business strategies. Strategic issues (defined earlier as issues that are likely to have a profound effect on present strategies and objectives) are most effectively monitored with the use of integrated databases. Integrated databases enable more up-to-date and accurate information to be available on a wide range of strategic issues. The detection of a significant change in any strategic issue can give rise to three possible evaluation scenarios (Camillus & Datta, 1988), namely:

- (1) changes in strategic assumptions are necessary (e.g., due to the Gulf war, there is a shortage of certain resources);
- (2) incremental changes in current strategies (e.g., increasing price and shortage of oil motivate automakers to develop more fuel-efficient vehicles); and
- (3) changes in implementation process (e.g., delay or accelerate the introduction of new products).

Management needs to evaluate not only the effectiveness of current strategies but also changes in the business environment that can influence business strategies.

DSS can assist in the evaluation of the impact of strategic issues through quantification and prioritization of likely outcomes. It can guide a planner's evaluation of alternatives, facilitate the testing of planning assumptions and evaluation of various scenarios. Furthermore, Group Decision Support Systems (GDSS), videoconferencing, electronic mail, etc., enable top management to harness inputs (e.g., suggestions on how to deal with strategic issues) from employees both locally and globally.

The evaluation subsystem is also concerned with the assessment of employees' performance. Computer based information systems enable the extrapolation of current trends in employee's performance and the com-

parison of current performance with past and average performance. Evaluation can then be made as to whether or not to intervene in employee's tasks to boost performance.

IT can also help managers to evaluate changes in customers' preferences for products and services. For example, an office products retailing chain has a database of customers and their shopping habits. The company keeps track of every complaint and constantly adjusts its products, policies and guidelines to match the customers' wants. As a result, the retailing chain has more than two million regular customers whom it regularly sends direct mail with tantalizing offers to keep them coming back.

Data that are recorded by electronic scanners in supermarkets can be used to evaluate turnover of inventory. This will help to prevent shortages of popular goods. In addition, information captured by electronic scanners can also be used to evaluate the effectiveness of sales promotions and pricing strategies. In the service industry, computers are often used to record sales representatives performance over a period of time. Evaluation can then be made more objectively and equitably. This can in turn motivate sales representatives' performance since they are aware that their rewards will be tied to their performance. For example, insurance agents are often paid a low basic salary plus commissions. These commissions are usually calculated based on the retention of existing customers and number of new customers. Information to evaluate insurance agents track record are stored in databases for easy retrieval by management.

The use of a computerized 1-800 customer service number can help firms to evaluate customer satisfaction with their products and services. Customers can use this service to make any complaints or suggestions that they may have. These complaints or suggestions are then evaluated and any necessary actions are taken expeditiously (e.g., revise product design, educate customers on the proper use of products) to minimize future complaints. Some systems can also keep track of complaints over time and link it to service representatives' performance. For example, Otis Elevator uses a computerized system to match elevators and service representatives. The system enables service representatives to access a customer's file and receive a complete repair history, thereby enabling better evaluation of the causes of the elevator's malfunction. The system also provides managers with a list of repeated repair records for each service representative, thereby enabling more equitable assessment of service representatives' performance.

IT can also be used to help employees evaluate customer requests. For example, American Express

developed the Authorizer Assistant which is a combination of an expert system and a database management system to enable its service representatives to reduce the time taken to process credit card authorization requests, minimize bad credit through more thorough searches of credit histories, and improve overall decision making. In addition, the system enables service representatives to adjust incorrect billing and replace lost or stolen cards—all while the customer stays on the telephone.

Reward Subsystem

This is concerned with the administration of extrinsic rewards based upon work performance, and also the design of intrinsically rewarding tasks to influence self-control of work behavior. It is generally a form of *ex post* control since rewards are administered after the completion of tasks. However, it can also be considered to be a form of *ex ante* control when the anticipation of rewards serves to influence individual or group behaviors toward desired organisational objectives (Flamholtz et al, 1985).

The use of IT can enable more efficient and effective analysis of work performance through its impact on the monitoring subsystem and evaluation subsystem. IT can make it easier to monitor the activities of workers directly instead of relying on indirect measures to determine appropriate compensation. Workers may be motivated to work harder if the evaluation pertaining to appropriate compensation is directly tied to their work performance. IT can also affect motivation by making tasks more meaningful and challenging. For example, the use of IT can restructure jobs such that workers no longer perform isolated steps but are now better able to understand the "big picture" pertaining to the nature of their job. By understanding the "big picture", workers are more motivated to perform their tasks efficiently and effectively since they have greater opportunities to learn and contribute to the achievement of organisational objectives.

IT can make it easier to monitor the activities of workers directly instead of relying on indirect measures to determine appropriate compensation.

The ability of IT to keep track and monitor the firm's overall performance relative to competitors enables the design of an appropriate reward system for top management. In other words, the reward system for top management can be more effectively tied to the firm's

overall performance. Furthermore, the ability of IT to keep track of line managers' performance enables top management to make appropriate decisions regarding employee compensations.

The ability of IT to keep track and monitor the overall firm's performance relative to competitors enables the design of an appropriate reward system for top management.

Consultancy firms (especially head hunters) use integrated databases to keep track of the current compensation levels of top executives. They act as consultants to the board of directors regarding appropriate compensation packages for current top executives. Furthermore, they help to design an appropriate compensation package to attract top executives with proven track records from other companies to switch jobs.

IT can help general managers to monitor their units' performance progressively and the reward system should motivate them to take appropriate proactive steps to minimize deviations from desired objectives. Furthermore, the ability of IT to record subordinates' performance over time enables general managers to better evaluate subordinates' performance. General managers can use these records to support their recommendations to top management regarding subordinates' promotions and salary increases. These records can also be used to motivate better subordinates' performance through the establishment of realistic goals for them.

Furthermore, a more equitable reward system for employees can be designed. For example, the salaries of sales representatives can be tied to performance which can be easily monitored and recorded through the use of IT. Performance can be tied to both new customers and also retention of existing customers. Sales representatives who build up relationships with existing customers as evident by high number of repeat customers can be rewarded appropriately. This helps ensure customer loyalty and minimize the danger of poor relationships with customers.

Another type of incentive system is used by some car manufacturers. The car buyer sometimes buys from the second dealer who gives him/her a slightly better price. However, the first dealer does most of the work in explaining the various features of the car. An incentive scheme is designed to reward both the first and second dealers when the customer makes the purchase. This

incentive scheme is made possible through the use of IT to record customers' particulars when they visit the showroom. Hence, IT helps to give the first dealer due recognition for the sale. This helps to reinforce teamwork and reduce undesirable internal competition among sales personnel.

Instead of using IT to monitor, evaluate and reward employees, the firm can also leverage IT to reward customer loyalty. For example, the ability of airlines reservation systems to automatically calculate and record mileage enable many airlines to offer the frequent flyers program to encourage customer loyalty. The success of this concept has prompted some retailers to implement similar frequent buyer program, e.g., Zellers Club Z.

IT can also help firms to achieve their objectives by facilitating partnerships among diverse companies. For example, the coalition of American Airlines, MCI and Citibank is facilitated with the use of IT. Travel on American Airlines, phone calls with MCI, and usage of Citibank credit card reward customers with free mileage on American Airlines. In addition, customers who use Citibank credit card are rewarded with free telephone calls with MCI. Rewarding of customer loyalty would not be possible without computer systems which record and process relevant customer information. Furthermore, the data that is captured can be used to design sales promotional strategies to encourage customer loyalty. This can create competitive advantage for the firm since loyal customers are less likely to switch to competitors' products/services.

Conclusions

The impact of IT has widespread implications for the design of MCS. IT offers unique opportunities for rethinking conventional approaches to the design of MCS. Firms have more choices than before in how they plan and control organisational activities in order to achieve organisational objectives. We note that IT can be used not only to increase efficiency but also to revolutionize MCS by reengineering the processes in which planning, monitoring, evaluation and reward are carried out.

Although the above discussion focuses on the impact of IT on individual subsystems of MCS, it is important to note that changes in any one subsystem can have implications for other subsystems. For example, Frito-Lay's use of hand-held computers to track inventory and enter orders also provide necessary information for planning subsystem (e.g., where, when and what merchandise to restock), evaluation subsystem (e.g., determine fast and slow selling items and the need for sales promotion), and reward subsystem (e.g., tie

rewards with performance of sales representatives). Similarly, although airlines reservation system was first developed by American Airlines to enable real-time monitoring of seats availability, the information that is collected and stored by the system enables managers to better plan pricing strategies, evaluate success of sales promotions, and reward customer loyalty through frequent flyer program. It is evident that IT impacts each of the four subsystems of MCS in many diverse ways. Underlying these diverse impacts is the ability of IT not only to enable accurate, reliable information to be available but also to provide support for using these information for planning, monitoring, evaluation and reward. IT helps management to better manage and use information in their daily tasks. It should be noted that each of the subsystem of MCS requires the support of the other three subsystems. For example, since the planning subsystem is predominantly concerned with the formulation of business plans, it requires the monitoring, evaluation and reward subsystems to oversee the implementation process to ensure that the business plans are efficiently and effectively implemented. In other words, without the support of the monitoring, evaluation and reward subsystems, a good planning subsystem will not contribute to organisational success. Each subsystem by itself is therefore necessary but insufficient unless it is complemented by the other three subsystems.

Since the planning subsystem is predominantly concerned with the formulation of business plans, it requires the monitoring, evaluation and reward subsystems to oversee the implementation process to ensure that the business plans are efficiently and effectively implemented.

The use of IT to re-engineer each of the four subsystems of MCS can be a source of competitive advantage since no other firm is likely to have exactly the same planning, monitoring, evaluation, and reward subsystems. Porter and Millar (1985) have emphasized that managing linkages between stages of the value chain

can be a powerful source of competitive advantage due to the difficulty rivals have in perceiving them and resolving trade-offs across organisational lines. Similarly, linkages among the four subsystems can make the MCS unique, and therefore difficult to imitate. In other words, rivals might imitate any one subsystem, but they are unlikely to be able to imitate each of the other three subsystems due to inherent differences in organisational culture, structure, strategy that make the MCS unique.

In conclusion, it is important to note that IT, by itself, is neutral. However, if IT is used to revolutionize MCS, firms must also carefully consider the resulting implications for organisational structure, strategy and culture. Changes in power relationships, authority and responsibilities are likely to occur. This means that the social implication of using IT should also be considered in addition to technical feasibility. Appropriate measures and precautions must be undertaken to ensure that the benefits of using IT to revolutionize MCS are not eroded by resistance to change or failure to take appropriate measures (e.g., retraining of staff) to minimize the undesirable effects of change (e.g., layoffs due to automation). If judiciously managed, the use of IT to implement a more effective MCS should result in better productivity and quality.

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Electronic Education & Training

M.P. Gupta

Information Technology has the capacity to change the traditional teaching model. Virtual Universities is the new emerging concept wherein high speed access will provide off-campus students with two-way interactive classes at TV broadcast quality including video, multimedia, software access, and on-line homework/question-answer sessions/ test/advising/intelligent tutors etc. These trends are gradually influencing the teaching methods of Indian institutions. 'Distance learning' is getting a new definition as more effective delivery is now possible through electronically mediated instruction through satellite, video, audiographic, computer and multimedia. The new technologies of distance learning hold the potential to revolutionize business and executive education in India though their introduction is slow. This paper provides a brief discussion on the above trends and developments in the Indian context.

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Introduction

Internet and Multimedia, being basic facts of IT, have recently become important media in the education system, adding new value in teaching-learning by covering a wide spectrum of subjects, objects and locations. An Indian teacher still relies on the traditional lecture materials: a chalkboard, standard white chalk and some handouts to supplement the text. An innovative teacher might use a coloured chalk! Drastic changes in teaching methods, however, are now being experimented by the enhanced application of information technology (IT) which has the capacity to change the traditional teaching model: expert system/intelligent tutors, virtual classes, multimedia and internet. Computer and telecommunications allow for a more interactive, integrated learning environment. This has revolutionized the 'distance learning' segment of education. Traditional teaching methods of Indian institutions are gradually influenced by these trends and improvements are visible from new experiments. IGNOU has taken the lead in establishing 1-way video 2-way audio conferencing facility for supporting its distance learning programmes. Indian Institute of Technology, Delhi, provides audio-visual equipments in classrooms and helps designing and developing value added video programmes and computer software for teaching. It also maintains state-of-the-art studio class rooms. In North American Universities, Computer-Aided-Instruction (CAI) has been active for a number of years while not disturbing substantially, the traditional methods. Virtual Universities are the new emerging concept, a milestone of IT facilitated education system.

The benefits arising from IT in educational settings have been widely discussed. Chen (1995) reported the development of team skills and communication skills. Osborn (1995) reported an experiment using groupware, noted IT's support of the use of more realistic problems and cases, including real managers on teams. Sandal and McGowan (1995) reported that writing skills were enhanced with the use of Internet tools. Technology can lead to new support of familiar pedagogies

such as paced instruction (LaBonty 1995). Khalifa and Limayem (1994) conducted an empirical study which found students' performance greatly better when students had access to hyper courseware. Automated lecture presentations led to more interested students who tested better. These techniques are of immense relevance on effective scope of IT application to distance learning.

Emerging Trends

Experiments in teaching methods are guided by two major tidal movements that are experienced today. First concerns a change in society's view of education: e.g., the perception of education's value to society, the willingness of society to pay for higher education, the value of a 'sheepskin' to the average employer, the value of 'sheepskin' to the average prospective student, the assessment of student performance, etc. Second tidal movement is the information technology (IT) driven introduction of new methods which has the ability to improve and upgrade the traditional teaching model. Virtual Universities with high speed access will provide off campus students with two-way interactive classes at TV broadcast quality including video, multimedia, software access, and on-line homework/question-answer sessions/test advising/intelligent tutors etc.

These trends are gradually influencing the teaching methods of Indian institutions too. For example, the author alongwith other colleagues at IIT Delhi, uses Web page for class material such as syllabi, handouts, readings, student papers, homework etc. for MBA students. Center of Education Technology at IIT-Delhi provides audio-visual equipments in classrooms, besides lending projection and video hardware to faculty members, as also designing and developing value added overhead projector (35mm) transparencies, video programmes and computer software for teaching, seminars and project work. The center maintains a state-of-the-art studio classroom with all audio-visual resources. It has a CAI laboratory with multi-media PC and a range of software products to design and prepare CAI packages, plane and 3-dimensional animation, E-mail and Internet facilities for worldwide networking and for teaching, research and communications. The center has undertaken an AT&T supported project for Global Distance Learning Initiative on Video Conferencing for faculty development and another project of All India Council of Technical Education (AICTE) on Video Teleconferencing and Nationally Coordinated AICTE Project on Education Technology.

Distance Learning

Distance learning is one dimension of education

where experiment with new/information technology has benefited the maximum. Distance learning has been a term used for years to describe any sort of education from Nursery/KG to professional colleges/institutions where the instruction occurs at one place, and learners are seated is somewhere else (or nowhere at all in the case of 'virtual' on-line universities). The issue here is computer mediated instruction which can be obtained from courses offered on the Internet. Computer and telecommunications allow for a more interactive, integrated learning environment. 'Distance learning' has been now redefined by United States Distance Learning Association (USDLA) as the "delivery of education or training through electronically mediated instruction including satellite, video, audiographic, computer and multimedia".

New technologies such as real time computer animation, simulation, interactive video, and voice capability are allowing people at different sites to interact as if they were in the same room. As against the traditional classroom, chalk, and blackboard (Cunningham, 1996), modern classroom will consist of students scattered all over the globe, whose only interaction with the instructor is through electronic medium. A paradigm shift is occurring from teaching environment to learning environment. Internet is found to be an important facilitator of this shift. While a major part of a class may be delivered on-line, guidance, assistance, discussion and learning tools have to be provided by other media. Here human interaction will still play a significant role. A clear vision of the educational purpose, therefore, is needed while following the emerging trend because the cost involved is very high (i.e. cost of training, equipments, logistics, maintenance, power etc.) Nevertheless, the new technologies of distance learning hold the potential to revolutionize business and executive education in India. Multinationals have found it very useful, though its introduction in educational institutions is slow.

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There is an effort by the author to initiate a large-scale video conferencing facility VIDCON at the leading institutions in India, and in particular at Roorkee University. In Sept. 1997, such a facility was inaugurated the National Informatics Centre (NIC). By linking various central government departments with state secretariats,

the video conference facility would improve government efficiency, provide better service to citizens and bring in transparency. It will be especially useful in disaster management such as flood relief where several state and central agencies have to work together. NIC had been asked to expedite the setting up of VIDCON studios in the secretariats of all the states/union territories in addition to the major government departments in New Delhi within six months. The centre will bear the software and hardware costs. The system will cut down on travel and stay expenses associated with official meetings and interaction. NIC's indigenous development of the software and hardware has brought down the costs for using the facility to Rs.3,000/ per hour, less than the cost of a trunk call, for point to point connections. The new facility has the potential of saving the government up to Rs 1 lakh for each conference of about 10 people participating from different cities.

Key Issues

It is quite obvious that IT driven innovations in teaching methods will substantially impact on the creative reasoning ability and the intellectual horizon of maturing minds. The change will be more evolutionary than revolutionary and we may move toward a new learning paradigm. We have to watch and understand the trends of changes such as: customer focus (treat student as customer), virtual universities, virtual students, reduced fund support, industry's role in curriculum development, increasing emphasis on skill and competition etc.

It is quite obvious that IT driven innovations in teaching methods will substantially impact on the creative reasoning ability and the intellectual horizon of maturing minds.

Employing IT driven systems for enhanced quality of delivery in a higher education environment is more complex than replacing the chalkboard with expensive telecommunications equipment. The issues go well beyond the set up costs and technology concerns. If the system is created for distance learning, it will require besides impacting existing infrastructure, new policies and procedures for enrollment, testing, grading, determining faculty load, transfers, recruitment and managing contradictions in meeting social demands etc. The positive aspect is that students can learn at times convenient to their schedule and at their own pace and they need not commute long distances. However, there will

be limited opportunity for collaborative learning, because, for Internet based programmes, students have to acquire computer systems and get on-line connection. Faculty will get opportunities to work in the new media and develop ability to focus on instructional design issues rather than lecture performance. However, they have to spend time on extensive development with uncertain rewards and outcomes.

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There are several other issues that would have to be addressed such as:

- Problem of equivalence or otherwise between on and off-campus courses
- Compatibility of the course delivery model with the mission of the institutions
- Reasons for the new geographic areas to be covered
- Policy regarding eligibility, prerequisites, admission, registration, examination and other evaluation related issues
- Public view of Internet based delivery system as compared to traditional courses/programmes. Time frame (year/semester/quarter?)
- Cost benefit (social responsibility with respect to benefits and resource generation)
- Equipments/connectivity requirements imposed on the students
- Discussion opportunity
- Credentials required, technical knowledge/expertise needed for faculty handling distance learning and Internet courses
- Mechanism of faculty load distribution, monitoring involvement in quality of course material and delivery
- Incentives to encourage traditional, non-technical faculty to be involved in new delivery systems
- Appropriateness of courses to be offered and the best suited delivery systems

- Components of delivery system that actually enhance the learning opportunities.

Solution to the above issues will vary by the type of institution, programme and course. For example, there are several programmes offered by IGNOU which the Indian Institute of Technology would not like to take up, as their missions are different. Similarly, being close to the Garhwal region, University of Roorkee (UOR) might have more flexibility to take up many programmes to suit its strength (viz. Water Resource Management, Earth Science, Earth Quake Engg., Hydro Electric Energy, Welding research etc.) in meeting regional/local requirements through distance learning. Being a university, it may also open up in the area of Tourism Management and Medical/Health Care Education and other need based programmes. This flexibility may not be there with IITs though they are technical institutions like UOR. Of all, the most important factor is to carry out a (social) cost benefit analysis of the new system/programme to be created. Many of the issues would be resolved once we have satisfactory results of the cost benefit analysis.

Concluding Remarks

Higher education in the country is being slowly revolutionized, through information technology. The most used IT related tasks in class room are live software demo/tutorials, Internet/Gopher/www, presentation software and e-mail transmission. These advantages have been clearly reported so far in North American universities. 'Distance learning' tools have sig-

nificantly advanced and the delivery of education/training is made possible through electronically mediated instruction including satellite, video, audiographic, computer and multimedia. The new technologies of distance learning hold the potential to revolutionize business and executive education in India. At present, its introduction in educational institutions, however, is slow. The central government has taken the initiative with National Informatics Centre (NIC) starting the full-fledged Video Conferencing facility linking various central government departments with state secretariats. The facility would improve government efficiency, provide better service to citizens and bring in transparency. It is hoped that gradually educational institutions will start taking the benefits of this facility.

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"There is no organisation chart at Sun. The only thing that matters is e-mail traffic."

**— John Gage of
Sun Microsystems**

"The first 30 years of the Information Technology revolution were all about paving the cow paths."

— Michael Hammer

Technical Education & Training for the Information Age

C.T. Bhunia & N. Upadhyaya

Technical Education is an essential ingredient for higher education and is vital in the information age today. Developing countries in general tend to invest much less in higher education in relation to elementary education, stating that latter has a priority over the scarce resources available. The author, alongwith many many earnestly feel that if higher education is costly necessary steps must to taken to remove limitations in providing funds. These aspects have been considered by the present authors for a longtime and they have proposed a new model of technical education known as I-C-I (Institute-cum-Industry). In other words, the industry being the beneficiary in the long run of the inputs to technical education, should associate itself in providing the much needed financial resources'. In the present paper, the cultural and societal changes reflected by technology are indicated and argued for the growth of technical education in the country. Some useful results emerged from their study pointing out to need to augment I-C-I befitting the information age.

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Introduction

In the present age of globalization, person-power development is one of the major strategies [Abdus Salam, (1991); Report, (1993); Temase, et al (1994) and Bhunia, (1996)] for poor nations to survive and/or lead with. Person-power Development is needed at two levels: (a) at elementary level to make common people literate, by the process of which average human development of a nation is uplifted and (b) at higher education level, particularly in science and technology field, to make nations technology-independent. In the paper we shall discuss about the people power development at higher education level for the information age.

Poor countries usually allot a marginal amount in budget for higher education. Argument in its favour goes on saying that poor nations cannot find it proper to invest more in costly higher education system ignoring other priority area like elementary education, health, and family welfare. Such a proposition has two inherent faults. Higher education in poor nations is mistaken as costly. If higher education is really costly, the reasons behind this, need to be analyzed and necessary steps should be taken to remove the limitations rather than cutting the budget of higher education. This has created a wide mismatch between what the poor nations generate and what they need. These aspects and fea-

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tures (see Bhunia, 1994, 1995 & 1996 for a discussion and Solutions to the problems). In particular a theory of new model of technical education known as I-C-I (Institute-Cum-Industry) has been proposed.

In the present paper, the cultural and the societal changes reflected by technology are indicated and argued for the growth of higher education for technology adoption. Some results of survey to augment the necessity of I-C-I befitting the information age are provided.

Institute-cum-Industry

Poor nations could set up "Institute-Cum-Industry" (I-C-I) (See Bhunia, 1994 & 1995; Natarajan, 1994) to produce better skilled man power, as a modular structure of technical education to realize internal revenue generation (IRG) scheme in institutes and to curb brain-drain.

Poor nations could set up "Institute-cum-Industry" (I-C-I) to produce better skilled man power, as a modular structure of technical education to realize internal revenue generation scheme in institutes and to curb brain-drain.

In the modular concept, class 10 passed students are admitted in the base-module engineering course. Base-module course is equivalent to typical vocational course. Base-module course is of 2 years duration. Top 60 per cent students passing out of base-module course are admitted in next higher module known as diploma-module which is also of 2 years duration. Top 60 per cent of students passed out of diploma-module are admitted in the final module known as degree-module which is also of 2 years duration. This reduces the investment on technical education without affecting productivity. The objective of producing better skilled technical engineer is embedded in modular concept where diploma and degree students get continuous exposure to technical field respectively for 4 and 6 years rather than 3 and 4 years as in conventional systems presently being followed in India. However I-C-I shall be slightly different of modular type. For vertical students whereas duration of base and diploma will be each 1.5 years, for degree students it will be 3 years. Terminating students have to go 0.5 years rigorous training in industry section at each module to make them eligible for certificate or diploma. Duration has been suggested keeping in mind that for base and diploma, the requirement is the "know-how" whereas for degree it is the

There shall be financial advantage in merging industry section with laboratories and in using students as skilled persons in an environment of "learn while doing" and "do while learning".

"know-why"; and in consideration of production of better skilled human resources at all levels. Out of the two departments of I-C-I, namely industrial department and institute department, the role of the industrial department will be to earn IRG by implementing commercial viable projects and consumer products of high quality where final years students will be the major contributors. Practical classes and productive research shall be conducted at industry section. There shall be financial advantage in merging industry section with laboratories and in using students as skilled persons in an environment of "learn while doing" and "do while learning". Dr. Colombo (once said "... the most important resources in today's world is human intelligence, creativity and ingenuity. Education and training must be number one priority in any sound development strategy". I-C-I is an instrument of this strategy for India.

NERIST Project

The partial solution to I-C-I is being experimented in the project of NERIST (North Eastern Regional Institute of Science & Technology) with a concept of modular structure of technical education. Figure 1 illustrates the entry policies of institute like NERIST. The inputs to the proposed I-C-I will be tenth passed students as in modular scheme, thereby combining two innovative ideas. However education structure will be somewhat different from modular scheme as explained below:

- (1) 1.5 years will be the duration for certificate course for vertical mobility students. Another 0.5 years is to be studied by terminating students at industry section.
- (2) 1.5 years will be the duration for diploma course, and only top 60 per cent students of certificate course will be admitted in to diploma provided they secure more than or equal to certain percentage of aggregate mark in the certificate course. For terminating students, additional 0.5 years industrial training will be there in industry section.
- (3) 3 years will be the duration for degree course and admission procedure will be as in diploma level but based on both the results of the certifi-

cate and the diploma. The specialized course will be offered at the first year of degree course. The special papers will be allotted 50 per cent of aggregate marks of the total marks.

- (4) 1.5 years will be the duration for P.G. course out of which 0.5 year for theory class, 0.5 year for project and 0.5 year will be kept reserved for research (extension of project) in respective specialization with the condition that based on this research at least one paper must be published by the individual student/group in order to make them eligible for getting degree. In the ICI theory, duration has been fixed for base/diploma based on their requirement of know-how, while for degree and post-graduate, the duration has been fixed based on their need of know-why.

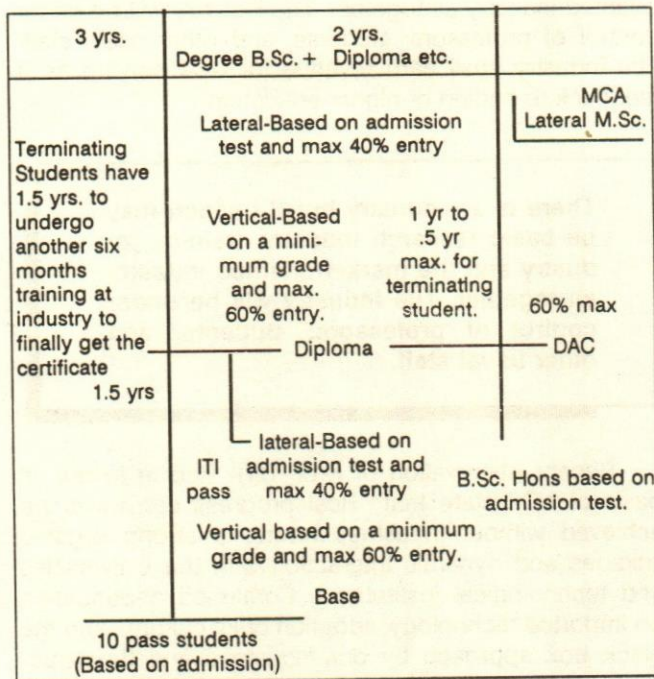


Fig. 1. Structure of Students Input/Output

The industry section will earn revenue for running the institute as well as for investment in R&D. By this the developing countries can overcome the financing problem of higher education and research.

In order to find how best and cost effective is the I-C-I over conventional institutes, at the primary level we can make a comparison between NERIST and conventional institutes. We assume expenditure incurred per student as the parameter for such comparison. The expenditure figures of NERIST are portrayed in Fig. 2 for a period over 1992-1996. NERIST is typically a 3-in-1 in-

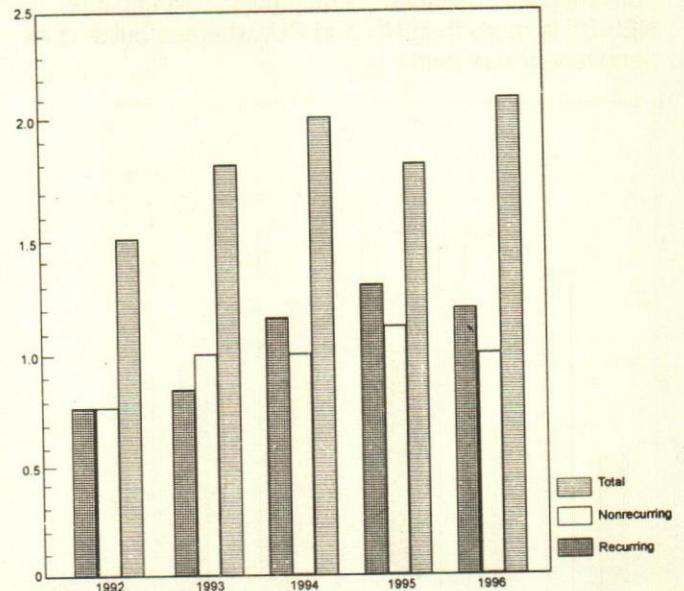


Fig. 2. Expenditure per Student (Rs. in lakhs) of NERIST

stitute, in which ITI, Polytechnic and Graduate and Post-graduate levels of studies are integrated. The data of NERIST is extended to conventional institutes in the following means:

- (1) Non-Recurring would-be Expenditure in 3 Conventional (ITI + Polytechnic + Graduate and Post-graduate) institutes = Building Cost of NERIST + Equipment Cost $\times p$ (1)

wherein it is assumed that (i) building cost remains constant being proportional to students, staff and faculty strength and (ii) equipment cost in conventional institute p ($p > 1$) times of NERIST.

- (2) Recurring would-be expenditure of 3 conventional institutes, that is (Salary + other costs of NERIST) $\times p$ (2)

From computations based on equations (1) and (2) one finds the would-be are indicated in the bar chart of Fig. 3. Fig. 4 compares the expenditure of NERIST with that of conventional institutes.

As suggested by Natarajan (1994), financial indicators RP/TP (Revenue or Recurring Payments/Total Payments), NRP/TP (Non-recurring Payments/Total Payments), BP/NRP (Building Payments/Non-recurring Payments) and EP/NRP (Equipment Payments/Non-recurring Payments) are depicted in Fig. 5 to compare two conventional institutes, namely, HU (Hyderabad University) and PU (Pondichery University) with non-conventional institute, NERIST. We find that as per financial expenditure, NERIST comparable to other

conventional Institute. Equipment expenditure of NERIST is more than HU and PU; whereas building expenditure is less than HU.

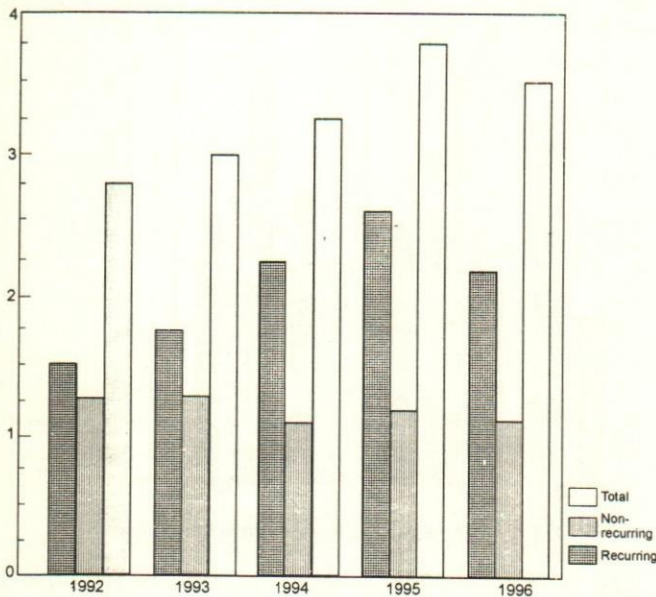


Fig. 3. Expenditure per Student (Rs. in lakhs) of Conventional Institute

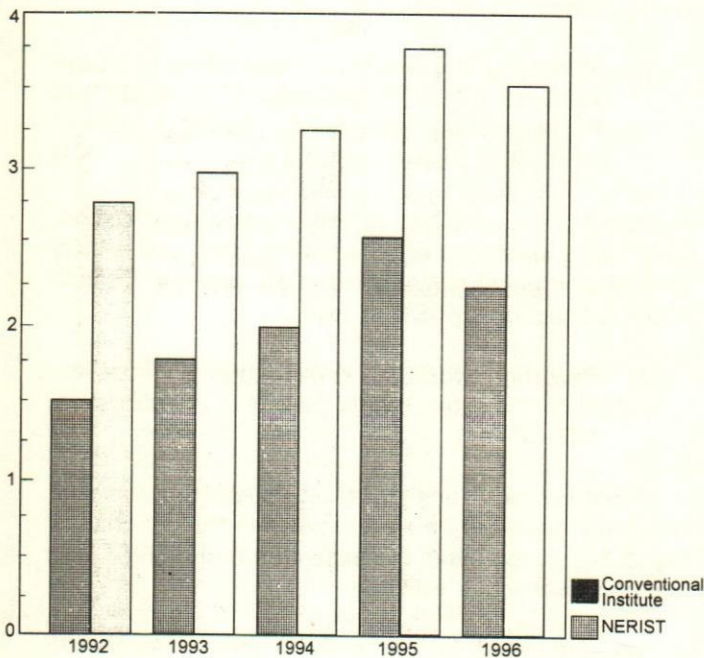


Fig. 4. Expenditure per student (Rs. in lakhs.)

In I-C-I there shall be two sections: institute and industry. They will go hand by hand and flourish uniformly in an integrated manner. 100 per cent and practical interaction of institute and industry will be implemented by I-C-I. One needs today an environment where educators and researchers must not be separated from engineers by some hypothetical walls.

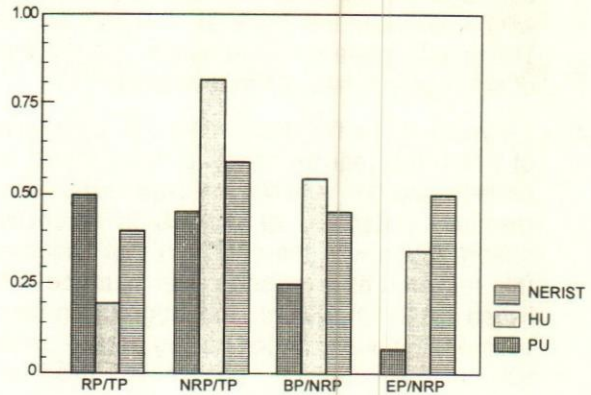


Fig. 5. Expenditure Comparison Year - 1990-91

There is an industry in I-C-I which may be basic research industry, training industry and the market-oriented industry all together. The industry will be under control of professors, students, and other usual staff. The industry shall earn revenue for I-C-I serving as a feedback to finding of higher education.

There is an industry in I-C-I which may be basic research industry, training industry and the market-oriented industry all together. The industry will be under control of professors, students, and other usual staff.

Recent observation of Prof. U.R. Rao in favour of basis of I-C-I state that "Real progress can never be achieved without industries having a strong organic linkages and dynamic interaction with the Universities and technological institutions. Continued dependence on imported technology, adoption of kit cultures and the black box approach by our industries and the reluctance of our R & D institutions to work in closed cooperation with industries, have resulted in our industries becoming outdated and uncompetitive in global market."

Basically I-C-I comprises:

- (a) an innovative type of technical education system that will produce technical engineer rather than academic engineer at different levels,
- (b) a cost effective higher education system,
- (c) an internal revenue generator (IRG) establishment,

- (d) an institute which can flourish industries innovatively and economically.
- (e) an institute which can curb brain-drain, and
- (f) an institute which can raise status and pay-scale of faculty members.

HRD and IT

By and through I-C-Is, proper human resources may be generated. But due to fast changing of technologies and engineering particularly after the invention of information technology, the human resource needs to be continuously trained and educated to make them ever useful.

HRD of any organisation can be achieved in major two means – (1) Recruiting PEOPLE who are resources and (2) Developing existing HUMAN resources of the organisation by continuous in-house and out-door trainings pertaining to respective field of specialization. The last one is the continuous and in-built process of the organisation.

Even a few years back, HRD and personal departments were rated as cost centers rather than profit centers in the organisation. With liberalization and privatization and convergence of them with information technology, the business and management scenario have changed. Human action and human work are given recognition as pillars of productivity. Moreover application of information technology in education and training has vastly improved the quality of training and self development meant for HRD process. HRD as a system has three sub-units: Training, Education and Development (TED). Training is meant for the present job. Training bridges the gap between the present level of performance and the expected level of performance.

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Training is for continuous improvement of quality, performance and creative ability. As per Laurent Bessanco of International Telecommunication Union, "Fear of change typically constitutes a major obstacle. There is real need to educate people on

how to use the new technologies and applications, as well as on WHY use them." Education is for the future job and development is to provide with the learning experiences and guidances to employees so as to make them fit to move with new organisational and technological changes. Information technology helps an organisation staying ahead in providing improved TED of HRD.

Multimedia is fast emerging as an important tool of information technology and as a basic tool of tomorrow's life. Multimedia proposes to stimulate human-like communication and services in an environment of "you see as I see" and "you feel as I feel." Virtual reality is envisaged in multimedia services. Multimedia transfers your messages in your's way. Multimedia is believed to prosper with the general human trend from "nice to have" to "value to have." With multimedia a society with "plug and play", "look and feel" and "point and click" shall emerge. In near future, we shall have multimedia cities and centers. It is often said that in future multimedia shall be the rule and the monomedia shall be the exception. Interactive multimedia is a service which provides simultaneous access, dissemination, transportation and processing of more than one information services like voice, video and data in the interactive mode in the real time environment.

Multimedia is fast emerging as an important tool of information technology and as a basic tool of tomorrow's life. Multimedia proposes to stimulate human-like communication and services in an environment of "you see as I see" and "you feel as I feel."

Multimedia in particular and IT in general have introduced teleteaching, telescopic courses and audio-video cassettes to deal with training and education at home or office both at individual effort and at organisational level. This has made HRD process more cost-effective, time controlled, comfortable, and easier. IT application brings advantages of learning in leisure time and as life time experiences. Satellites (LEO, MEO, GEO), VSAT, Cable TV, Radio and TV are other means of such experiences of learning. Due to use of IT, there has been paradigm shifts in training and education process. New shifts are training and courses on demand, life long and year round learning, global education at everywhere and at any time, and students as customers rather than products. Application of audio visual displays in training is facilitating both trainers and trainees to improve by a common finding that people recalls 20 per cent of what

they see, 30 per cent of what they hear; and about 80 per cent of what they see, hear and do simultaneously. Multimedia provides integrated service of seeing and hearing and involving.

Culture, Technology and Society

Life on earth has to overcome the crisis for sustaining and creating conditions for survival and existence. Human being has complemented the existence, the growth, the prosperity and the development using technology. Since the long back, there has been existing a feeling that the application of technology has an emphasis on the culture and the society.

In the present paper the correlation, the reflection and the relation between culture and technology, particularly in the era of liberalisation, globalization and privatization era duly brought forward by a single most technology known as Information Technology—have been examined.

Culture consists of values, ideas, language, means of socializing and getting foods, clothes and shelter, customs, codes, art, rituals ceremonies, use of tools, machines and techniques according to Majumdar (1996) so forth. Culture is the means and the ways of living of a given society (while 1959; Russell & Pelto 1972; Claxton 1997; Dunn 1978 and Urevbee, 1997) the definition of culture stipulated at the UNESCO conference held in Mexico in 1982, is "(culture) comprises the whole complex of distinctive spiritual, intellectual and emotional features that characterize society or social group. It includes not only arts and letters, but also modes of life, the fundamental rights of the human being, value systems, traditions and beliefs." The second draft adopted in Mexico city proposed, culture as "a complex, comprehensive and multidimensional process which extends beyond mere economic growth in corporate all dimensions of life and all the energies of a community, all of whose members are called upon to make a contribution and expect to share the benefits. Modes of life is a part of culture. Discoveries and innovations are the essential elements for the life to survive, prosper and grow.

As per contemporary writer Raymond Williams, culture consists of four things: state of habit of mind, state of intellectual development, general body of arts and way of material life. With discovery of light, solely discovered by people through necessity and innovation and discovers are attributes to changing life's styles and modes, causing culture to change. Thought process, when early people began to live in group, is also an essential attribute for change of modes of life. Innovation discovers, thoughts and their application are what

we call science, philosophy and technology. Actually belief, science and philosophy are three categories of the intellectual activities of human beings which are essential ingredients of society: "belief where no questions are asked; philosophy, where all questions are asked and debated on the basis of logic; and science, where some questions are ruled out because... Science is what can be tested by experiment and observation. Amartya Sen stated that "central to culture is freedom; and in particular to value, and what lives we have reason to seek." this culture is the totality of the scientific, technological, philosophical, psychological, ideological and economical features of a given society. With change of any of these, culture is bound to change. Culture is a dynamic system, a system which changes with time and a system which changes gets evolution with time.

What is technology? It is the application of science. More specifically technology is the application of the various branches of knowledge in general and the science in particular to practical problems. With technology, people solves the problems and masters over the environment. Technology is the accumulated practical knowledge, experiences, skills and procedures "for making, using and doing useful things and for accomplishing recognized purposes. Technology includes not only modern industrial technology i.e. techniques, tools and machines but also crafts the artifacts, what is sometimes referred to as the material culture." Technologies sometimes are defined as: material and non-material technology. Material technology refers to all tangible objects like machines, tools and equipment used by people in their environment and activities of solving problems. Non-material technology refers to ideas, thoughts, philosophies, customs and frameworks embodied in social process. Education, training, economic, ideologies, political process and procedures are classified as non-material technology.

Culture is an envelope of non-material technologies. Non-material technologies are changed and institutionalized by material technology. Thus, "there is a natural inter-dependence between technology and culture which requires that the relationship be an essentially authentic one, since it exists to satisfy man's immediate and particular needs as well as to enable him to live in harmony with his very own environment. Indeed tools are the interface between man and nature. The development of new technologies is linked to a society's evolving needs, to the relative importance accorded to satisfying them, and to the application of new and different solutions to existing practical problems based on the society's creative capacity and its particular knowledge and experiences. The introduction of a new technology often creates new social situation, which in turn, creates new values, thus stimulating fur-

ther technological development." Culture and technology are interlinked and vary with each other, change with each other and enrich with each other. The implication or Raymond William's definition of culture is that the technology is an element of culture. The depth of change and that of enrichment of the culture. The depth of change and that of enrichment of the culture due to technology adoption in a given society depend on may factors:

(1) Educational level, (2) Economical level, (3) Corporate culture, (4) Ethnic, gender and cultural composition, (5) Available infrastructure, technology and skill, (6) Psychological profile.

However basic factors are: (1) Average education (E_1), (2) Average economic level (E_2), (3) Political stability and openness, P (4) Information flow and availability (I). One can write: Cultural change = f_1 (technology adoption)

$$\text{Technology adoption}^1 = f_2 (E_1, E_2, P, I)$$

$$\text{Cultural change} = f_3 (E_1, E_2, P, I)$$

$$\text{Cultural change} = f_4 (\text{GNP/GDP, HRI, P, IR/IP})$$

It will be pertaining to mention about Amartya Sen's observation (Encyclopedia Britannica), that "Education is important not just for the help that it might give to economic growth, but because it is an essential part of cultural development." The observation that is put in above four equations can be corroborated by the statistics of international in culture in terms of printed materials, cinema, photography, fine and graphic arts, audio visual field, sporting games and equipment in 1991. This is depicted in Table 1.

Table 1: Culture Development Scenario

	Share in the world export of the cultural goods	% of world population
Developing nations	68.2%	23%
Developed nations	31.8%	77%

"Education is important not just for the help that it might give to economic growth, but because it is essential part of cultural development."

On the information sector, one can just verify our observation just on basis of the number of simple Radio receivers per 1000 people (Table 2). Arguing on the political nature of technology, professor Andrew O. Urevba wrote that "While we admit that technology is cultural enterprise, we must not fail to be aware of the political nature of technology as well."

In the developed world, with applied technology (machines, gadgets etc. in all aspects of human life. We are dependent on machines and gadgets, not to mention the whole infrastructure of societal living. There is a feeling that the technology has taken over. This line of thought has arisen because of the political nature of technology.

Both the nature of present technology and technological innovation and maintenance are politically determined. In other words, "technology does not just provide in its individual machines the physical means by

Table 2: Number of Radio Receivers

	Number of receivers (Millions)				Number of receivers/1000 Inhabitants				% in terms of world total (number of receivers)			
	1970	1980	1990	1994	1970	1980	1990	1994	1970	1980	1990	1994
World total	771	1307	1877	2008	209	294	335	357	-	-	-	-
Africa	19	49	160	122	51	104	171	173	2.46	3.74	5.75	6.07
America	350	566	711	756	687	926	991	991	45.39	43.3	37.87	37.64
Asia	78	254	568	621	37	96	178	183	10.11	19.43	30.26	30.92
Europe	314	418	464	481	481	604	643	662	40.72	31.98	24.72	23.95
Oceania	10	20	26	28	526	871	996	1007	1.29	1.53	1.38	1.39
Developing Countries	123	323	724	790	46	97	177	179	15.95	21.71	38.57	39.34
Least developed Countries	7	20	48	55	23	51	95	98	90	1.53	2.55	2.73

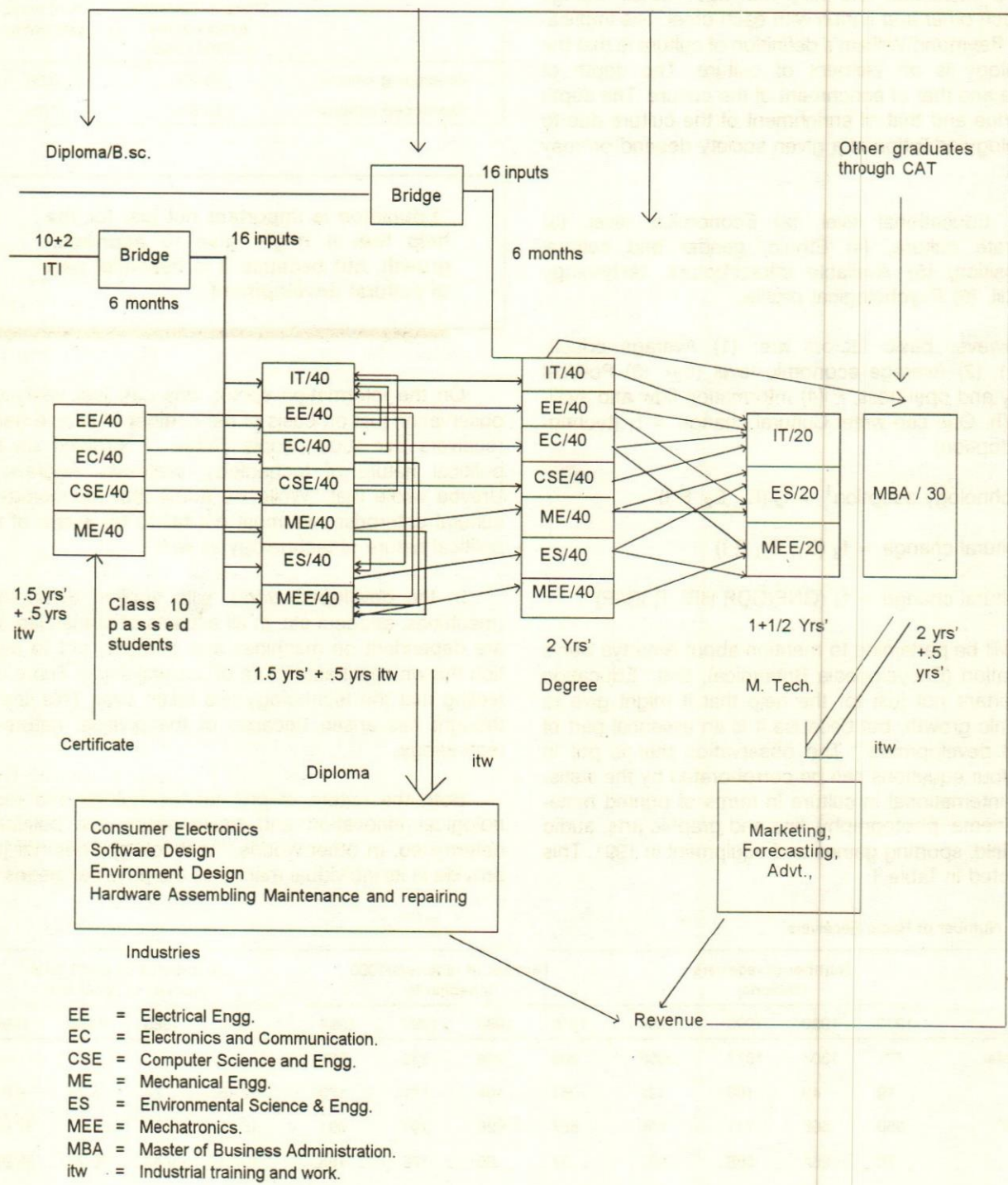


Fig. 6. I.C.I Scheme of Technical Education.

which a society supports and promotes its power structure, it also reflects as a social institution this social structure in its design." And one finds that education is the basic tool for technology adoption, cultural growth and societal improvements.

From a survey on problems and prospects of higher education in India conducted by the authors, a few interesting findings are given below:

1. To a question of the nature of problem being faced by the scientists, the response received is as below:

Financial	42%
Scientific	30%
Administrative	42%
Non-availability of materials	15%

I-C-I can solve the problems related to financial.

2. To a question of whether Research and Development (R&D) be given special priority, 100 per cent response go in its favour. I-C-I supports this response.

3. To a question of industry and institute interaction in the field of R&D, more than 50 per cent says about its extreme essential. I-C-I is an 100 per cent interaction scheme.

4. To a question of growth of indigenous research, 100 per cent responses go in its favour. I-C-I can augment indigenous research.

5. To the requirements of development of Science & Technology, responses received are as under:

Higher salary and perks	42%
Placing scientists and engineers at top positions of technical deptts/sections	70%
Substantial budget provision in R&D and higher education	100%

I-C-I can conform with such requirements.

6. To a question of priority areas of research and development, responses received are as below:

Information Technology	14%
Power Sector	28%

Electronics and Communication	28%
Environmental Studies	14%
Biological Science & Human Science	14%

Based on this, we propose a model I-C-I as shown in Fig. 6 for the information age.

Conclusions

Person-power development is the only sound strategy for the poor countries to survive with open economy and in the information age. Institute-Cum-Industry is an instrument of generating proper and powerful technical personnel in the poor nations befitting to their economic situations and affordability to support and sustain costly higher education. For the national development information flow (information that a nation's human resources possess, the nation's ability to utilize information resources) is a key factor. Keeping in mind these aspects, a model I-C-I for information age (Fig. 6) as proposed in this paper needs experiment in the poor countries like India.

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Information Technology as a Strategic Tool for Workers' Retraining in Brazil

Luiz Antonio Joia

This article presents a framework for retraining Brazilian workers from industry, commerce and services activities, in order to make them useful for the new knowledge society we live in. The approach presented in an alternative to the traditional retraining models which are solely based on training the workers in the fundamentals of Information Technologies, without going further on the essential skills and expertise that allow the workers to own a professional laterality degree. The model discussed herein is based on field research undertaken by the author within the Brazilian productive environment, to analyse why the implementation of new technological innovations, mainly based on Information Technology, has barely leveraged their companies' productivity. Based on this survey, a new Information Technology Based Training framework is presented to be deployed within the companies, through the development and use of a Web-Based Instruction system.

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Introduction

There is a new reality today, when the Cartesian, Taylorist, fragmented and sequential thinking is being replaced, in a very fast way, by what can be named hereinafter as 'Digital Thinking'.

Digital Thinking depends upon the creation of a new mental model that, far from what is preached by the analogic and Cartesian concepts, is based on an asynchronous mental model and on the ability of linking, combining and associating different, or even opposite ideas. It has its rationale on the blending of some intelligences despised by most educators and managers for a long time. In 1983, at the Harvard University School of Education through a seminal work, research was presented describing seven different types of intelligence is multi-edged and multi-dimensional (Gardner, 1983). Later on the emotional intelligence concept was gathered into this array of multiple intelligences (Goleman, 1996), and other authors have expanded this initial string of intelligences (Handy, 1997). The purpose of this article is not to deepen the discussion about the Multiple Intelligence. The Digital Thinking concept has most of its features accruing to the following Intelligences (Handy, 1997):

- Analytical – defined as the ability to rationalise and formulate concepts and questions;

Digital Thinking depends upon the creation of a new mental model that, far from what is preached by the analogic and Cartesian concepts, is based on an asynchronous mental model and on the ability of linking, combining and associating different, or even opposite ideas.

- Numerical—defined as the ability to handle numbers;
- Spatial—defined as the ability to recognise patterns of action and behaviour;
- Expositive—defined as the ability of having verbal and written communication skills.

Corporate IQ

Today, everyone is living in a world where change is the only constant, which applies to knowledge that is being discarded and made useless in a frenetic way, shortening its useful life-span. The CPM operational system can be cited, as well as some once very important programming languages, such as PL1, ALGOL etc. A lot of professionals were trained to use these technologies, that now are useless to our society, which has made them migrate into other knowledge areas. It has been not an option, but a survival issue.

The use of Information Technology in enterprises is no longer limited to the introduction of computers to automate the old working processes, but encompasses redesign and/or innovation of their old processes.

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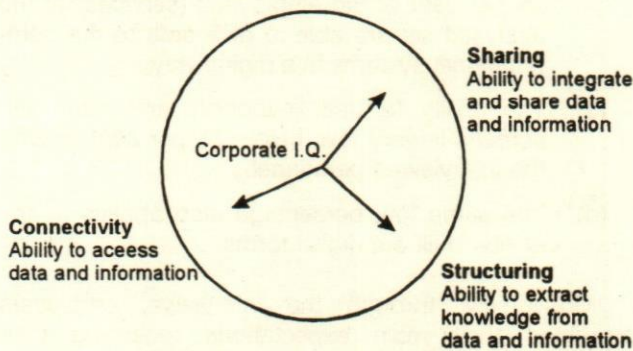


Fig. 1. Corporate IQ

The Corporate IQ (Haeckel and Nolan, 1993), using an analogy with the personal IQ (notwithstanding its flaws), can be evaluated through the enterprise's capability of connectivity (internal link and link with its partners), sharing (data and information shared among

its personnel, and its partners) and structuring (ability to extract knowledge from information and raw data). The Fig. 1 depicts this concept (Joia, 1995).

Concerning the structuring issue, as might be expected, most corporations have a very low score, since their employees have great difficulty (or very poor skill) in getting the necessary knowledge, from the available information and data.

Data, Information and Knowledge

Data means a set of discrete and objective facts concerning events. Therefore, it can be understood within an organisation as a structured record of transactions (Davenport and Prusak, 1998). Information is data that makes difference and is relevant, or as Peter Drucker says: "information is data with attributes of relevance and purpose". Normally, information is understood as a message, usually having the formal of a document or visual and/or audible messages. Information is, above all, context-based.

Normally, information is understood as a message, usually having the form of a document or visual and/or audible messages. Information is, above all, context-based.

Knowledge is linked to the capacity of action (Sveiby, 1997). It is intuitive, therefore hard to be defined. It is linked to the user's values and experience, being strongly connected to pattern recognition, analogies and implicit rules. Most of the time, knowledge is located within an organisation, inside the employees' heads (tacit knowledge) or in documents (explicit knowledge). This can explain why too much confusion is arising between Document Management and Knowledge Management.

Although it is a generally accepted distinction, doubts have been cast recently over the tacit-explicit dichotomy (Polanyi, 1958). According to the autopoietic epistemology school (Varela *et al*, 1992), knowledge is a private, personal thing, and so an organisation cannot possess it. Hence, knowledge cannot be explicit, only tacit: explicit knowledge is actually data and/or information which help other people to create their own knowledge through what is known as "structural coupling". However, this article will accept the tacit-explicit distinction for reaching more interesting conclusions.

Then, assuming the tacit-explicit dichotomy, the

following mathematical formulas depict what has been said:

$$\text{Information} = \text{Data} + \sum (\text{Attributes, Relevance, Context})$$

$$\text{Knowledge} = \text{Information} + \sum (\text{Experience, Values, Patterns, Implicit Rules})$$

Mental Models

The world is being submitted to a transition from the electro-mechanical to the digital era. The mental model of the ordinary worker is an analogic-based one, which generates great difficulties for most of them for handling informatized processes in this current digital era. Most foremen do not understand how a string of commands, launched from computer screens, can command a machine far from them that was formerly commanded directly through the manual contact of gears, levers and buttons. As they cannot understand this rationale, a mental routine is created by them, to memorise automatically the needed procedures. As a result, most of the technological innovations based on Information Technologies implemented in the Brazilian companies are far from reaching the forest productivity target, as people are not taking advantage of all the potentialities to which these innovations can lead.

Experience has shown that training based only on courses that teach the employees the basic concepts for handling a computer are not effective in the creation of the necessary new skills and expertise. These courses are made around the computer, which leads to a technocentric vision in opposition to the anthropocentric vision from the Tavistock School of Human Relations, whose concept is to have man in the middle and as the main target of any technological innovation. Regarding this issue, what is learnt is less important than how is it learnt, i.e. the educational process. Hence, the ability to learn new things or learn to learn is paramount today. Rather, the ability to "de-learn" what was learnt is necessary most of the time, which is not a very smooth process, unless well led.

Learn to learn, ability to solve problems which were

Experience has shown that training based only on courses that teach the employees the basic concepts for handling a computer are not effective in the creation of the necessary new skills and expertise.

not faced before, to be creative and to use inductive thinking, instead of deductive that still forges the current educational process, among others, are the workers' current major challenges.

In this environment, the present paper presents some ideas to redesign the employees' training process using the Information Technology as a strategic tool, in order to make them able to act when faced, for instance, with screens, keyboards, virtual realities and so forth, in opposition to the instruments of the industrial era.

Methodology

The methodology aims at surveying some current employees' indicators regarding their ability to be engaged in this new digital society, as also the employers' expectations concerning their employees. After that, as the results match themselves, a new IT based training model is proposed to develop the employees' digital thinking needed for a learning organisation in a digital society.

Field Research

From a representative set (industry, commerce and services, in Brazilian major cities), the portrait of what is happening today is as follows:

- (a) Only half of the employees working in industry, commerce and services activities of the analysed set have communication skills (*latensu*).
- (b) Only 15 per cent of the employees (industry), 45 per cent of the employees (commerce) and 35 per cent of the employees (services) of the analysed set are able to give data to the computational systems in a digital way.
- (c) The ability to use keyboards and deal with screens is very low, below 20 per cent among the interviewed personnel.
- (d) The same low percentage also applies to the ability to fill out digital forms.

Conversely, through the interviews, employers presented their main expectations regarding their employees:

- (a) More than 60 per cent of all the employers expect their employees to increase their skills in mathematics.
- (b) More than 70 per cent of all the employers ex-

pect their employees to increase their communication skills (both written and oral).

- (c) The research unveils the employers' expectations regarding improvement of their employees in the knowledge of informatized systems (nearly 70 per cent among all three areas).

Digital Thinking

All that was said before in this article, as an actual need of current society can be summarised as Digital Thinking.

Therefore, one aims, through the use of Information Technology as an enabler, and tailor-made modules developed for that purpose, to allow employees to get this new mental model to be more useful for their enterprises and to reach a stage where they will be able to solve problems themselves. They are better the challenges generated by the impressive and too fast introduction of technological innovations in the companies, which affects their daily work routine. The results accrued to the implementation of these new technologies have been far less than the forecast ones, mainly due to the inadequate profile of the workers assigned to deal with them.

The Information Technology used as a tool to achieve this new mental model leads, has a ripple effect, to the training of the employees on how to handle this technology.

The Information Technology used as a tool to achieve this new mental model leads, has a ripple effect, to the training of the employees on how to handle this technology. However, it must be stressed that this training must not be an end in itself, but just an enabler.

So, briefly, it aims to allow the workers:

- To increase their communication skills (verbal and written);
- To have the ability of decodifying and structuring the data and information, transforming them into knowledge;
- To improve their mathematical abilities and arithmetical skills;
- To identify, enunciate and solve problems;

- To keep the roots necessary to research, evaluate, criticise and select information among complex knowledge nets;
- To be creative;
- To know how to take part in teamwork and to have the skills to manager themselves;
- To work within digital, and even virtual environments.

New Professional Role

Currently, it can be said, without doubt, that most of the schools and companies (even the so-called learning organisations) – in their internal training processes – are creating professionals inadequate for the productive society all of us take part in today. In Brazil there are headlines in the newspapers as (O Globo, 1998):

“Unemployment: Courses are being given for extinct functions”, about requalifying courses for areas for which demand is nil. Or “Lack of skill is an obstacle to get a new job”, where the concept of laterality is stressed. This concept analyses the workers' ability to develop tasks different from the ones they are acquainted with, as they own the basic and fundamental skills that allow them to migrate from one function to another. As the technological innovations turn up at supersonic speed, it is cheaper and more effective for the enterprises to have employees with this laterality, instead of always having to retrain them for the new technologies introduced in the company.

It is enough to analyse what the society wanted from their professionals in the decade of 80's, and what it has wanted for the 90's, a difference of just ten years (Joia, 1997):

<i>The 80's</i>	<i>The 90's</i>
Specialised Technical Skill	Experience on Learning
Encyclopaedia's Culture	Generalist Culture
Competitive Attitude	Collaborative Attitude
Competence and Passiveness	Entrepreneurship
Stability	Search for new opportunities

Hence, as most of the time the schools are not playing their role in an effective way, it is paramount that the enterprises play the schools' role, as learning organisations.

Training Modules

The structure of the training process depends highly on the people it is intended to deal with. In this case, these people are compounded of employees with, at least, a high school diploma. It is intended to structure a training that, at once, addresses the medium (the information technology), to achieve a greater purpose: to give the workers digital thinking. The teaching-learning process leads to the use of computers, which give a feedback for the learning loop. This training (basic use of computers) is optional, as some employees already deal with computers successfully. On the other hand, the fundamental modules are given with the adequate use of the medium—the computer.

The modules are as follows:

Medium Handling (optional)

This module intends to qualify the employees for using the tools where the process applies. As the employees had already been trained in these issues, this module is not necessary.

The main issues of this module are presented below:

- (a) Training in Basic Informatics (Hardware and Basic Software)
 - (i) Introduction to the Hardware
 - (ii) Introduction to Operational System and
 - (iii) Introduction to Basic Software (Word Processing; Spreadsheet and Presentation Generator)
- (b) Introduction to Networking and Data Communication
- (c) Introduction to INTERNET

Generation and Moulding of the Digital Thinking

Here, it is intended to give the workers the specific skills and expertise where the Digital Thinking applies. These are:

- (a) Mathematical Abilities (Introduction to Basic Arithmetic, Algebra, and 2D/3D Euclidean Geometry)
- (b) Logical and Creative Thinking—Introduction to Basic Logic, addressing mainly Boolean logical operators, inference, recurrence etc., as well as pupils' creativity development.

- (c) Problem Enunciation and Solving—Here the two former modules are gathered, in order not only to enable the employees to solve the problems associated with their professional reality (contextual problems), but also mainly to know how to find out problems, and to enunciate and structure them to be solved later.
- (d) Communication Skills—Here, notions of text composition, oral and written presentations to third parties addressing several issues, and also comprehension of the questions and environments are exposed.

Training Process

The training process is led by professionals with techno-pedagogical skills and expertise, that have the target of inserting and making the employees aware about the process of creating their own knowledge. The pupils must be proactive agents within the learning-teaching process, not just waiting to receive raw data and information.

A Web-Based Instruction System was developed, to allow the instructors to structure their courses digitally. In this system there must be the contents developed by the teachers addressing what must be learnt by the workers, tutorials, problems to be solved, FAQs, modules to manage and track the pupils' way inside the system. All the modules must be contextualized to the employees' working realities.

The target is to have a "Just-in-Time Training", or an "Anytime & Anywhere Learning", as two different moments are forecast:

Synchronous training: all the workers use the computers at the same time, being monitored by a tutor. It is used for Module I: Medium Handling.

Asynchronous training: the workers can use the system whenever they want, on their own, through the Internet and/or the companies' intranet. This flexibility allows them to conciliate their working timetable with the training. It is used for Module II: Generation and Moulding of Digital Thinking.

The training process can be split into two branches: an analytical and a dialectical one. Fig. 2 shows the process workflow to be followed.

The Web-Based Instruction System

A Web-based Instruction system was developed, in

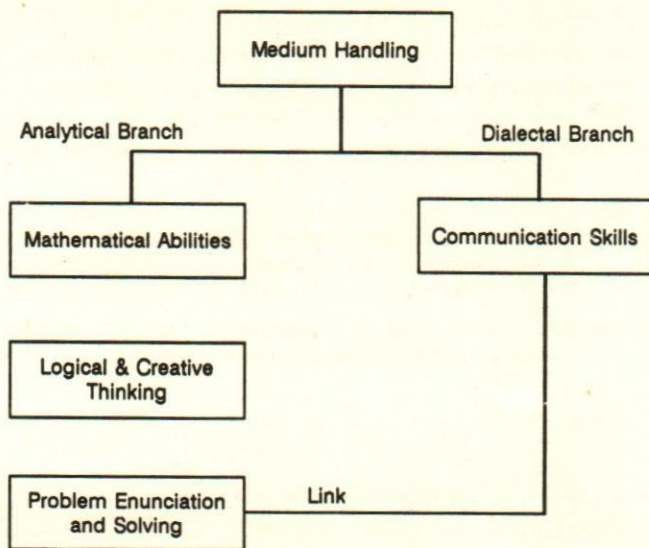


Fig. 2. Modules' Workflow

order to allow the workers to be trained, in an asynchronous way, through the use of the Internet/intranet potentialities. This system is compounded by the following modules:

(a) Pupils' Management and Tracking Module

To manage the pupils' data and track their performance throughout the course (grades, reactions, evaluations etc.)

(b) Content-Based Module

The module where the contents presented above are stored by the system, after their development by the experts.

(c) Assessment Module

There is no training without assessment. Therefore, the development of assessment modules is paramount, not just pupils' reaction evaluations, but also performance evaluation, otherwise Digital Thinking can be transformed in another fad that will only last for a while. These assessments are deployed into the system and the workers undertake them as each module is over. Having reached, automatically, the minimum needed score, the worker can go straight to the next one, till the process ends.

Fig. 3 depicts the structure of the system:

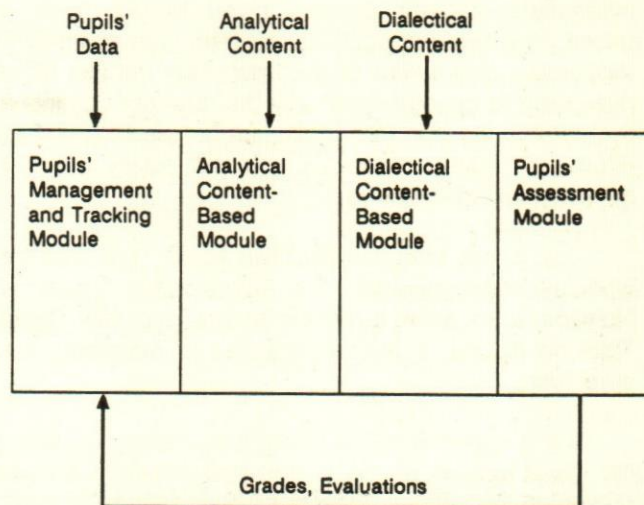


Fig. 3. Web-Based Instruction System's Structure

Conclusions

Although we are in the Digital Age, most employers rely on conventional training methods adequate for the Industrial Age. This unawareness of the new environment conveys the company to low productivity even when state-of-art technologies are implemented and used. The schools are graduating students unable to deal with the current challenges, and are far more suitable for the last century. Who is guilty? Surely the educational system shares this responsibility with the companies that do not say exactly what they need. As Charles Handy says, it is time for the schools to be more like companies; and companies to be more like schools (Handy, 1997).

Unfortunately, the formal education all over the world taps badly just the analytical and numerical intelligences, aside with the factual intelligence (absorption of data and information, without knowledge creation). The development of other intelligences is frequent neglected. Hence, it is necessary to unveil the naked truth: this research tries to prescribe a policy to deal with the effects of a problem that lead to great difficulty for the workers to deal with technological innovations and virtual and digital environments, generating low productivity rates compared to the forecast ones. So, the effects are attacked, but not the causes, i.e., an

Unfortunately, formal education all over the world taps just the analytical and numerical intelligences, besides factual intelligence. The development of other

inadequate learning process given to our students based on a failed educational system. Notwithstanding this reality, and aware of the enormous hurdles to be overcome to change drastically the current educational system, the ideas in this article can be used while great efforts are being made to reengineer totally this outdated educational system.

This is not only the Brazilian reality, but also the world's—encompassing the developed countries. Nowadays, to allow a worker to grasp a new Digital Thinking is one of the main duties of managers and employers.

Some research is still under way, mainly regarding the development of the best-suited interface for the presented Web-Based Instruction System (McCormack and Jones, 1998) containing the modules proposed, and new assessment methodologies (Laffey and Singer, 1997). However, some practical results have already been obtained, with success.

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ISO 9000 in Software: Planning & Implementation

Ajit Singh

In comparison to any other export industry in India, particularly those concerned with high technology, the software industry has been growing rapidly in the recent years. And India is hoping to emerge as one of the largest exporters of software in the world and has been taking initiatives in this direction. However, in order to ensure that such exciting things happen, it is imperative that adequate attention is paid to maintain software quality standards at internationally acceptable levels. This paper looks at the various issues relating to software quality. It dwells at some length on the ISO 9000 quality system with reference to software and the organisational requirements to develop and maintain such systems. The author signs off by stressing the need for building a quality organisation and suggests that ISO 9000 certification is one of the ways to succeed in this endeavour.

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The Age of Information Technology

Today information technology (IT) is redefining every facet of human life. It impacts us from operation of kitchen devices to entertainment. The shape of things to come is increasingly being dictated by information technology and therefore a mighty demand of growth for software and related services is going to be created. In comparison to any other export industry—particularly concerned with high technology, software industry has shown compounded annual growth rate exceeding 50 per cent. Software exports from India have grown from Rs 3800 crores in 1996-97 to Rs 6400 crores in 1997-98. NASSCOM's survey has projected that total software exports from the country by the end of this financial year would be Rs 11,000 crores. The industry is poised to touch revenues of \$ 6 billion by the turn of the century (Mehta, 1998).

This mind boggling growth witnessed in the software sector has aroused unlimited hopes that the best is yet to come and accordingly India is formulating plans to emerge as one of the largest exporters of software in the world in the coming decade. While all the exciting things happen, we as a country need to pursue quality assurance parallelly to maintain software quality standards (Narotra, 1998).

Among many recent policy amendments, the Government of India has announced Special Import License (SIL) to be allowed to ISO 9000 certified software companies, even for exports of on-line consultancy services. With the progress of information technology and move so the software industry, the quality management of software products has become essential. However, the process of development and maintenance of software is very different from other industrial products.

Why ISO 9000 in Software?

Industry, business and government are critically dependent on computerized systems, whose effective and efficient operation largely depends on software. It is a compelling business need to optimize costs while delivering products and services that meet market-required quality levels. These needs have to be met through planned and efficient utilization of technological, human and material resources.

It is fundamental to quality that customers should identify and define their requirements adequately in terms of functionality, cost, maintainability, quality and schedules and to select suppliers who have the capability and capacity to deliver products that meet their requirements. For products like software, quality cannot be determined solely by functional checks on completion. The software has to be verifiable and has to be verified progressively throughout the development process. Quality assurance which embraces all these progressive activities and functions is crucial to the attainment of quality.

For products like software, quality cannot be determined solely by functional checks on completion. The software has to be verifiable and has to be verified progressively throughout the development process.

The ISO 9001 quality system standard defines a model for quality assurance in design, development, production, installation and servicing. It has 20 key elements of common business practices that form the foundation for product quality across products, technologies and industry sectors in all countries. ISO 9000-3 provides specific guidance for implementing and auditing quality systems for software. Various sections of ISO 9000-3 recognize the key role of the customers and suggest ways in which customers can support the efforts of supplier and participate in providing software products. The interaction is aimed at customer's management cooperation, review activities, defining requirements and acceptance process.

Quality Management System

Quality system is defined by ISO 8402:1994 as 'Organisational structure, procedures, processes and resources needed to implement quality management'. According to this definition, a quality system represents

a mechanism which coordinates and controls the activity needed to achieve the quality required of a product or service. The ultimate test of a quality system is that the product or service meets all specified requirements and it provides a foundation for continuous improvement. A quality system of an organisation is designed to satisfy internal management needs and the needs of its customers.

Typically, the quality system is documented in a quality manual, associated procedures/processes and other detailed work documents.

Benefits of ISO 9000 Quality System

Benefits of having a quality system lie in improving the uniformity, consistency and repeatability, which is reflected in better process efficiency and reduced failure costs. Surveys conducted in early nineties indicated that failure costs for companies without a quality system are around 20 per cent of turnover. These surveys also suggested that a company could save 50 per cent of these costs by having a well tuned quality system. Following the introduction of TickIT scheme, there have been a number of documented case studies, which contain examples of the assessments and certification costs being recovered in 12 to 18 months (BSI, 1995).

Much of the importance of using a quality system, however, rests on qualitative benefits:

- Improved uniformity and consistency of action and so the quality of software.
- Less bugs, rework and so less costs.
- Less indirect costs which users incur due to poor quality software.
- Improved in-house visibility of software development.
- Better management and control of the processes.
- Improved software deliverables.
- Benefits from focus on error prevention and customer satisfaction.
- Marketing advantage and a corporate quality image.
- Internationally recognized system and so better acceptability.
- 'Goodness' of practices, policies and processes.

The increasing introduction of product liability laws, for example, the UK Consumer Protection Act may have considerable consequences for the software industry. Under the provisions of such laws, software producers might be held liable for any injury, death or damage to personal property resulting from faulty software (BSI, 1995).

Majority of the work activities and records are maintained in electronic media. It is therefore desirable that all ISO 9000 related documents be kept in electronic media.

Software is Different

In the software industry, keeping delivery dates and schedules is an important parameter. The costs of maintenance and modifications are unexpectedly high. Customers very often experience significant problems with software products. In this respect let us see the definition of software:

“Intellectual creation comprising the programs, procedures, rules and any associated documentation pertaining to the operation of a data processing system” (ISO, 1984).

Software production and supply is predominantly a design and development activity rather than production/manufacturing. It is therefore quite a different activity as compared to other products and this attribute has to be recognized while designing and establishing a quality system. Some of the unique aspects are as follows:

- It is difficult to understand customer's needs fully as customers find it difficult to specify their needs completely.
- In defining and documenting requirements and subsequent amendments, a large quantity of information needs to be communicated.
- Software is seemingly easy to change but it is difficult to accommodate all requirements when they do change.
- Software is an intangible product involving thought, imagination and experience.
- It is difficult to test software exhaustively.
- Customer and supplier interface is required at many crucial stages of the product life-cycle. The customer therefore plays a key role in the achievement of quality.

Paperless Environment

ISO 9001 or 9002 requires a set of adequate documents which remain under change control. It is expected that most software companies operate in a paperless environment. Majority of the work activities

and records are maintained in electronic media. It is therefore desirable that all ISO 9000 related documents be kept in electronic media. The document control procedures should be applied to the relevant documents including:

- procedural documents describing the quality system to be applied in software life-cycle.
- planning documents including applicable checklists, formats and progress of all activities of the supplier and interactions with the customer.
- product related documents describing a particular software product such as development phase inputs, outputs, verification and validation plans and results and maintenance documentation.

All documents require review and approval by authorized personnel prior to issue. These can be done by indicating names through passwords. In the IT industry, a password is as important as signatures in traditional procedures. Those who are on distribution list will be on 'read only' mode. Extensive use of computer files will be made and therefore special attention is required to be paid to the appropriate approval, access, distribution, back-up control and archiving procedures. It is necessary to have effective control as documents and data are kept in computer system. Since authorization of documents is done electronically, during auditing of the system, the auditor should look both for access control in advance and a journal to provide traceability to authority.

Establishing the Requirements of a Software Quality System

Designing, developing, implementing and maintaining a software quality system is a complex task when the requirements of both the business and ISO 9001 are considered in tandem. Establishing a quality system has to ensure and demonstrate that software products meet specified and/or implied needs of users together with the resources and activities necessary to support the delivery of these products to the customer. The quality

system must reflect the actual operations performed by the organisation and for audit purposes against the requirements of ISO 9001, it will need to be supported by appropriate records.

Designing, developing, implementing and maintaining a software quality system is a complex task when the requirements of both the business and ISO 9001 are considered in tandem.

Understanding Needs and Responsibility

When a supplier unit is ISO 900 certified, it has an obligation to operate with its customers in a defined way. By using a certified quality system, the customer is given a confidence that specified requirements concerning quality will be addressed. Therefore, customer support, planning aspects and need for formal acceptance stages and sign-off by the customer.

Most software development activities have some aspects of tailoring and non-standard, specific data conversion and testing requirements and therefore it becomes necessary to use a quality plan. The quality plan shall address the specific requirements of a software product, project or contract.

Developing a Software Quality System

When developing a software quality system compliant with ISO 9001, it is desirable to identify and describe all major stages and features involved. The quality system is designed to act as a support and foundation to the main objectives of the business. Benefits need to be clearly identified and cost–time commitments to be linked to benefits. Although a quality system is justified in all situations, it is essential to understand that the above steps will involve the senior management. It is not a question of only the cost–benefit analysis but management commitment to quality and ownership of the quality system.

Role of Management and Staff

Introducing an effective quality system needs the full backing, commitment and leadership of management. Quality is an organisation-wide issue and it is important that all departments are involved in the development. Management needs to visibly participate and actively share the view on importance of quality to the organisation. The initial management task is to

define and document quality policy and quality objectives. Some of the considerations here are:

- Overall organisation strategy and goals
- Establishing customer satisfaction as a principal objective
- Philosophy of continuous improvement
- Responsibility for quality and related activities
- The involvement of people and associates contributing to the organisation

The quality system should be endorsed by the Chief Executive to demonstrate management commitment. It needs to be made clear that it is not a fad but a business requirement. A quality system will work effectively only if it is understood by all levels of staff in an organisation. Documented procedures are required to encompass all quality activities in compliance to 20 elements of ISO 9001. The staff at different levels should be involved in defining and documenting procedures and then also for implementing the same. The fate of a quality system depends upon how much one is able to involve the organisation's staff. This is achieved through training and motivation.

A Team Effort

It is important not to expect and promise too much too soon. Changing the culture of an organisation takes time and calls for patience. It is essential to create an organisation where every member take pride in associating with the quality movement. It is important to establish a core team, a few work groups and a pool of trained internal auditors. Of course, a person needs to be in focus to oversee the implementation of ISO 9001 requirements. He is named as the Management Representative (MR) with sufficient status and authority.

Use of External Consultant

External consultant, if introduced at the initial stages of developing the quality system can be very beneficial for facilitating a successful outcome. Of course, it is needless to mention that selecting the right consultant is the key to a good quality system. An organisation should ensure that the consultant understands the fundamental requirements of quality and quality certification. Consultants are generally very useful with respect to the following:

- Helping in selling the idea to senior management
- Identifying requirements and helping in designing the quality system

- Developing an implementation plan and helping in monitoring
- Assisting in training the organisational personnel
- Providing an independent view of progress and suitability of the system
- Bringing in a lot of experience of varying nature and thus confidence in the people
- Developing a plan for continuous improvement

It is important to feel comfortable with external consultants as they are needed upto final certification stage and even beyond that point. A wrong consultant can do a lot of damage to the whole system. Remember that the lowest expensive consultant may turn out to be the most expensive. Due to increasing opportunity of business in ISO 9000 field, lot of consultants are moving in. Organisations should be careful in choosing the right consultant with good consultancy background. Quality system is not designed every day and therefore it is important to spend money on a good consultant.

A wrong consultant can do a lot of damage to the whole system. Remember that the lowest expensive consultant may turn out to be the most expensive.

Quality System Documentation Structure

A quality system requires careful documentation. There is a great deal of misunderstanding of what is required to document under the ISO 9000 quality system. A documented quality system is usually presented in an hierarchical structure. A quality manual covering the requirements of ISO 9001 standard is prepared as an apex level document. It should be logical, correctly indexed and referenced to ISO 9001, reflecting the business needs of the organisation. It is not necessary to have a paper quality manual. Quality manual preferably should be online in the electronic media. Above all, the documented quality system should cover how quality is achieved, managed and controlled. A common approach is represented in Fig. 1.

Additions to this simple structure may be required in large organisations. The quality manual is usually restricted to a policy statement, organisation, scope of activities and how each element of quality is addressed.

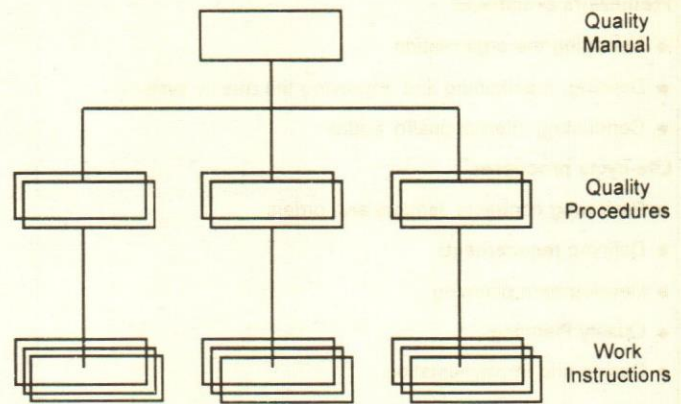


Fig. 1. Hierarchical Quality System Structure

The quality system procedures give the details of what processes are carried out, when (sequence) and by whom. The specifics of processes should go into work instructions containing conditions of operations and standards. (Dunford, 1998). The structure is further supported by detailed documents for controlling and maintaining records. Quality system documents are dynamic in nature and as businesses and organisation activities change, the document must keep pace with these changes. A quality system that meets the requirements of ISO 9001 or 9002 and does not show any improvement over time is not addressing the real needs of the organisation. This means that the organisation is not capitalizing on the effort and resources already used in the quality system implementation.

Quality system documents are dynamic in nature and as businesses and organisation activities change, the document must keep pace with these changes.

The quality system should identify and elaborate upon the major elements required to provide effective and continuous control of software quality. It should be organized around the basic processes required for software development, maintenance and support activities and should follow the structure of ISO 9000-3 as given in Table 1.

Governing Considerations

The nature of software development is such that some activities are related to particular phases of the

Table 1: ISO 9000-3 Quality System Structure

<p>Framework processes</p> <ul style="list-style-type: none">● Managing the organisation● Defining, maintaining and improving the quality system● Conducting internal quality audits <p>Life-cycle processes</p> <ul style="list-style-type: none">● Reviewing contracts, tenders and orders● Defining requirements● Development planning● Quality Planning● Design and implementation● Testing, verification and validation● Acceptance● Replication, delivery and installation● Maintenance <p>Supporting processes</p> <ul style="list-style-type: none">● Configuration management● Controlling documents and data● Controlling quality records● Measurement● Controlling rules, practices and conventions● Controlling tools and techniques● Purchasing● Controlling included software products● Training

Source: Part-C, Supplier Guide, The TickIT Guide (1995)

development process, while others may apply throughout the process. A software development project should be organised according to a life-cycle model. Quality related activities should be planned and implemented with respect to the nature of the life-cycle model used. Following important considerations should receive priority:

Defining Customer Needs

The customer requirements should be defined clearly and documented. The scope of the contract should be outlined along with possible contingencies or risks. Proprietary information must be adequately protected and terminology agreed. The relevant items on quality on all contract matters should be jointly reviewed such as: acceptance criteria, handling changes, customer complaints, customer roles at various stages, facilities, tools and software items, replication requirements etc.

Quality planning

The project should be broken into definite activities or phases. Quality planning should be carried out for each phase and updated along with the progress of the development. The quality plan should be formally reviewed and agreed upon by all concerned organisations. Defined input and output criteria for each development phase, type of tests, verification and validation activities should be established.

Design and Implementation

A software product is the result of design and implementation activities which transform the customer requirements into reality. Because of the complexity of software products, it is imperative that these activities be carried out in a disciplined manner, in order to produce a product according to specification rather than depending upon the test and validation activities for assurance of quality.

It is therefore desirable to identify input and output specifications, adopt a systematic design methodology and use past experiences. Implementation should include programming rules, programming language, consistent naming conventions, coding and reviews to ensure that the requirements are met and the above methods are correctly carried out. Records of such reviews should be maintained.

Testing and Validation

Testing is required to ensure that the software product meets all specified requirements. Testing may be necessary at several levels starting from the individual software items to the complete software product. Before starting the testing activities, test plans, specifications and procedures should be established and reviewed. Consideration should be given to types of tests, test environment, tools and test software. The test results should be recorded as defined in the relevant specification. Before offering the product for delivery and customer acceptance, the complete product should be validated, and when possible, under conditions similar to the application environment as specified in the contract. Where testing under field conditions is required, the features should be tested in the field environment.

Replication

Replication is a step which should be conducted prior to delivery. In providing for replication, consideration should be given to the number of copies of each

software item to be delivered, the media including format and version, in human readable form, the stipulation of required documentation such as manuals and user guides, copyright and licensing concerns. During the replication phase, consideration also needs to be given to the custody of mater and back-up copies, where applicable, including disaster recovery plan. The period of obligation of the supplier to supply copies also requires to be considered.

Building a Quality Organisation

Increasingly, organisations are realizing the specific role of quality as a position of strategy to meet business aims and objectives. Total Quality Management (TQM) is a comprehensive approach which places quality as an integral strategic issue affecting the attitude of the entire organisation towards all its operations and markets. ISO 9000 certification is a demonstrable first step towards TQM. ISO 9000 is ultimately about interfaces, particularly about defining them to facilitate work that crosses functional disciplines (Wilson, 1998).

ISO 9000 implies an audit schedule based on status and importance of business activities. The audit is to be done by trained internal quality auditors. Organisations must make this internal audit process as a window to future outcomes by identifying opportunities for improvement. Corrective and preventive actions are at the heart of the quality system. It requires monitoring the problem solving effectiveness and developing prevention orientation. Customer complaints must lead to corrective and preventive measures. Complaints are the best gifts your customer can give you. Use them as opportunities for improvements.

In many cases, the companies simply overlay ISO 9000 requirements and allow their old system in place. ISO 9000 therefore does not get integrated into the busi-

Customer complaints must lead to corrective and preventive measures. Complaints are the best gifts your customer can give you. Use them as opportunities for improvements.

ness. ISO 9000 is then treated as an afterthought, something to be done in addition to normal work, rather than an integral part of the business. When ISO 9000 is implemented, employees quite often can learn about the company from inside out and have the opportunity to change their mindset towards improvement. This focuses the organisation's effort on value addition and help in retaining its customers and increase the volume of business adding new customers. ISO 9000, if implemented rightly, makes the organisation take a definite step towards achieving world class quality.

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Software Quality Assurance & Testing

C.L. Kaul

Software which in the backbone for all the computers is for an efficient processing system. Software Quality Assurance and testing are two such areas of activity which are vital for ensuring that software is reasonably free from errors, is reliable and competitively priced. Most errors found in software packages during testing and operation have been attributed to poor understanding or misinterpretation of the requirements. Software reliability takes into account the impact that errors have on the system users. SQA role is to monitor the methods and standards the software experts use to verify that they have properly used their expertise. Software Quality Assurance thus aims to guarantee that the software products perform at an acceptable level before being released.

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Introduction

It as started in late sixties, when it was realised that computers can make mistakes (which in fact they do), that attention was paid to the Quality Assurance aspects of software developed. The objective was to avoid the mistakes which can prove costly and damaging depending upon the actual usage of the software package. This, however, was not done before a few episodes got attention of the press. The following interesting case can be cited to highlight why software Quality Assurance has assumed importance over the years:

A computer system in a departmental store sent a bill for \$0.00 to a customer. The customer communicated to the departmental store about the computer error. This resulted into an endless reminders from the store and finally a threatening to terminate his account. The simplest solution to the problem would have been to pay a cheque for \$0.00 by the customer but instead he went with his story to the press and exposed the departmental store leading to an adverse publicity. The problem finally landed with the Software Engineer who after analysis observed that such a possibility had not been taken into account while developing the software package.

In India, we are all familiar with the railway reservation system. The system of Reservation Against Cancellation (RAC) is in operation on most of the routes for quite sometime now. In this system the reservation of a seat is guaranteed. However, allotment of a berth is made only if cancellation of a ticket takes place. Now, imagine the inconvenience caused to a family of 4 members (parents with two children) when they find, on the day of their travel, that the RAC seats allotted to them initially in one bogie have got upgraded to berths, not in the same bogie but in four different compartments, a possibility that was not taken into account while developing the software. The Y2K problem has suddenly taken all of us by surprise and the problem has assumed such a magnitude that all those affected by it are

looking for an early Y2K compliance. The possibility, that a date field could cause this problem, was not taken into account while developing software packages in eighties and early nineties till the problem came to surface in 1995.

The Y2K problem has suddenly taken all of us by surprise and the problem has assumed such a magnitude that all those affected by it are looking for an early Y2K compliance.

These examples only illustrate the cases which can cause personal inconveniences due to software errors or certain possibilities which have not been thought of or considered while developing the software packages, intended to perform certain desired functions.

Now let us imagine the following:

- (a) A computer controlled train has a programming error. It attempts to accelerate the train to an undesirable speed instead of the expected speed.
- (b) A modern aircraft has a software error which can lead to a disaster.
- (c) A computer system performs an unintended function.

The consequences of these situations may be grave and include:

- Invasion of privacy
- Loss of or damage to property
- Personal injury
- Loss of life
- Financial loss

Over the years the software users have complained of two things that is software is costly and unreliable. The problems encountered above have given the users the feeling about the unreliability part of the software and it is this aspect which is generally responsible for the first. To overcome these problems new areas of activity have emerged and have assumed importance over the years. Software Quality Assurance and testing are two such areas of activity which are vital for ensuring that software is reasonably free from errors, is reliable and competitively priced.

What is Software Error?

There is no single definition to describe a software error. Broadly speaking software error is present, if

A Software does not Perform According to its Specifications

(However, the flaw in this statement is that we are presuming that the specification is correct).

Let us consider this example:

Suppose you have a front lawn with wild grass and weeds and you intend to remove the wild grass and weeds and make the lawn beautiful. Now you call a contractor and ask him to remove the wild grass and weeds, make it green, durable and easy to maintain. When you come back to inspect the lawn you see that the contractor has put a concrete slab and painted it green. Is it acceptable or unacceptable, as a user or as a developer?

A software does not perform according to its specifications provided that it is used within its design limits.

Accordingly, if the system is used accidentally beyond its limits it is easy to imagine the consequences? But what happens in a situation like this:

An air traffic control system is designed to control 100 aircraft at a time. However, on a particular day, for some reason, 101st aircraft enters the sector and software performs unexpectedly—Say, it forgets about one aircraft and aborts one entry. What are the consequences (theoretically the system has not been used beyond its design limits)?

The software does not behave according to the official documentation or publication supplied to the user.

It does not behave according to the document (describing expected or planned use of software). Error in documentation.

It does behave according to the document but errors are present.

A failure of software to perform according to the original contract occurs.

The above examples indicate the situations which can give rise to software errors. In this context an agreed principle is "A software error is present if the software does not do what the user reasonably expects it to do. A software failure is an occurrence of a software

error". The word 'reasonably' used is subject to argument but for this discussion it basically emphasises the involvement of the user. As such the designer must know what the user expects?

The Overall Requirements

Requirements basically indicate the needs of the customer and are meant to help in deciding *what* to design and *what* to accomplish, taking into consideration the various design constraints.

In the explanations given above it is evident that the following aspects of the software emerge as most important:

- (i) Specifications
- (ii) Design Limits, and
- (iii) Documentation

Let us understand each one of these aspects to appreciate their importance:

Specifications

Based on the clear understanding of the *requirements* one is able to develop the specification. Most errors found in software packages during testing and operation have been attributed to poor understanding or misinterpretation of the requirements. Problems arise due to the fact that it is not easy to check the requirements for completeness and consistency. Requirement problems or ambiguities are now written up in discrepancy reports to ensure that they are eliminated early. The specification part of the software is covered in what is known as Software Requirements Specifications (SRS) and includes details like functions, performance, attributes etc. It also describes requirements like simplicity, maintainability, reliability etc.

Design limits

The design aspects of the software are covered in Software Design Description (SDD) and includes description of all functional modules, interfaces, operating environment, formats, security, integrity, prioritisation, design limitations etc.

Documentation

The SRS and SDD are the two important documents to be developed. Besides this, other documentation includes:

- (a) Software Configuration Management document

- (b) User documentation. This includes

- * Installation Manual
- * Operating Manual
- * Maintenance Manual
- * Training Manual

The important consideration that must be kept in mind while developing the user documentation include:

- (a) Indicating the specific application for which software is designed
- (b) Specifying the known limitations, if any
- (c) Extensions that are possible in future
- (d) Platform on which it is to be installed
- (e) Description of all the error situations which can occur
- (f) Maintenance methodology
- (g) Special software features, if any.

Software Reliability

The software reliability is the probability that the software will execute for a particular period of time without a failure, weighted by the cost to the user of each failure encountered. Software reliability takes into account the impact that errors have on the system users. A comparison of software reliability and hardware reliability shows that the concepts of hardware reliability do not apply to software. This is because of the fact that software does not fail or wear out which is common feature of the hardware. Software reliability is mostly attributed to design errors (errors introduced initially during the production process). The reliability aspect of software is to be understood in the context of hidden errors in the software which come to surface only under certain operating conditions. The system operates successfully for a number of years with its users becoming confident in its operation until it unexpectedly fails when hidden errors suddenly surface because of new conditions. To achieve software reliability it is necessary to understand the qualities that the user requires and ensure that they are present in the end product and continue to be present during its life cycle.

Software Quality Assurance

One of the critical challenges for any quality programme is to devise a way for ordinary people to review the work of experts. The need is to focus on these Software Quality Assurance methods that permit the

development work to be reviewed by people who are not primarily developers. The SQA role is to monitor the methods and standards the software experts use to verify that they have properly used their expertise. Software Quality Assurance takes into consideration the desired Quality characteristics and documenting the characteristics after discussion and agreement (Discuss-Agree-Document); as also the assurance part through a (Documentation-Review-Comparison) Process Cycle. SQA programme provides the assurance to the management that the officially established process is actually being implemented. It ensures that

- an appropriate development methodology is in place
- standards and procedures are used
- independent reviews and audits are conducted
- proper documentation is in place
- each Software task is satisfactorily completed
- deviation from standards and procedures are exposed
- Mechanisms are in place to control changes
- Testing takes place
- Quality control work is performed against established standards.

Software Quality Assurances thus aims to guarantee that the software products perform at an acceptable level before being released.

Software Testing

Software testing is the process of finding errors in the product. The process as a main activity involves systematic execution of a programme, under controlled condition, to verify the software quality and at the sub-activity level involves requirement analysis, the programme analysis, test-data selection, testing strategy, execution, checking and validation. The testing

covers testing of all the stages namely unit testing (module testing), integration testing, external function testing, system testing, acceptance testing and installation testing. The key points to be remembered in software testing are:

- If the goal is to find absence of errors, you won't find many.
- If the goal is to find errors, you will discover a large percentage.
- A test case is one which has high probability of discovering undiscovered error and not that shows programme works correctly.
- Most difficult problem of a Testing person is to decide when to stop.
- It is impossible to test your own programme.
- Testing must start with objectives.
- Programme should not be allowed to make testing easier.
- Write test cases for invalid as well as valid input conditions.
- As the number of undetected errors in a piece of software increases the probability of the existence of more undetected errors also increases.

These days a wide variety of testing tools are available which can reduce the testing effort considerably. The use of testing tools has made testing easier and more effective. The tools that are available are:

- * tools for reviews and inspection
- * tools for test planning
- * tools for test design and development
- * test execution and evaluation tools
- * software testing support tools.



Supply Chain Management in PC Hardware Industry

Viswagna Charyulu & Janat Shah

Product life cycle for desktop computers is short compared to other products. A desktop is an assembly of identifiable components and the components have different product life cycles, starting at different points of time. Hence it is necessary to use the component life cycle for inventory policy decisions. An attempt is made here to study and understand the present supply chain structures of different key players in the PC hardware industry and compare their performance. A framework is developed to analyze the performance of supply chain incorporating the factors to demand uncertainty, order cycle time, manufacturing and transportation lead time in terms of supply chain cycle time and inventory costs. This framework can be used to compare the cost of a component from source to the end user for imported vis-a-vis local sourcing by considering costs of obsolescence, foreign exchange risk, storage, working capital etc. The impact of the changing market conditions has been studied and analyzed in terms of the effect on current supply chain structures and inventory management. How a component level supply chain can help in these conditions is also studied and emerging structures analyzed. A brief case of Intel GID program is taken up to understand the emerging supply chain structures.

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PC Hardware Industry: A Brief Overview

The Personal Computer (PC) hardware industry is characterized with short product life cycles, falling prices, high obsolescence costs, and rapid changes in technology. All these factors put emphasis on better management of the supply chain. With high growth from household purchases and increasing presence of channel partners, the importance of reach and supply chain response is being felt by the industry.

The consequence of poor supply chain management can be illustrated by the fall of PCL Limited. PCL Limited was started in year 1984 and grew multifold within a short span of time. By the year 1995-96, the turnover of PCL reached Rs. 1000 crore. Out of this, around Rs. 500 Cr. got added within two years (1994-96). During this phase PCL focused more on growth and neglected the operational efficiency and case management. After 1996, the turnover plummeted to Rs. 200 crore because PCL failed to honor its commitments to customers and defaulted on bank accounts. Today PCL plants are on sale and struggling to survive.

Desktop Market

In the year 1997-98, the Rs. 6000 crore IT hardware industry was dominated by desktop computers with sales turnover of Rs. 3700 crore. Desktop market has grown at the rate of 27 per cent (CAGR) in the past three years from 390,000 to 800,000 units. Yet the desktop market today is limited to metros and some big cities. Out of 800,000 units sold in year 1997-98, 565,000 were sold in cities only. The PC penetration in India has grown from 1 per 1000 in 1995-96 to 1.8 in 1997-98. By the year 2002, the penetration is expected to reach 10 per 1000. At present, the desktop market is dominated by Intel's Pentium processor with a market share of 86 per cent. Twelve per cent of the market still bought 486 configuration (MAIT, 98).

Market Segments

Desktop market is segmented into two segments: Business computing: 79 per cent; Home computing: 21 per cent (Chakraborty, 98)

- Home computing: Home computing segment includes pure households and home offices. In 1997-98, 170,000 PCs were purchased by the home computing segment, out of which 110,000 bought by pure households and the rest by home office segment.
- Business computing: Business computing segment consists of small, medium and large business establishments. In the year 1997-98, business segment accounted for 350,000 units, medium for 180,000 units and the rest from small business establishments.

Market Structure

The market is divided in three ways:

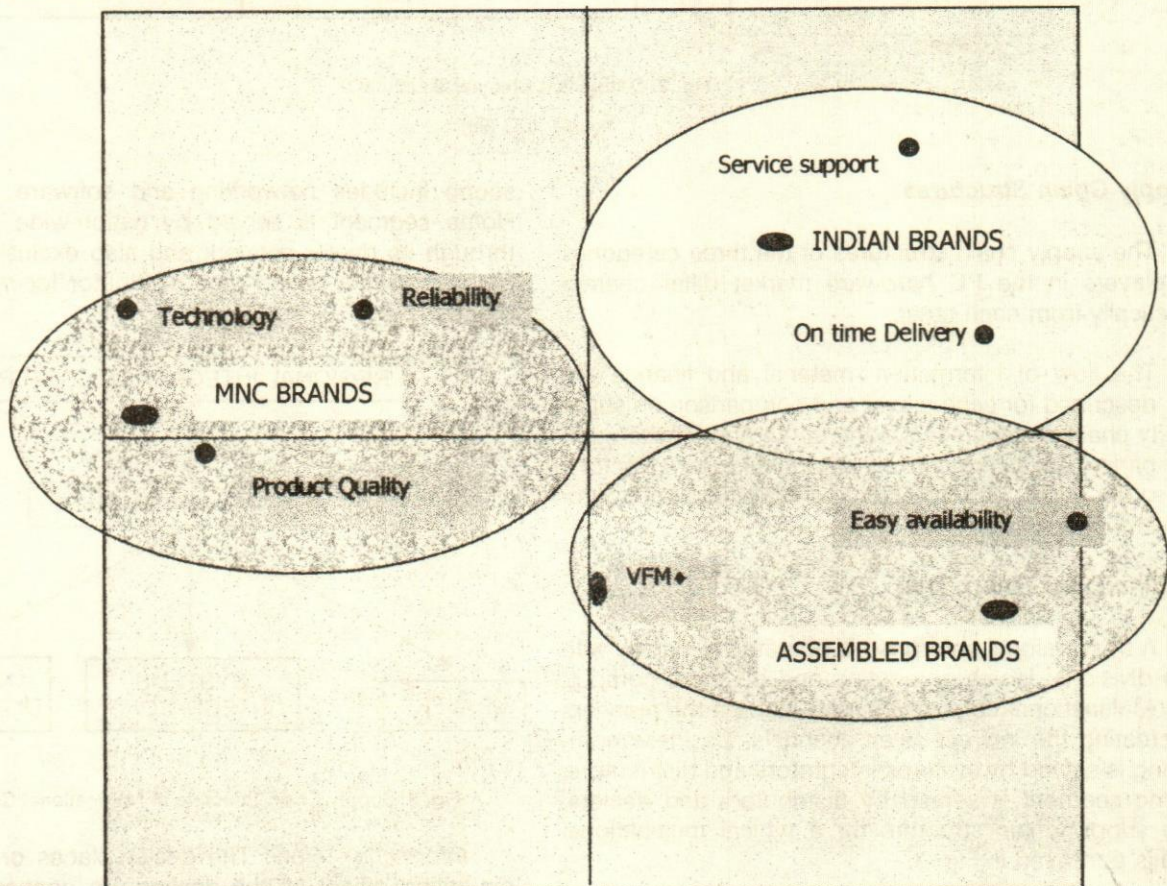
1. Multinational: Compaq, IBM, HP, Acer

2. National: HCL, Wipro, Zenith, Unicorp
3. Assemblers: GIDs, non GIDs (GID: Genuine Intel Dealer)

In the past, national brands were delivering with reliability and cost effectiveness. With the entry of multinational companies, on their own or through joint ventures, the definition of reliability underwent a transformation and assemblers took the cost effectiveness plank. Today, national brands are in the middle of the road. The key market segments are mapped in Fig. 1, showing the relative strengths and weaknesses.

Distribution Channel System

The customer is reached in two ways: 1. Directly by manufacturer 2. Through partners. Indirect selling includes Systems integrator, Value Added reseller, dealer, distributor and retailer. The business segment is served by direct sales, systems integrator and VA reseller, and the home segment is served by distributor, dealer, retailer network (IDC, 98). A graphical representation of key partners in the channel system is shown in Fig. 2.



* Value for money

Fig. 1. Comparison of the Three Segments on Key Parameters

Source: Chakraborty I (98)

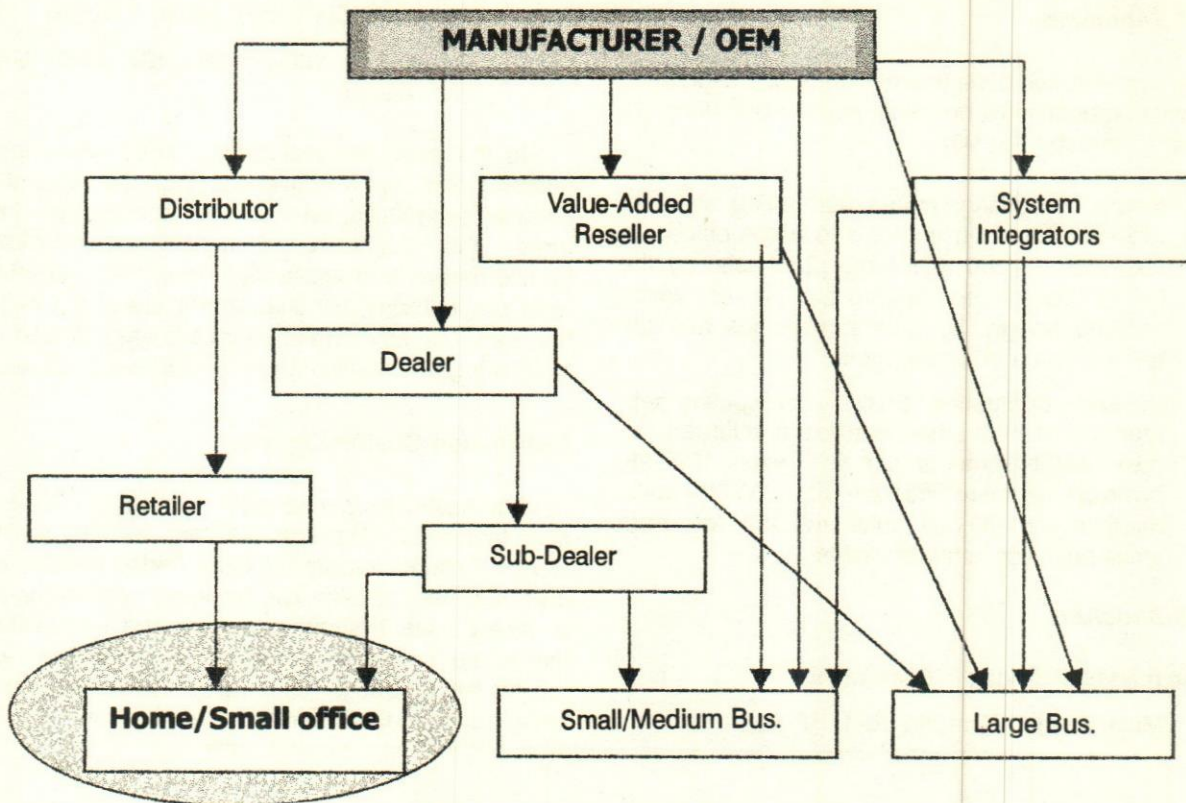


Fig. 2. Distribution Channel Structure

Source: IDC (98)

Supply Chain Structures

The supply chain structures of the three categories of players in the PC hardware market differ characteristically from each other.

The flow of information, material and finance are described for each player and comparison on supply chain parameters is done at the end. These companies are compared on parameters like inventory, order cycle, lead time, payment, component sourcing, and volumes.

Multinational Enterprises

A multinational enterprise is operated generally with two divisions: Home computing and business computing. Multinational corporations (MNCs) are the pioneers in creating the indirect sales channels. Business computing is served by systems integrators and distributors. Home segment is served by distributors and dealers. The supply chain structure for a typical multinational firm is portrayed in Fig. 3.

The systems integrator is responsible for providing complete IT solutions to the business organisation. The

scope includes networking and software integration. Home segment is served by nation-wide distributors through its dealer network and also exclusive dealers. Remington is a nation-wide distributor for multinational brands.

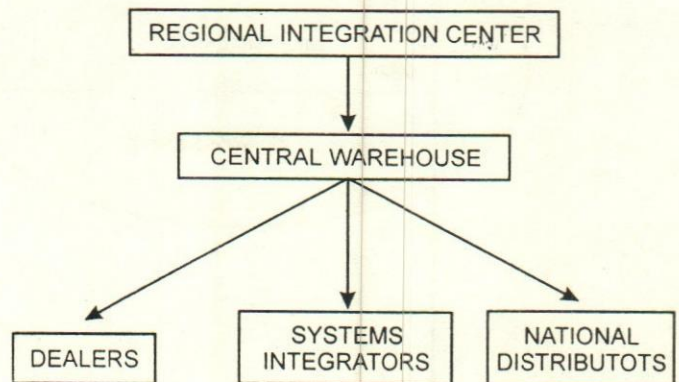


Fig. 3. Supply Chain Structure of Multinational Company

Information Flow: The dealer places order on the marketing office. All the dealers are connected to the marketing office through modem connectivity. The ordering is done on a daily basis. The orders are ag-

gregated on a daily basis at the central marketing office and the requirement is transmitted to regional integration center. Marketing offices are connected to the network worldwide. Lead time of information from dealer to Singapore integration center is 2 days.

Material Flow: Currently multinationals are importing the complete assembled PC from the regional integration center. The material is airfreighted to India. Consequently, the PC is transported to the dealer through local courier. Time from order placement to receipt at India is one week. In India, warehouse to dealer it takes 1 day (Because most of the dealers are located in cities and cities are well connected through courier network).

Financial Flow: At dealer end, most of the orders are booked on advance payment basis and payment to company is on receipt of order. Dealer enjoys a credit of 1-2 weeks from customers.

National Brands

Typical national PC hardware company is organized with two divisions (a) channel division (CD) and (b) systems division (SD). Channel division handles the home computing segment and systems division handles business computing segment. The supply chain structure for a typical national firm is shown in Fig. 4. The CD division handles the dealer network. These dealers can be exclusive to a particular national brand or can deal for more than one brand.

Information flow: Forecasting is done on a monthly basis. Branch requirements are aggregated at CD (head office) and using the trends and other technological, marketing information, CD furnishes the aggregate requirements for the month to the plant. Dealers are connected to commercial offices and CD is connected to plant. There is no central information in the system.

Orders are placed on CD through commercial offices. Subsequently CD places the order on plant. The lead time is 2 days to transmit the order from dealer to plant.

Material flow: Components are sourced from Hong Kong, Taiwan, China. Material is transported through air and sea. Plant assembles the PCs on order from CD and transports to the commercial office warehouse. The normal lead time of fast moving items is 1-2 weeks and slow moving items 4-6 weeks (plant to dealer).

Financial flow: No credit facility is provided to dealers. At dealer end, most of the orders are booked on advance payment basis and payment to the com-

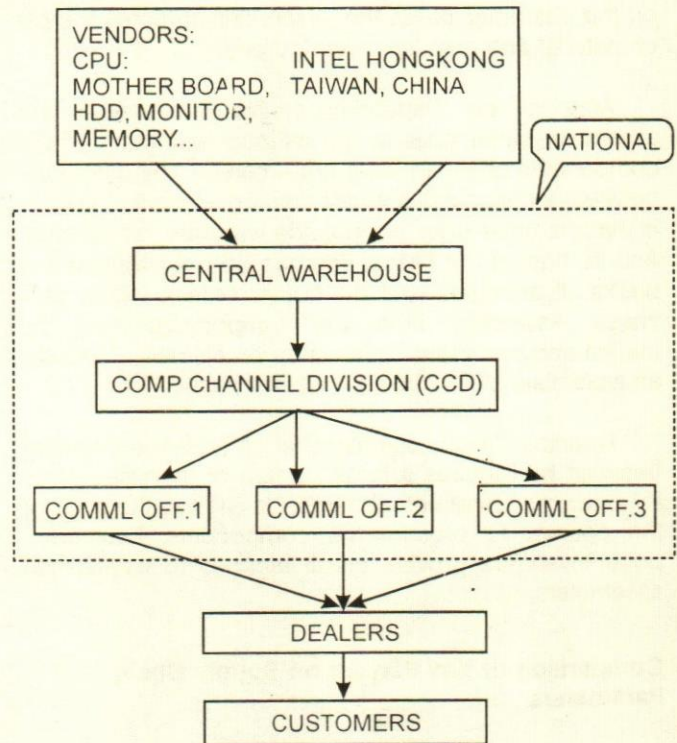


Fig. 4. Supply Chain Structure of National Company

pany is made on receipt of order. Dealer enjoys a credit of 1-2 weeks from customers.

Assemblers

Most of the assemblers render their services to the home computing segment. An assembler functions in a local market and usually the customer approaches the assembler. Today, approximately around 5000 assemblers exist in all over India. The supply chain structure for a typical assembler is depicted in Fig. 5.

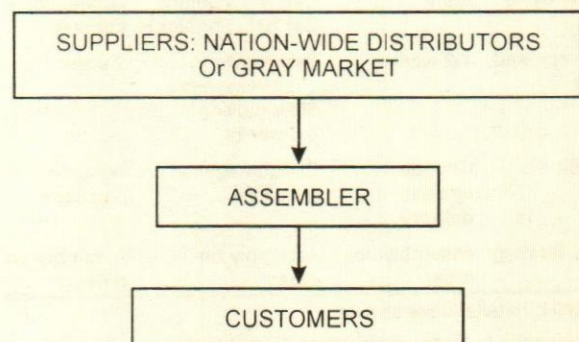


Fig. 5. Supply Chain Structure of Assembler

Information flow: Normally customers directly approach the assembler outlet and place the order. Based on the customer order, the assembler prepares the bill of material and plan for his procurement.

Material flow: Depending on his requirements, the assembler either goes to the national distributor of the components or to the local grey market. The difference between a national distributor and a gray market vendor is that the latter does not provide warranty certification. And in most of the cases, vendors do not maintain any books of accounts and do not provide a bill of purchase. Assembler buys the components from the market and transports to his shop on his own. Typically, an assembler does this on a weekly basis.

Financial flow: Assembler takes advance payment because he requires a large portion of the sales value for procurement of components. He will pay the bill over the counter to procure the components. Few component vendors provide credit facilities to established assemblers.

Comparison of Key Players on Supply Chain Parameters

A detailed comparison on key supply chain parameters for multinationals, national firms and assemblers is presented in Table 1.

Table 1: Comparison of Key Players on Supply Chain Parameters

Parameter	Multinational	National	Assembler
Inventory	Negligible	Cat. A: 45 days Cat. B: 15 days FG: 2 days at RWH [@]	Negligible
Raw Material sourcing	From regional integration center	Global resourcing Hongkong, Singapore China, Taiwan	National distributor, Grey market
Forecasting	Weekly	Monthly	-
Order cycle	Daily	Cat. A*: Monthly Cat B**: Fortnight	As and when required
Delivery lead time	1-2 weeks	Fast moving: 1-2 weeks Slow moving: 4-5 weeks	1 week
Credit	Cheque against delivery	Cheque against delivery	Advance payment
Mfg. Strategy	Assembly on order	Assembly on order	Assembly on order

[@] RWH: Retailer's warehouse

* Category A: Order cycle time: 6 weeks, Demand is aggregated for 3 fortnights, Lead time: 5-6 weeks.

** Category B: Order cycle time: 2 weeks, Lead time: 2 weeks.

Framework to Analyze Supply Chain Performance

Model to compare costs for imported and local sourcing

Normally companies consider the landing costs while comparing the local and the imported products. The important costs missed in the process are storage costs, working capital costs and foreign exchange rate risk costs.

The significance of these cost elements is brought out through a hypothetical illustration emphasising the need to consider the total supply chain cost rather than landing cost alone.

For imported sourcing, the following costs are considered:

1. Landing cost: Comprising basic cost in US \$, exchange rate (Rupees per \$), customs duty and countervailing duty (CVD)
2. Obsolescence cost
3. Storage cost
4. Working capital cost
5. Transportation cost
6. Foreign exchange risk cost

The factors of demand uncertainty (in previous year), order cycle time, manufacturing and transportation lead time and inventory were included in arriving at working capital cost.

This comparison is for components that enter and leave the plant without any value addition like – monitor, key board, speakers, modem connection etc. This illustration is a hypothetical one. A company has to consider the cost from source point to end point for comparison. In addition, in the case of local sourcing, ordering cycle can be reduced and this helps in increasing forecasting accuracy, reduction in inventory, and other associated costs.

Changing Market Scenario

Desktop volumes are expected to grow at 35 per cent and at 15 per cent value wise. The domination of business segment will reduce (from 80 per cent to 72 per cent) and home segment share will increase from 20 per cent to 28 per cent. In 1997-98, the volumes grew by 19 per cent, where as the value growth was merely 4 per cent. The market is not growing at the rate of falling prices.

Table 2: Cost Comparison for Components: Imported Vs Local

Cost Component		Cost	Cumulative cost (Rs.)
Imported			
Basic cost	US \$	170	
Exchange rate	Rs.	44	
Rupee value	Rs.	7480	7480
Customs Duty (in %)	10	748	8228
CVD (in %)	10	823	9051
Landing cost			9051
Obsolescence cost (in %)	0.50	45	9096
Storage cost (in %)	1	91	9187
Working capital cost (in %)	16	184	9371
Transportation cost (in %)	2	187	9558
Cost of component for the customer			9558
Local			
Basic Cost	8000		8000
Excise duty	14%	1120	9120
Sales tax	2%	182	9302
Transportation cost	1%	93	9395
Cost of component for the customer			9395

The price comparison for different configurations in Jan. and Sept. of 1998 was as follows:

Configuration	Unit Price (in Rs.)	
	Jan. 1998	Sept. 1998
Vanilla	40,000	28,000
Multi Media	60,000	40,000
Power System	80,000	60,000

The home segment is expected to grow at over 50 per cent per annum in the next 3-5 years. Volume wise, desktops will grow from 170,000 to 500,000 by the turn of the century.

Increasing Role of Channel Sales

With increasing growth from home segment, the reach has to be improved to cater to the distributed customers. But to reach home segment, channels will have to play very important role. Channels provide market place for buyers to come and select the product.

Before 1995, most of the sales were made directly through the company. Entry of Compaq brought changes in the channel system. Compaq introduced systems

integrators and direct dealers in 1995. This increased the importance of channel partners as indirect sales raised from 25 per cent (1995) to 40 per cent (1998).

Product Life Cycle

Normally, we read in many reports that computers have very short life cycles (as short as 3-6 months). As a computer is compatible for modular manufacturing, one should note that studying component level life cycles would make more sense.

A PC is an assembly of various components like motherboard, microprocessor, memory chips, hard disk, power supply, floppy disk drive, CD-ROM drive, etc. Different components have different life cycles which start at different points in time (Table 3).

Table 3: Average Life Cycles of Various PC Hardware Components

Component	Life Cycle
Microprocessor	
Variant	3-6 months
New architecture	18-24 months
Memory	2 years
HDD	2-3 years
FDD	4-5 years
Monitor	5 years
Power supply	10+ years

Source: Rupley & Clayman (95).

Due to this reason, the configurations (a combination of different processors/memory etc.) may be changing quickly (say 3-6 months) even though the component life cycles are longer. By tracking at component level, the PLC methodology can be used for rationalization of inventory based on PLC and categorization of components.

Implications

Suitability of Supply Chain Structure

Multinational Enterprises: With increasing sales from home segment and indirect sales, the supply chain responsiveness and reach of channel has to be improved.

National Brands: National brand's supply chain is organized to address the business segment at large. Supply chain cycle time is 35 days, which is high. Home segment is characterized by low prices and fast response. To address the home segment, the com-

panies has to increase the reach and cut the costs by reduce the cycle time, low inventory and better forecasting. The companies need to cut the layers in the distribution system by supplying fast moving items directly to the dealers. A system of integrated information network to be established to improve the forecast efficiency. With reduction of the gap between forecasting and actual demand (At present the company has to forecast 3 months ahead of actual demand because of order cycle time and order quantity). From the costing perspective, the companies have to analyze the trade off between short order cycle time, low inventory costs and quantity discounts.

Assemblers: At present, the assemblers are not carrying any inventory at their end. The normal lead time for the supply of the system is 1 week which is sufficient for assembler to procure and assemble the system.

Component Level Supply Chain

Analyzing the supply chain at component level instead of analyzing at system level will bring about cost reduction. In a PC, certain components can be supplied directly to the dealer/end user without bringing into the plant. Some such components are monitor, key board, speaker set, modems etc. which are add-ons to the system. By analyzing the cost of component from source to end point (imports) as against local supply directly to dealer/end user will give a better cost perspective. As seen in the case of a national player,

due to the long lead times through sea, the company buys requirements for 45/60 days in advance. It may be economical to buy from the local supplier, if we consider the total cost to the customer.

Emergence of New Supply Chain Structures

The dynamism in the desktop market dynamic today resulted in new innovative supply chain structures. We illustrated the emergence of new way of competing in the market through GID program launched by Intel in 1996.

GID (Genuine Intel Dealer) Program: An Analysis

How did Intel help assemblers increase the reach and responsiveness of their supply chain at low costs with good quality?

The concept of a Genuine Intel Dealer, popularly known as GID, was introduced by Intel in the beginning of 1996. The supply chain structures for a typical GID is shown in Fig. 6. Today, over 1000 GIDs are operating all over India with a market share of over 50 per cent. By the way, who is a GID?

A GID is a PC hardware distributor, who

- Is certified by Intel
- Buys only authentic Intel microprocessors

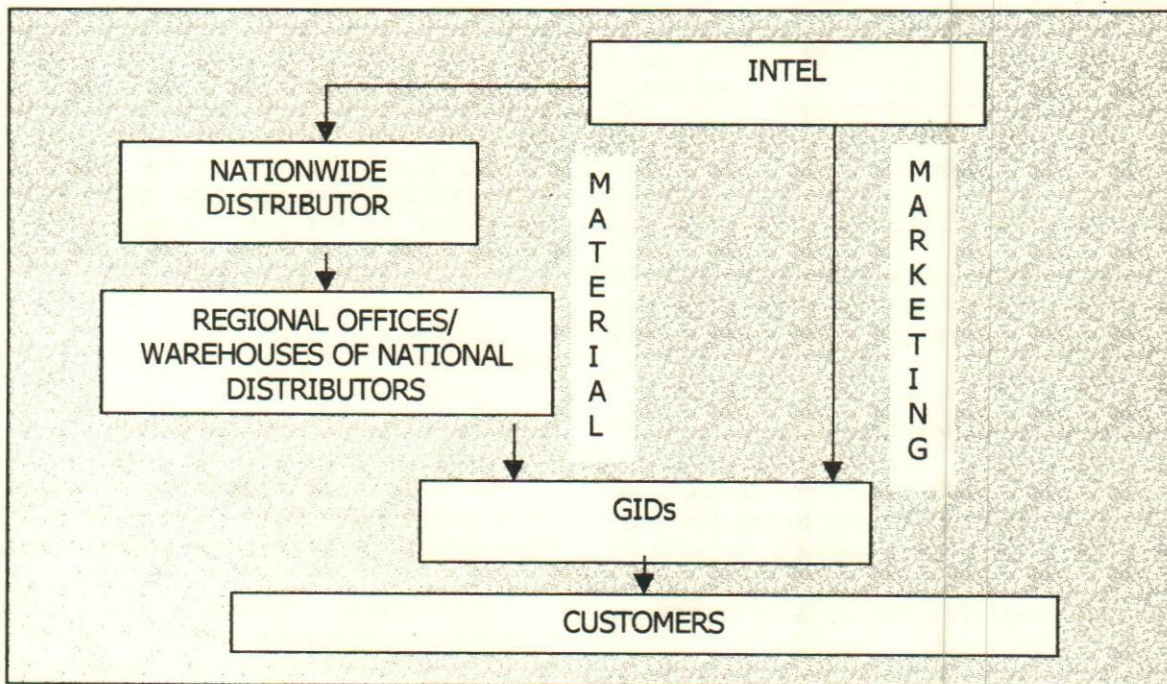


Fig. 6. Supply Chain Structure of GID

- Is a local grey market operator with an excise unit
- Operates within 10-15 kms and
- Charges 15-20 per cent less than the branded products.

What Benefits Do GIDs Get From Intel?

- Regular training sessions & marketing tips
- Cost structure analysis by Intel
- Technical information on new products and technology
- Advertisements run by Intel for GID products
- Participation in PC melas organized by Intel for GIDs

All this resulted in building the authenticity of the GID, who was a gray operator until yesterday. Today GID has an established name in the market place. The GID model brings together the low-cost, low overhead operations of hundreds of small assemblers with the marketing and technical might of Intel.

By identifying different entities in the supply chain and bringing them together, it is possible to bring down the costs while not compromising on quality and responsiveness. Price/performance ratio can be brought down by focusing on the supply chain. This emergence is causing a threat to other companies.

Conclusions

With high growth from household purchases and increasing presence of channel partners, the importance of reach and supply chain response is being felt by the PC hardware industry. In addition, the PC hardware industry is characterized by short product life cycles, falling prices, high obsolescence costs and rapid changes in technology. All these factors put emphasis on better management of supply chain.

To manage the supply chain effectively, one needs a comprehensive understanding of the present supply chain structures in the industry.

To manage the supply chain effectively, one needs a comprehensive understanding of the present supply chain structures in the industry. The framework developed in this paper should help companies in analyzing the current performance of the supply chain. In the comparison of importing with local sourcing, the importance of considering the total cost of the component in the supply chain has been highlighted. Such an evaluation is found to be more realistic and objective.

The emerging home segment, falling prices, inelastic business segment, and increasing importance of channel partners are identified as the major issues in contemporary situation of the PC hardware market which will affect the performance of the company from supply chain management perspective. A qualitative analysis is done to bring out the affects of these changes on supply chain. With more information, a detailed quantitative analysis may be undertaken.

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BPR – Mighty Tool or A Reformatory Philosophy?

Subrata Chakraborty

Business process reengineering (BPR) has become a craze in recent years with popular press creating much hype and consultants proclaiming it as the mega-tool of the century. Over the past few years quite a few aspects relating to BPR have been examined from the practice angle, thereby giving rise to several issues and posing many searching questions about its real worth. Available reports suggest that in about seventy percent of cases, BPR has failed to deliver what it had originally promised, the order-of-magnitude improvement. Going only by these, BPR would not appear to have been all that successful as the initial literature on it had projected. Nonetheless, the basic philosophy contained in BPR seems useful given the managerial myopia our organisations typically suffer from. This paper is a brief account of the concept and content of BPR brought out through an examination of BPR vis-a-vis few other improvement efforts, including some analysis of few field experiences. The conclusion is, BPR constitutes a purposeful philosophy towards improving in new strategic direction as opposed to being a mighty tool to effect major operational improvements.

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Introduction

No sooner did Michael Hammer (1990) come up with his pathbreaking article "Reengineering Work: Don't Automate, Obliterate", than the idea of business process reengineering (BPR) spread quickly as it seemed to appeal many in business. Reportedly, the prospect of effecting order-of-magnitude – of – improvement seemed to have held the most appeal in BPR. Prior to this, business researchers had suggested methods/approaches which were largely oriented towards effecting small or incremental improvements as opposed to seeking quantum jumps. More importantly, Hammer's contribution came at a time when businesses, all over the world, began to experience fierce competition for the first time ever. Getting thus caught in an unknown mire business were on the look-out for something dramatic that could put them back to the track of supremacy. Cropping up in such a milieu, BPR came to be regarded as an attractive recipe for instant success with its promise of over-of-magnitude improvement, prompting many business enterprises to try out this new found mantra.

The high hopes, however, could not be realised in majority of the cases. The initial appeal began to fade as experiences of field trials started coming in. The thing that came under most questioning is the ability of BPR to handle the required changes effectively in order to alter the trajectory of improvement. Gradually more and more eye-brows came to be raised prompting scholars like Mumford (1995) to wonder what the real consequence of BPR may actually turn out to be – constructive change or a creative chaos? Grover and Malhotra (1997) raised a more fundamental question as they asked, "whether there is a logic behind reengineering?" Scholars soon discovered that literature talks more about "how to do BPR" in comparison to "what it actually is" (Peppard and Preece, 1995). These observations made several scholars to sit up and pull out sharp lenses to examine things critically as BPR seemed to present a dual image – con-

siderable expectations held out in its persona, yet very little was uncovered of its anima.

As more and more companies attempted to embrace BPR philosophy, many other questions got raised. Some of the more introspective ones are: What drives BPR? (Dixon *et al* 1994), Is BPR fundamentally different from old Taylorian approaches to industrial engineering based on task decomposition and specialization? (Grover and Malhotra, 1997), What is the intellectual inheritance of BPR? (Peppard and Preece, 1995), Are there new ideas in BPR? How does BPR compare with other improvement philosophies? (Peppard and Rowland, 1995). Collectively these questions point towards lack of clarity of the epistemological and metaphorical assumptions which underlie BPR. It, thus, gradually came out that despite hope and the initial expectation of its potential, much remained to be known about BPR in order to successfully draw out in practice whatever potential it had. In addition, there has also been the felt need to demystify things relating to BPR so that one could go about the task without undue inhibitions. Putting together, they point towards the need to become clear about what is critical to understand for managing the design and implementation of a reengineering process.

Despite hope and the initial expectation of its potential, much remained to be known about BPR in order to successfully draw out in practice whatever potential it had.

The present paper is a modest attempt to clarify some of the confusions that surround BPR. The analysis here, begins with few frequently asked questions about BPR vis-a-vis other improvement strategies, and takes note of some common myths that came to surround BPR. Upon identification of the central theme in BPR through such an analysis, the paper proceeds to construct a broad framework that could facilitate future action. The objective here is to bring the much needed clarity in our understanding with a hope to purposefully guide operationalization of the basic philosophy contained in BPR, and to help improvement in new strategic direction.

BPR and Other Improvement Strategies

This has often been compared and contrasted with other improvement philosophies with an apparent objective to more clearly understand what it truly represents. One improvement philosophy that almost invariably found place in such comparisons is total

Some opinion that BPR subsumes TQM because the extent of improvement aimed at in BPR is much more than what TQM had been designed to achieve.

quality management (TQM). Some opinion that BPR subsumes TQM because the extent of improvement aimed at in BPR is much more than what TQM had been designed to achieve. On the other side, authors such as, Dixon *et al*, (1994) contend that, "continuous improvement, if consistently pursued, is capable of multi-year improvement rates equivalent to those attributed to many reengineering projects". Many authors, however, feel that reengineering and continuous improvement are at opposite ends of the improvement continuum, and both are required to get an organisation going. In the words of Harrington (1987), "often the process that is being used evolved over a number of years. Its first concept may have been sound, but over the years, quick patches to correct organisational, equipment, personnel, and product changes may have made the total system cumbersome, slow, unreliable, and unnecessarily complex. If this occurs, it is time to use a system engineering approach to streamline the process". Going by the assertions made by Harrington (1987), and also by other authors, a legitimate question seems to arise — is there any fatal conflict between the processes of reengineering and those of continuous improvement?

Broadly, the opinions on this appear divided in two major schools of thought. One school thinks periodic reengineering is the right thing to practice as that not only caters to the need to have continuous improvement but also provides a period of relative stability in between the major overhauls. Those belonging to this school justify themselves more on the premise of our current organisational realities, arguing that our work organisations like to operate in a state of stability instead of undergoing continuous change. Scholars belonging to the other school seem to hold the belief that notwithstanding such an operating mindset business today is not left with much choice but to pass through alternating periods of incremental improvement and radical process improvement, and both have become necessary since changes in environment are occurring relatively faster than the rate at which improvements could be effected. Authors belonging to latter school justify themselves with the reasoning that an organisation can easily create unwanted lags if it does not effect continuous improvements and simply waits for the next reengineering exercise. Perhaps some additional insights of the real intents of the two philosophies

Table 1: Comparison of BPR with Other Improvement Philosophies

Element	Total Quality Management	Just-in-Time	Simultaneous Engineering	Time Compression Management/Fast Cycle Response	Business Process Redesign/ Reengineering
Focus	Quality	Reduced inventory	Reduced time to market	Reduce time (time-cost)	Processes
	Attitude to customers	Raised throughput	Increased Quality		Minimize non-value-added
Improvement Scale	Continuous Incremental	Continuous Incremental	Radical	Radical	Radical
Organisation	Common goals across functions	'Cells' & team working	R&D and production work as a single team	Process based	Process based
Customer focus	Internal & External Satisfaction	Initiator of action 'pulls' production	Internal partnerships	Quick response	'Outcomes' driven
Process focus	Simplify	Workflow/ Throughput efficiency	Simultaneous R&D and Production development	Eliminate time in all Processes	Ideal or Streamlined
	Improve				
	Measure to control				
Techniques	Process maps	Visibility	Programme teams	Process maps	Process maps
	Benchmarking	Kanban	CAD/CAM	Benchmarking	Benchmarking
	Self-assessment	Small batches			Self-assessment
	SPC	Quick set-up			IS/IT
	Diagrams				Creativity/out of box thinking

would do good and could possibly take us out of this quagmire.

Deming (1984), the most known quality guru, underlined the need to focus on the system rather than on subunits—observing that only when all parts of the system function as a whole does the system really work (Out of crisis, 1984). Deming, in his writings, has used an interesting phraseology "Profound Knowledge", to articulate what he called knowledge of the system. According to Deming (1990), business transformation depends on the interactions between the elements of the system, clearly implying the need to identify these elements and to uncover the nature of their possible interactions. As Deming saw things, this had to be very much a part of continuous improvement philosophy. Juran (1969), too, held a somewhat similar viewpoint as he exalted the members of the TQM organisations asking them to reexamine their work processes repeatedly and do so with no holds barred: "Ask not just why we do it that way, and can we do it better, but also ask why we do that at all". Shoji *et al*, (1993), in their proposition of a new American TQM, recommend decomposition of continuous improvement to two major components—systematic improvement and iterative improvement. Although They did not use the term "systemic" in their detailing of the elements of systematic improvement, they talked about the need to identify and carry out things which are necessary for an organisation to cash

on the emerging opportunities in environment, in addition to doing whatever may be needed to effect routine process control and bring out reactive improvement to overcome product weaknesses. Thus, Shoji *et al*, (1993), too, seem to subscribe to the view that small ongoing incremental improvements need to be juxtaposed with major improvement initiatives coming up periodically. Therefore, the proponents of TQM did in no way preclude possible requirements of periodic overhauls. If at all any, they have all stressed the need of it, implicitly or explicitly, although may have had suggested different approaches towards operationalization of the intended philosophy.

A comparison, adopted from the work of Peppard and Rowland (1995), is presented in Table 1 with a view to share how some of the process improvement approaches compare.

Looking into the approaches, through the elements used for comparison in the above table, it should come out fairly clearly that BPR presents a mixture of both old and new, emerging as a logical combination of things that proceeded. More importantly, BPR reinforces a thinking trend that has been pursued for some time now. Over the years, reductionism, embodied in the thoughts of Fredrick Taylor, Adam Smith and many others of the early period, has been gradually making way for human interactionist models of organisational

development and, for relative softer systems. Parallely, on technology front phenomenal growths are being witnessed, especially in those dealing with computing. Reengineering, apparently, constitutes an attempt to bring together certain diverse things and seemingly unconnected views such as, quality, information technology, organisational change, innovation, work design etc. The period preceding the one in which BPR came up did witness new understandings develop around many of these, leading to some pathbreaking new theories. However, till BPR came up, all these were regarded as disjointed slices. What seems to have triggered the thought of having something like reengineering is the realization that choices which are best for the function may not necessarily be best for the organisation as a whole. Secondly, the steady rise of overhead costs, witnessed in recent years, gave a clear signal that of late we have started paying more for the glue than for the real work (Champy, 1995), and something needs to be done about it.

Reengineering, apparently, constitutes an attempt to bring together certain diverse things and seemingly unconnected views such as, quality, information technology, organisational change, innovation, work design etc.

It has been recognized that much of what comes out of any work organisation by way of its outputs and outcomes are influenced directly or indirectly by the organizing arrangement it adopts. This being the case, the kind of organising arrangement suggested in the two improvement approaches, BPR and TQM, would carry some relevance in our current discussion. Clearly BPR champions the need of having process-based arrangements which TQM unequivocally endorses. Perhaps the TQM proponents were the early ones to consistently emphasize the important role processes play, and to advocate the need to install process-based management philosophy. The difference, if any, probably lay in the answer of the question what should actually drive the process emphasis. TQM surmises that 'quality' be treated as the outcome variable with the observation that quality is perhaps the only thing of all business measures—qualitative or quantitative—which connects internal activities of an organisation to its external world; every other measure is focussed either inwardly or outwardly. Secondly, the belief held in TQM is that the necessary link can be established only through processes, hence process holds the key to improvement. Reengineering, too, is process focussed, but with one important difference—the identification of what should

constitute the ends. TQM talks of adjusting the "means" keeping in view "ends" which are experienced by the users of what comes out of organisational processes; whereas, in BPR, the ends are usually measured from an internal perspective. Thus, BPR would appear relatively inward looking although it may not have been its true intent.

TQM seems to steadfastly believe that any focus other than those reflecting customer needs and wants cannot provide meaning to internal working of an organisation since every single activity essentially derives its purpose, as well as existence, from customer requirements and are to be therefore performed in manners that ensure satisfying use experiences. This point is crucial in our discussion because, all said and done, it is the customer who really keeps any business ticking. One can therefore hardly undermine the need to become customer focussed. As a matter of fact the necessity of satisfying customer needs and wants had rarely been a subject matter of any major debate. Probably everyone could see through who the prime propeller of business is. However, what has been attracting debate is how to organize and conduct business activities so as to be able to fully satisfy customer needs and help in providing progressive better user experiences. Coming back to our comparison, all we can say is: TQM and BPR have different approaches to suggest, otherwise remaining largely similar in their philosophical contents. This is felt so because of reasons more than one. The necessity to develop a cross-functional view has been stressed in TQM literature as TQM wanted to identify the practices that inhibit thinking and distort performance. In its actual adoption TQM did face difficulties to imbibe horizontal thinking within our vertically structured organisations. Secondly, it also realised that to have any process-based arrangement in place, inputs are required from all the traditional functions. In fact, this is what the 'T' (total) in TQM stands to signify. TQM had emphasized the need to be management-led so as to tide over these and other hurdles. Eventhough thoughts remain somewhat cluttered in literature, TQM did come up with the suggestion to dismantle functional boundaries and build a process-based structure in its place, in order to bring a clear focus on value creation and delivery.

TQM seems to steadfastly believe that any focus other than those reflecting customer needs and wants cannot provide meaning to internal working of an organisation.

TQM and BPR would thus appear to be treading on largely similar grounds with one eye-catching difference, the trajectory of improvement aimed. Thus, if BPR signifies work level revolution of things, TQM probably deals them at the thought level (Perry, 1997). The most distinctive difference, however, seems to lie in the overall view taken. TQM is mainly viewed as a programme that can help the implementation of change with the purpose of obtaining improvements, as opposed to its being the consequence of improvement caused by change (Phillips, 1997), which is what BPR stands to represent.

A brief overview of the conceptual foundations of BPR is presented now. A working definition of reengineering, adopted at Boston university manufacturing roundtable research (Jeffrey *et al*, 1992), is used here to take us through our intended discussion.

Reengineering ... (is a) radical or breakthrough change in a business process. Reengineered process designs seek dramatic orders of magnitude, as distinguished from incremental, improvement in business value. Key value creation processes involving manufacturing operations include order fulfillment (the customer supply chain process), product development, order creation (selling and configuration), and customer service (post product delivery processes).

A close look at the above definition should bring out the real intent, which is, results desired from a complete process as opposed to remaining preoccupied with functional and/or individual unit needs. Perhaps the most important message contained in the definition relates to the need of improving workflows horizontally, instead of getting bogged down to cutting cost and/or work forces based merely on some targeted percentages. The core concern expressed here arises from a realization that many of our traditional systems could impede some of the strategic changes needed today. Therefore, the real intent in BPR had been to devise ways that can transform thinking, and thereby attune work behaviour to the needed direction. Further, if these could be achieved quickly, nothing like it. This is where BPR captured attention as it promised "order-of-magnitude" improvement to change things faster.

Since early eighties, the so called post-MBO era, there had been a growing consensus towards the need of having integrated approaches replacing the fragmented ones. This is because many improvement efforts attempted earlier did not meet with envisaged degree of success due to lack of support and cooperation through a whole range of activities that cut across organisational and/or functional boundaries. Further,

despite making improvements in the conduct of many individual activities the overall net effects, measured in business terms, turned out to be much lower than what have been envisaged. Realization of limited successes, even after repeated efforts the need to examine things in broader perspectives. Having done that for some years now, it is being realized that overall results are impacted by effective functioning of many critical linkages. Malfunctioning in any of these could reduce, even nullify, much of the effects produced through individualized improvements, permitting little change to be caused to the bottom line. The lesson learnt is, business perhaps cannot be run any longer using a simple "action—outcome" perspective. Time has come to remain alert of the presence of many possible interactions and their umpteen implications, the real need being one of managing these effectively. Unfortunately, concern for such linkages has been extremely limited, if not altogether absent, in our managerial thoughts and actions. Hence, even though concept of process occupies the heart of TQM, in actual adoption, process as an organizing concept—which puts together absolutely everything necessary to deliver some important component of strategic value—failed to draw the needed attention in majority of cases. Managers looked for symptomatic reliefs of what they felt is a source of trouble. Expectedly therefore, suggestions of improvement had to be repackaged in order to create the needed desire to fix the whole thing, instead of viewing components one by one. It, thus, appears logical that the emphasis in BPR had been to desegregate any business and then reconfigure it around a small number of processes. Obviously, something like this had to be suggested to trigger the much needed introspection, and guide organisations towards revamping the outmoded thinking patterns.

Care is obviously necessary to ensure that business processes contain all that are needed, in performance terms, to deliver to the market something of strategic value. Undoubtedly, the central aim of BPR had been to answer the question, "how to come out of the mentality of doing better in what we do?" The modalities adopted in BPR exercises should therefore have to build-in approaches to come out of the said mentality. Detailed analysis should suggest that the main objective in BPR had been: to become more purpose focused; and be effective in operation, not prescribing an approach that prods us to achieve things going the other way round. Singular attempt in BPR was to create an "out-of-the-box" thinking. To add meat to it, BPR talked of the need to have process-owners, especially for those processes which are largely cross—functional. The important first step to bring the kind of changes BPR aimed at was to capture managerial attention towards the needs of such changes. As had been said earlier, BPR seems to have

succeeded well in catching managerial fancy. However, what remains to be achieved is the development of right perspective so that aberrations in action could be minimized, if not altogether avoided.

Care is obviously necessary to ensure that business processes contain all that are needed, in performance terms, to deliver to the market something of strategic value.

The Myths of Reengineering

The hope created by consultants and the popular press has given rise to many myths about reengineering. Grover and Malhotra (1997) identified some of the common ones, which are:

1. Reengineering is a radical one time approach;
2. Reengineering involves breakthrough performance gains;
3. Reengineering enables change primarily through IT;
4. Reengineering should focus on cross-functional core business processes;
5. Reengineering enhances individual capacities through empowerment and teams;
6. Reengineering can use a standardized set of methods touted by armies of consultants;
7. Reengineering must be conducted from the top to down.

By this time, many reports have been published which are rich in field-experience-based findings. Practically all the myths would stand dispelled if one cares to go through some of these findings. Caldwell (1994) observed that instead of a radical one-time approach continuous improvement, thorough effective process stewardship, is found more beneficial by some. Secondly, many organisations are also not culturally adept to go for breakthrough gains (King, 1995); instead, they find themselves at a relative greater ease to purpose things that can bring them moderate gains on a continuous basis. Roby (1995), quoting the example of Hughes Space and Communication, pointed out what the enablers of change in that company were and how limited the role of IT was in the whole process. This should hopefully break the illusory notion that IT must be the prime enabler in all reengineering efforts. As a matter of fact, lately, there is a realization that redesign

is far from an IT exercise and is about changing how a messy real-world organisation works. Given today's world, technology could no doubt facilitate any task of redesign but that, in itself, does not make it an enabler in the true sense of the term. Wreden (1994) presents an interesting example to highlight what effects piecemeal improvements within functions could sometimes produce. Citing the experience of GE Power System, Wreden points out the massive reduction realized in inventory carrying charges in the said company through such piecemeal improvement efforts.

In order to cope with the changing world of today capabilities needed are many, and are also multifarious in nature. As noted earlier, one critically important requirement would be the development of horizontal team-based skills that facilitate communication and learning (Gratton, 1996). Such skills, however, would not automatically develop in individuals who participate in reengineering efforts (Bartholomew and Caldwell, 1995). Clear understanding of the real purpose of any reengineering exercise, and a planned agenda of action to promote holistic vision in people, are the things that hold the key to move in the desired direction.

Regarding a standardized method for reengineering, serious questions have been raised by many because no standardized approach exists to date. Goff (1995) talks about an internal think-tank which was set up in Texas Instruments to help the concerned organisation in designing new business processes, clearly pointing out the fact that no standard method exists. Dixon *et al* (1994) observe that the objectives of BPR being fuzzy, it is difficult to design clear milestones for the task. In the words of Grover and Malhotra (1997), "different organisational contexts are increasingly being recognized as critical to change decisions and subsequent success". That being the case, any talk of devising a standardized method would not make much sense.

Perhaps, other than demonstration of leadership initiatives there is little virtue in the observation that reengineering must be conducted from the top down. Unless people manning different processes develop horizontal outlooks nothing much could be achieved in real terms. And, when such outlooks eventually develop in people, they should be quite competent to redesign their own jobs. Therefore, what the top leadership needs to do is to try and promote the required outlook in people rather than mechanistically flagging-off a BPR exercise into action.

Interestingly, none other than Hammer (1996) himself talks about the mistake done earlier, asserting that "radical" is far less important than "process". Crucial element being one of building abilities to carry out

critical appraisal of any process, organisations would do better to imbibe process-based thinking and seek out to identify and adopt necessary change mechanisms that may suit them. Latest observations made by the original proponent of BPR may appear similar to taking an U-turn since it symbolizes shift of stands—from prescription to prescription. Be that as it may, it would perhaps mean that there is more in BPR philosophy than what has been captured so far in popular literature.

Making a comparison of BPR with socio-technical design, Mumford (1995) noted that the main difference had been one of emphasis, theory and values. While socio-technical design kept in view the needs of quality of worklife and job satisfaction along with efficiency; BPR, in its original prescription, seemed to be primarily focussed on efficiency. Perhaps Hammer's latest recommendations (Hammer, 1996) stem from a recognition of this, arising out of a belated realization of what the true facilitators of change are—well honed tools or agile minds? Now that the stage has been reset by Hammer (1996), and the job of separating the trees from the forest been done to some extent, the issues of future need to be looked at.

Implications

Any surface level analysis of what all have been said above may prompt one to conclude that much of the efforts spent in BPR have been largely wasteful since the high hopes of radical transformation did not materialize in reality in a majority of cases (Anonymous, 1993). However, this will probably not present the true story because despite such apparent disenchantments, certain useful lessons have been learnt in the process. Among the most significant learnings are clear recognition of the following needs:

1. To have an integrated approach using process as the organising concept;
2. To horizontalized the corporation in order to synchronize activities with the flow of work;
3. To divert managerial attention towards creating effective combination of material flows, information flows, and behaviour;
4. To redefine how top-level time gets spent; and
5. To develop a genuine holistic view;

Seemingly BPR was an early first attempt towards fulfilling the above needs. There should therefore be no regrets if the extent of success realized has been relatively less compared to our original expectations. Much learning had been derived from the experiences of re-

engineering efforts which can be of immense value in planning any future redesign exercise. All said and done redesign, as an exercise, is probably here to stay, immaterial of what name it is called by. Thus, what we seem to need are suitable approaches to redesign organisations using process as the organising concept.

Much learning had been derived from the experiences of reengineering efforts which can be of immense value in planning any future redesign exercise. All said and done redesign, as an exercise, is probably here to stay, immaterial of what name it is called by.

A broad framework of carrying out such tasks of redesign is offered here which, it is hoped, could serve as a purposeful guideline. The said framework, details of which follow, has been developed keeping in focus the needs identified above, and the overall requirement of effecting the much needed integration between thoughts, words and deeds of an organisation. The starting point in this redesign exercise would be a clear and concise statement of the distinctive value an organisation proposes to deliver to customers through its various processes. A properly articulated value proposition helps in binding the customer and the provider together, simultaneously facilitating identification of various core processes. It may be noted that coming up with a clear value proposition is crucially important because organisations exist to serve their customers; and what the customers want are help, service, product or solution to a problem. Hence, the requirement of having a clear value proposition. An absence of such a proposition, or a poor job here, can cause problems all through the rest of the action chain because execution of every activity is effectively guided by the perception of its need. Company's value proposition provides this much important need perception. At the heart of the philosophy of having process as the organisation concept, is the goal to provide greatest utility to customers at least cost, where value is determined by how well the product/service allows its customers to perform the desired tasks for the prices paid. The statement of value proposition is of help not just in providing a start but also in connecting various organisational activities with customer requirements, permitting therefrom meaningful translation of various use needs to process engineering and design.

Historically, activities in our work organisations have been combined vertically, connecting layer by layer, eventhough smooth product flow clearly calls for

horizontal linkages. In early days, dominant organizing consideration had been internal efficiency. Getting somewhat blinkered by this efficiency focus, business failed to recognize the importance of having smooth flow of all value creating work. Only during recent years when competitive pressures started mounting, concerns for value creation began to show up, bringing process into the fore-front. Ways are being explored for carrying out effective appraisals of processes. Mapping of the movement of product/service has been widely acknowledged to be a possible way as it permits visualization and construction of the end-to-end processes. However, the practices of grouping activities vertically, around functions, often came in the way of developing a genuine process view. BPR was the first salvo fired to break this mould, although it met with only limited success. Nevertheless the need to horizontalize the corporation was emphatically established through BPR. We have to now find out how to smoothly go about the task of creating a horizontal organisation. Lessons learnt from the attempts of reengineering would tell us not to seek one best prescription for this. Generation of possible alternative approaches can help one to choose from, keeping in view the specific needs of any given situation. It would perhaps be even more beneficial if appropriate understandings are generated to clearly identify things that are to be done, leaving the needed wherewithals to evolve from internal churning of ideas within an organisation.

The term process is used for what happens as things travel through a factory, department or office crossing many departmental/functional boundaries from initial input to final output. Core processes would be those which are valued by the stakeholder and are to be therefore conducted efficiently and effectively. In BPR, the attempt was to identify such core processes so that adequate care is taken to do them well and also effect timely improvement on them, leaving out many unnecessary rituals followed primarily to cater to departmental/functional objectives. Eventhough some rituals may appear essential to those who are used to them, the objective has to be get rid of every single thing that does not create value. Once this objective is clearly held in focus organisations can be seen through a different lens, viewing them as series of core processes, linked horizontally, instead of a group of vertical building blocks. Horizontalized outlook would have to be built, making it the heart of our redesign effort with the objective of getting focussed on how work is performed.

Although no clear prescription yet exists on how to horizontalize work different authors came forward and contributed some useful ideas to make this happen. Hope and Hope (1996) suggested the following, to

serve as guiding principles in the design of a true horizontal organisation.

- Flatten the hierarchy and minimize non-value adding work;
- Assign the ownership of processes and process performance;
- Make teams the building blocks of horizontal structure;
- Develop self managing teams;
- Encourage multiple competencies;
- Provide teams with appropriate training and shared information;
- Reward team-based, not individual, performance.

To some, the above guidelines may appear somewhat tilted in favour of a team-based culture. While this may indeed be true, one cannot possibly disagree with the suggestions of Hope and Hope (1996) when it comes to the question of the need to simultaneously promote team-based approaches in our work organisations. Perhaps the extent of emphasis to be placed on this aspect could be a subject matter of some debate and situational considerations. Except that, there could hardly be two opinions about the need to have responsible teams, to work as process owners and to contribute in creating value for the customer. Having said that, one has to also readily admit the fact that building such teams is never easy. Many variables, such as, individual attitudes and beliefs, organisational values and practices, as well as some complex interactions of the elements of these two sets come on the way and affect things. Predominantly, managers ask for basic commitment and necessary job involvement from individual employees. No doubt these are important. However, all by themselves, are not sufficient to make things move in the desired direction. For that to happen one must create an appropriate organisational environment, installing some well thought out performance measures which could act as drive forces. Building clear process focus and promoting effective team work must receive sufficient managerial attention as well as the needed emphasis. Towards this, value-adding work could possibly be used as the primary performance measure of the teams since this would serve many performance objectives, promote teamwork, and also help an organisation in its drive for continuous improvement.

Once the basic enablers are in place, the next critical thing to be worked on is the appropriate output measures to gauge process performance. Traditionally, process had not been the basis of organising arrange-

ments. Therefore, little had been done so far to measure process outputs in core business terms. The cost-based performance measures, most commonly used for decision making purposes, do not often help in timely diagnosis of process health. These measures were devised to cater to a different set of needs. What we require are real-time measures which, apart from telling us how we have been doing, must also quickly point out what is going wrong and where. Our decision objectives being: (i) what to change, (ii) what to change to, and (iii) how to change, we need to devise output measures which can cater to all the three objectives, either singly or in combination. A step-by-step approach listed below may help in the design and development of such output performance measures (Hronec 1993):

Once the basic enablers are in place, the next critical thing to be worked on is the appropriate output measures to gauge process performance. Traditionally, process had not been the basis of organising arrangements.

1. Identify the customers of each process (This means who is/are the one(s) to seek the value the particular process is creating, and is/are ready to pay for every single thing that gets done to create such value);
2. Identify and understand customers expectations—the expressed as well as the latent ones;
3. Prioritize these expectations to chart out a course of action;
4. Identify measures that link the process to the goals to the customer;
5. Select those measures that unfold gaps and also drive performance;
6. Set targets using benchmark information.

Basic idea contained in the steps suggested above is how to help people manning the processes to determine what they should focus on, rather than providing ready answers to the three questions stated under our decision objective. The belief is that if the above steps are gone through the needed answers should emerge.

The three-point action agenda comprising of making a clear value statement, horizontalizing, and, having influencing performance measures, could be put in operation only in a setting where continuous learning

and transformation take place. For this, managers would have to learn to look at how their unit fits into the "big-picture", and exert themselves to understand how interactions within the system (sometimes unexpected and unseen) can help or hinder overall performance (Buckler, 1998).

Conclusions

In retrospect, it would seem that BPR is a philosophy, not a methodology. It is adjudged to be so because BPR does not offer prescriptions for the way organisations should work day-to-day, although there is little doubt that it is concerned with how organisations can improve performance. Browning (1993), quoting Haygate (a partner in London Office of McKinsey) on BPR, points out, "here the task is to step back from daily activities and take a fresh, radical, end-to-end view of the skills, capabilities, flows, and linkages that drive critical aspects of overall performance". BPR thus allows one to take a new perspective even of the old approaches which may have failed to deliver expected benefits, and to know why these did not work that well. Operating realities suggest that any organisation needs to simultaneously deal with a number of variables typically, classified as the situational variables, strategic variables, performance variables, pattern variables, structural variables, and behavioural variables. In the past, these have been considered in isolation and there were hardly any attempts to coherently link them with a clear and unambiguous purpose focus. Apparently BPR was the first attempt to take us out of our myopic thinking. The need to understand business in totality—viewing through its core processes—has been the central message in BPR. How one should actually balance the breadth of vision with the needed depth of analysis in a given situation has been left to the individual organisations to figure out. Thus, transformation of managerial minds, as opposed to overhauling day-to-day operations, is what BPR seems to have actually attempted; although any cursory look of popular literature could easily present a picture somewhat different from this.

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Business Process Reengineering: Value Beyond Productivity & Quality

R.P. Mohanty & S.G. Deshmukh

There is a growing interest among professionals about BPR. In essence, BPR is a comprehensive package aiming to deal with the totality of an enterprise, with an urgency to transform every aspect of variety of core processes, yet the generic fundamentals complimenting the gamut of productivity improvements and quality management. This paper is an attempt to put forward a comprehensive view about the BPR in a value adding perspective. The changing role of productivity demands that innovative mechanisms to institutionalize change in the corporate culture must be installed with a view of having quantum productivity improvements. The paper also suggests a framework for implementing BPR.

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Introduction

During the decade of 90's, Business Process Reengineering (BPR) projects have been explored and implemented in many industrial and service organisations across the globe. These projects aimed at improving organisational efficiency and productivity improvements through automation, labour savings through downsizing, streamlining systems and procedures through information technology and reforming the management through business, market, technology and leadership development. Primarily, BPR has been implemented to bring about radical changes not only in contemporary business performance but also in management philosophy, styles and patterns. Zairi and Sinclair (1995), Aggarwal (1997) and Mohanty (1997) have outlined a variety of benefits that companies achieve by pursuing BPR projects.

Business Process Reengineering has been acknowledged as one of the powerful management tools for restructuring the organisations. Many companies who have taken initiatives in implementing BPR have indicated the benefits such as improved financial performance, enhanced customer satisfaction, cost reduction, improved product/service quality, improved delivery performance, improved flexibility/responsiveness etc. There is a wide array of literature written on BPR since its idea was first proposed by Hammer (1990) and Hammer and Champy (1993). Various researchers have provided prescriptions for implementing BPR. McManus (1994) dwells on the art and

Business Process Reengineering has been acknowledged as one of the powerful management tools for restructuring the organisations.

science connotations of BPR. A lot of literature has appeared on various aspects of BPR such as its implementation in various industrial sectors, human aspects, the role of Information Technology (IT), comparison of BPR with other management tools etc. Nandi and Banwet (1998) have reviewed relevant literature in BPR and have identified a few research directions.

The Genesis of BPR

With the advent of liberalization, privatization and globalization of economy, a new organisation is emerging (Drucker, 1997). The following six generic forces have stimulated the business:

- Customer power
- Information power
- Global investors power
- Power of market place
- Power of simplicity
- Power of the organisation

The Customer power—the predominant one stems from the fact that customer remains at the heart of any enterprise and therefore an organisation has to perpetually learn and relearn as will be dictated by the customer's choice, and his requirements. This power compels an organisation to move from bureaucratic mode to responsive mode to deliver value to the customers and necessitates to be flexible, lean and yet be able to create new customers.

The information power, with advances in Communication and Information Technology, helps an organisation to learn at a faster pace. Now it is possible to transfer volumes of data globally from one organisation to another. The information power enables to promote knowledge networking, increases the speed of decision making, eliminates the needs for large number of managers to exercise control and frees doers at all levels to concentrate on delighting customers.

The power of global investors affects the edifice of an organisation. Because of liberalization that is globally evident, an organisation is stimulated to capute new opportunities because now there is no closed spatial boundaries or restrictions for making investments in any part of the globe. The organisation continues to invest in its total development by initiating global search for all resources. Jayachandra (1994) discusses the impact of networking of organisations on sharing of the resources.

The power of global market place generates fierce time-based competition which motivates an organisation to learn faster for making quick innovations so as to maximize value for the stakeholders.

By power of simplicity, we mean streamlining of systems and procedures within the organisation and moving away from a ritualistic culture to an empowering and autonomous entity. Because of this, the organisation has to quickly undertake redesign of business processes and has to forge organic partnerships with the multiple stakeholders to eliminate delays and bottlenecks.

The power of organisation itself rests in its capabilities to quickly transforming market opportunities into tangible bottom-line results. Such a force leads to recreate lean and agile structure and high performance action teams. The power of organisation is manifested in the quality of leadership who can deploy knowledge across the organisation to initiate and implement quick innovations in generating growth and maximizing value for the economy.

BPR has emerged as a novel approach to take proactive cognizance of these interactive forces. There are many names to BPR, such as Business Restructuring, Core process redesign, Business process management, Business process improvement etc. BPR is the means by which an organisation may be able to achieve a radical change in terms of performance as measured by cost, cycle time, service and quality by the applications of variety of tools and techniques that focus on a set of related customer oriented core business processes rather than on a set of absolute functions (Hammer and Champy, 1993). This effort aims at simplifying and streamlining the process by eliminating all the redundant and non-value adding steps, activities, transactions, reducing the number of stages of transfer points of work and speeding up the work through the use of IT and systems.

There are many names to BPR, such as Business Restructuring, Core process redesign, Business process management, Business process improvement etc.

BPR as an approach is based on the following premises (Hammer, 1990; Hammer and Champy, 1993):

- Results in radical change
- Assumes clean slate change

- Focuses on end-to-end processes
- Top-down directed
- Information technology enabled

Thus, BPR concentrates on the fundamentals of work processes such as; "Why are we doing", "What are we doing", "For whom are we doing", "Where should we do", "How do we organise, operate and control". Is BPR completely a new package? Is there a fundamental distinction in terms of micro and macro views of problem solving? Is BPR oriented towards total transformation of business apart from achieving operating excellence? Is BPR an innovation or little new? What is the connection between productivity and BPR? It is interesting to review BPR in light of productivity and quality.

Productivity measures as to what extent the resources of an organisation are being utilised effectively in transforming inputs to outputs. It is a measure of how well the resources of a firm are used in producing goods and services. The rate of growth in productivity determines a nation's economic progress. A low rate of productivity spawns a vicious cycle. Problems of inflation, international trade, competitive market, unemployment are directly affected by the level of productivity growth and quality of goods and services. Sluggish productivity growth has been an ongoing concern of business managers, economists, and researchers alike. Interest in productivity in the academic area is evident from the vast body of literature. However, more and more, economists are looking at "micro" issues—that is issues concerned with the firm, work group or individual—rather than "macro" issues (industry or national level) as causes of poor level of productivity growth (Misterec *et al*, 1992). The productivity improvement studies may draw upon specialised knowledge and skill in the mathematical, physical and social sciences together with the principles and methods of industrial engineering (IE). It is in this context that it is necessary to have a look at Business Process Reengineering as a value adding tool for management which goes beyond the traditional gamut of productivity and quality.

Productivity measures as to what extent the resources of an organisation are being utilised effectively in transforming inputs to outputs. It is a measure of how well the resources of a firm are used in producing goods and services.

Davenport and Short (1990) have recognized that business process reengineering aided with the powerful

tool of information technology has demonstrated the same potentialities in the organisational context, to increase productivity as the Taylorism once had. They have identified a recursive relationship between IT and BPR and have termed this as the New Industrial Engineering. There are various other concepts like Total Quality Management (TQM), Just-in-Time (JIT) production control methodology, which are essentially aimed at productivity enhancements. Productivity improvement and BPR have strong connection between them. Conceptually BPR aims at increasing productivity of the organisation. Same is true about productivity and quality improvement studies. Traditionally, IE deals with design, improvement and installation of integrated systems of people, materials, equipment and energy. BPR talks about reinventing new ways to accomplish a process and arrange the factors of production about the process their both of them aim at increasing the productivity, through the application of scientific techniques of design and analysis.

There are several ways in which productivity can be improved:

- Improving Efficiency by lowering costs, generating savings in labour, machine time and reducing waste.
- Improving Effectiveness by better decision making, proper organisational design, proper staffing.
- Achieving higher performance by increasing quality, reducing accidents and lost time, and proper machine maintenance
- Developing better organisational health by improving morale, satisfaction and cooperation.

In each of the above, it is expected that systems and procedures, and work culture would be affected by the changes so desired in the system. However, it may be pointed that, the conventional tools of productivity improvements have a narrow task perspective whereas BPR is process oriented. BPR redesigns the processes. Through BPR, effectiveness is improved at the same time giving due regards to quality and involvement by all including the top management. By the application of industrial engineering what we do is workplace rationalization and improve the ways of doing a particular task. This works well when the organisations are operating in a largely stable business environment. But this is rarely the case nowadays as individual tasks and jobs change faster than they can be redesigned. Today responsibility for an outcome is more often spread over a group, rather than assigned to an individual as in the past. Hence rather than maximizing the performance or productivity of a particular individual functions,

companies, companies must maximize interdependent activities within and across the entire organisation.

There is a need of redefining the principles of productivity enhancements on the face of the need for systematic redesign of the age old business processes. In order to make these productivity improvement principles relevant to the present changed business scenario, a relook at the traditional practices is necessary. BPR and IT, in association with each other, have been identified as the new paradigm for business improvement. BPR can change the conventional practices by employing management by customer driven processes and cross organisational boundaries. BPR has worked well in many organisations, which have forced others to start thinking in terms of processes. Hence organisations should think of employing people to the task of redesigning the business processes along with the experts in information technology quality control, process control, finance and human resources etc. This cross functional group will be responsible for change management. Although, the very functional nature of the IE discipline has undergone changes historically, but fundamentally the concepts have surrounded around "speeding up actions to improve total productivity". Great strides have been made in the applications of mathematical programming, economic and accounting methods.

Computers have improved the effectiveness of applications. IE has incorporated overall systems design, systems integration and quality improvements. The discipline has been made rich by synthesizing knowledge from other disciplines, and at the same time, many sub-disciplines, such as TQM, BPR, CIMS etc. have emerged. Today, all these in conjunction represent a very wide umbrella embedding generic as well as emerging disciplines. There is a very radical departure in practices of IE in many organisations in the recent times. If we closely look into the variety of publications in BPR, we can see that BPR is varied versions of IE (Aggarwal, 1997). However, we are of the view that BPR is really *value innovations* in IE practices and in fact an enterprise-wide critical intervention to design competitive work processes with a view of having an order-of-magnitude improvements. Innovation is best defined as the transformation or application of knowledge to a novel and useful end. This knowledge can arise out of fundamental research or can be derived from a set of established disciplines. The essence of innovation remains at integration and used for value maximization. BPR, thus applies and integrates the time tested principles of the matured IE discipline but brings macro level value innovations at the enterprise level and not at the micro level, which IE traditionally pursued for many years.

The Imperatives for BPR

Organisations across the globe are experiencing the pressures for change. These changes are generic from: Demographics; Social values; Economic environment; and Information revolution. These pressures for change need not only the fitness to compete, but the qualities needed to reengineer our management systems and build up a totally different and new architecture which will be able to meet the new demands of the society under the given boundary conditions defined by the parameters of affluence level, consumer literacy level, quality of life, economic indicators etc. The modalities of organisational change have been outlined by Mohanty (1996). They are:

- Outside-in changes
- Inside-in changes
- Inside-out changes

The pressures for change need not only the fitness to compete, but the qualities needed to reengineer our management systems and build up a totally different and new architecture.

These modalities give rise to the following fundamentals:

- * Do we need to develop new products/services to become competitive?
- * What are our competitors doing?
- * Do we employ more people than what are required?
- * How is our price in the market?
- * What are the new aspirations/demands from the market?
- * Are outside forces threatening our survival?
- * Are we getting ready for internal reorganisation, major automation initiatives?

There are three major issues facing the contemporary organisations:

1. Avoid failures when threats are knocking at because of competition
2. Sustain the position of strength
3. Create the future which are unknown to others

These issues in turn lead to four main imperatives: Manage costs; Upgrade quality; Improve service levels; and Speed up actions.

These imperatives ultimately force an organisation to think of 'Proactive Transformation' in 4 dimensions: Structural dimensions; Management dimension; People dimension; and System dimension. Most of the organisations are frighteningly unfamiliar to: Customers delight; Competition and, Change. The traditional productivity improvement exercises assumed the environment to be static and through quality small incremental improvements were desired. But, now we are making a transition from a "market of sellers to a market of buyers". Today, the market is the center of focus where the battle is fought in 4 dimensions: Price; Reaction time, Quality; Performance Change occurs in every area: Products, Customers, Competitions, Suppliers, Technology Life cycles etc. Traditional organisation structures built as "vertical silos" did have some advantages, in that one does not need people with advanced degrees to accomplish the task. Everyone has the responsibility to do just one aspect of the task and managers at the higher level maintain the system through the bureaucratic chain of command. Consequently, organisations have become sluggish, because no one person is responsible for the whole process, the process is prone to errors since so many handle the order, the process is inflexible and the lead time is increased.

Table 1 gives the changes in attributes that are required in a BPR compared to the traditional set up. Figure 1 depicts the driving powers and the changes that are due because of BPR.

Table 1: Change in Attributes due to BPR

Attribute	Before BPR	After BPR
Work unit	Functional	Process
Job Skills	Simple uni-tasks	Multi-functional Multi-skilled
People	Controlled	Empowered
Job Preparation	Performance	Ability
Values	Protective	Productive
Executive Mind Set	Gate-keepers	Leaders

On this background, we describe the value innovations brought out by BPR which go beyond the productivity and quality issues.

Value Innovations Brought about by BPR

Innovations often lead to development of risk-taking ability in the employees of the organisation, give them job satisfaction, increase job involvement. BPR by way

Innovations often lead to development of risk-taking ability in the employees of the organisation, give them job satisfaction, increase job involvement. BPR by way of its radical thinking offers an opportunity to have value innovations.

of its radical thinking offers an opportunity to have value innovations. The innovations add value to the process, people and structure and goes beyond the gamut of productivity and quality. These innovations can be visualised in the following dimensions:

Innovation in the Role of Manager: Managing Vs Leading

Traditionally the role of manager was well defined. He was required to plan, coordinate, direct etc. His time was accordingly allocated between these activities. However, in BPR led organisations, a manager is supposed to lead instead of managing! He is required to be an innovative thinker, as a coach and act as a facilitator. The contrast between the traditional role of managing versus the role of leading implicit in BPR is summarised in Table 2. This has also necessitated redefining the demands on executives in a BPR led environment. It is imperative to redefine leadership style and management pattern required to undertake BPR initiatives. A reengineering executive must develop a mindset of an institution builder. Tomorrow's reengineering will demand for construction of new structures by demolition of the existing non-responsive filthy structures. The mindset of the executive must be a commitment to create value for the society, to maximize it not only for the sake of work justice, but also for the social justice. The goal is the establishment of the culture of production and services and taking such production and services into societal ownership.

Table 2: Differences in Managing and Leading

Managing	Leading
Impersonal, Passive attitude towards to goal	Personal, active attitude towards goal
Relate to People according to the role they play	Relate to people in more intuitive and empathic ways
Order and consistency by drawing up formal plans	Coping with change

The mind set of an executive in an BPR led organisation is completely a transformed one. His role is completely redefined. He is supposedly acting as a

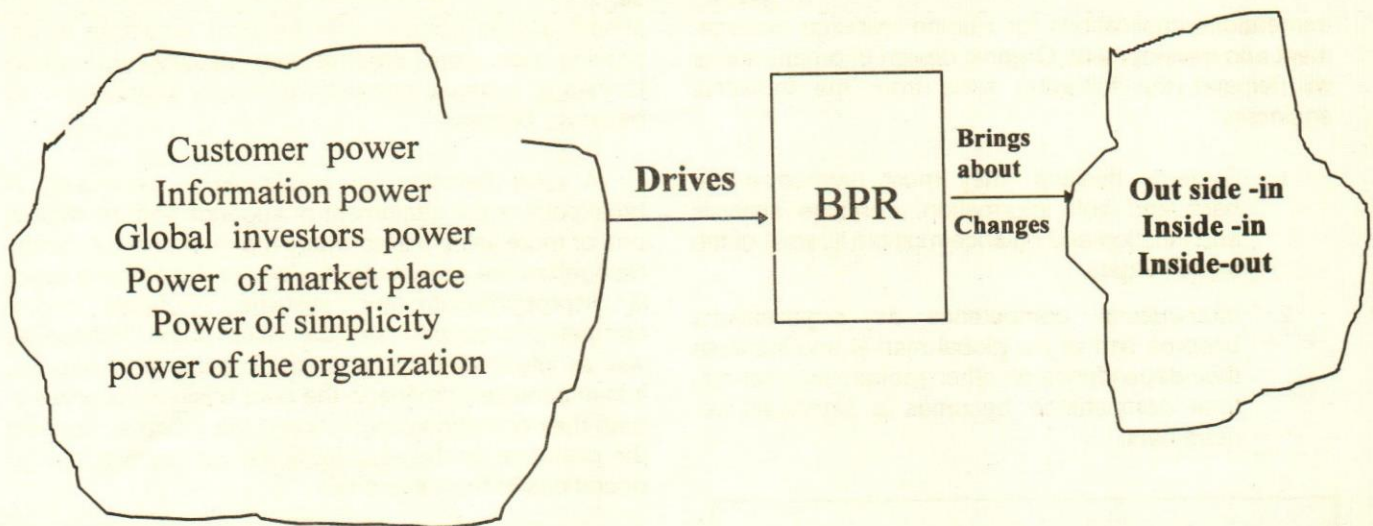


Fig. 1. Drivers responsible and changes due to BPR

facilitator having an outward looking disposition towards the work. He is to act as a change agent, a role which is implicit in the traditional definition of an industrial engineer. Decisions and interdepartmental issues which use to require manager meetings are now resolved in teams, or by use of IT. Organisational structure, whether functional or strategic business units, have become irrelevant.

Innovation in Performance Measurement: Systems Matching the Mission

In the IE based performance measurement system, the measures were myopic, inward looking and focusing solely on efficiency. In contrast to this, the innovation that has been brought about by BPR is in introducing a system where the measures are systemic and cutting across the entire organisation aligning with the mission of the organisation. The fundamental question of why performance measurement at all is perceived from a systems perspective. Maskell (1991) elaborates about the performance measures required

Table 3: Performance Measurement in Traditional System and BPR Driven System

Traditional Measures	Measures in BPR
Focus on attributes of Efficiency	Focus on Effectiveness for competitive business success
Isolates various functions	Integrates various functions
Individual departmentalized orientation	Team oriented cutting across the entire organisation
Uni-dimensional	Multi-dimensional
Subjective impressions are the major elements	Quantitative and Qualitative value oriented measures

for a world class organisation. For example, in the area of supply chain management, the measure related to the total cost could be useful where right from inbound logistics till the customer service, every element of the cost is tracked down. This fosters a sense of ownership amongst various stakeholders of the organisation. Instead of focusing on efficiency, these measures focus on value based effectiveness cutting across the entire organisation. Table 3 gives the differences between performance measurement system for the traditional and BPR led system.

Innovation in Organisational Structure: Mechanistic Vs Organic Organisation

In a BPR led organisation, workers make decisions. The worker at the work place takes up full process responsibility and works towards satisfying the customer and is empowered to innovate and improve. This leads to the elimination of number of occasions where the worker has to obtain the approval of the manager. Taking right decisions at the right place at the right time becomes the part of the integrated management system. The workers use their heads and hands simultaneously bringing a symbiotic effect to the work process. Planning, execution and control are not separated by organisational boundaries which vanish. In such organisations, work is performed where it makes the sense, checks and controls are reduced and reconciliation is minimized while many activities are combined.

BPR completely transforms a mechanistic, procedure-led and bureaucratic organisation into a people-led organisation with focus on processes and having an organic outlook. There is an emergent need for a shift from a mechanistic organisation to an organic model if BPR is to be in place. This kind of shift has

tremendous implications for Human resource management and development. Organic design of organisations will demand the following skills from the Industrial engineers:

1. Systems thinking—they must harmonize the hard and soft information, combine analysis and intuition and balance multiple interest of the stake holders.
2. Inter-cultural competence—as organisations become part of the global market and increase their dependence on other economies, inter-cultural competence becomes a significant requirement.

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Innovation in outlook towards systems: Standards Vs Break Points

In classical framework, emphasis is on standards and uniformity. However, in BPR the innovation is to focus on break points. A BPR initiative can be driven by one of the following three different business goals:

1. Process improvement can lead to dramatic cost reduction in non-core processes far beyond what can be accomplished through traditional cost-cutting efforts.
2. Within the core business process, the reengineering effort is usually aimed at reaching the "best in class" Attaining competitive parity with those who have in past set standards and made the rules of the competition.
3. The attempt is made to find and implement the Breakpoints, to change the rules and create the new definition of the best-in-class for all others to try to emulate.

It is important for management to look at all of these business goals when determining the direction of BPR effort for a number of reasons. First, not all of the companies will find breakpoint opportunities in operation, even if they are achieving them is another matter. Second, not all companies will feel it is appropriate to put in the time, effort and the cost of trying to achieve the breakpoint. And third, there are

almost always opportunities for cost reduction in improving non core process and usually big opportunities to increase competitiveness by improving core business process.

A clear definition of breakpoint is necessary. A breakpoint is the attainment of superior performance in one or more value metric where the market place clearly recognizes the advantage, the where the ensuing result is disproportionate and sustained increase in the competitor's support service, value chain, finance as well as information systems etc. To achieve breakpoint, it is imperative to manage the core business process in both their operational aspects and the way they connect the customer or the supplier to the company's internal operations in the value chain.

Some of the breakpoints may be characterized as: (i) robustness, (ii) price, (iii) lead time, (iv) flexibility, (v) process design, (vi) reliability, (vii) product design, (viii) service empathy and (ix) information systems.

Innovation in Organisational Focus: Myopic Manipulations Versus Strategic Learning

In the classical organisational set up, management had a myopic outlook and 'managing' had negative connotations. The role of a manager was manipulative and he/she enjoyed playing one group versus another in the organisation. However, in today's competitive scenario, with a strategic focus on 'learning', the BPR has enabled to have a focus shift from a myopic outlook to a long term strategic focus on group learning. This is effected by having an array of focused and high performance teams. These learnings are indeed organic and help an organisation to capitalise on its knowledge base. This base helps in streamlining a process, having a relook at these processes and trying to change these processes in a radical manner. In this context, it is very important to realise that people are the greatest asset for any enterprise (Herzong, 1991). But often, the notion is merely empty rhetoric. Companies that seek to create and pursue new paradigms, attempt to defunctionalize by redesigning process-driven work flows and wishing to effect new break points or finish lines need to make sure that they fully take advantage of their greatest asset. The human development with breakpoint-oriented companies must go beyond producing merely "empowered" employees to the development team to another, who can enhance performance status on any project and who in turn can use their competencies in each task so that it can help them in future too.

Innovations in the Improvement Path followed: JIT, TQM and BPR

There are a lot of commonalities and also distinctions among the three, but they all belong to process management family. Just-In-Time is a manufacturing philosophy that calls for total reorganisation of the operations, activities in order to minimize wasted, "non-value adding" activities, align and balance operations to demand. In JIT improvements are focused on individual functions and continuous improvement is always the watchword and dominant motive. TQM seeks to create an atmosphere in which "doing right thing right first time and every time" becomes the goal. Quality is designed and built into each activity rather than being inspected in after the event. It involves every individual, every department, every level and the total enterprise. The focus is always on reducing the cost of quality by developing continuous improvement mindset to bring about zero defects, zero wastes, zero down time etc.

BPR is the means by which an organisation can bring radical change in the level of performance as measured by cost, cycle time, service and quality, by applications of variety of tools and techniques that focus on the business as a set of related customer oriented core business processes, rather than a set of organisational functions. BPR escalates the efforts of JIT and TQM to make the process orientation of management a strategic approach in the most contemporary and futuristic angles.

A core business process, as distinct from other processes is a set of inter-linked activities that crosses functional boundaries having interfaces and when carried out in concert, addresses the needs and expectations of the market place and drives the organisation's capabilities. Reengineering of these core business processes takes place when operational, technical and business knowledge are all used in a unified manner to sustain competitive advantage in the ever changing milieu.

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BPR differs from TQM and JIT in the following significant ways:

1. The adoption of TQM and JIT though results in balanced operational activities and minimizes the bottlenecks but they fail to overcome the bureaucratic nature and ritualistic pattern of operating the business. BPR attempts to break the absolute functional walls by providing an understanding to one and all about the ultimate goals, the ways of getting there, the ways in which success will be measured, the working in cross-functional teams, and appreciate the values.
2. BPR provides a new definition of operational excellence which helps to destroy the old tenets. This provides internal drives and external focus so that the customer and the supplier receive more attention.
3. BPR pushes the JIT and TQM approaches both upstream and downstream to the customer and supplier (end-to-end) in order to either add value in the supply chain more effectively or to penetrate into market more aggressively so as to eventuate operational excellence to such an extent that it can provide new opportunities in the market place and outside environment.
4. BPR requires corporate leaders not only to discover new avenues but to eliminate non-value added activities by challenging the very purpose, principles and the basic assumptions on which the systems are founded.
5. The traditional TQM and JIT often fail to break the functional barriers and engage the individuals in improving the process.
6. BPR examines and analyses the work flow structure of a process incisively and reconstructs them with the capabilities of IT systems as necessary. It cuts across the functional boundaries and integrates the processes from beginning to the end across the organisational boundaries.

A comparative picture between TQM and BPR is presented in Table 4. It can be only said here that BPR, as a strategic cross-functional initiative must be integrated with others if it is to succeed. Therefore, there is a strong linkage between TQM, JIT BPR, all aiming towards enhancing competitiveness of organisation through change mechanisms. Competitiveness is a multiplicative function of competitive assets and competitive processes. In effect, BPR is 'TPQM', i.e. "Total Productivity and Quality Management" which is in line with our

fundamental concepts and generic principles of Industrial Engineering which have evolved over the last so many years by the profound contributions made by academicians and practitioners.

Table 4: Comparison Between TQM and BPR

Characteristic	TQM	BPR
Customer Focus	Very Good	Essential
Elimination of "silos"	Ignored	Central
Continuous Improvement (Kaizen)	Very Good	None
Training	Universal	Significant
Use of Teams	Very Wide	Marginal
Improvement of Team members	Encouraged	Vital
Integrated Overall Process	Marginal	Central and Significant
Expected Improvement	Medium	Very High

The symbiosis of belief systems, value systems, and behavioural transactions of people and leadership style or management pattern is the essence of organisational culture. The kind of organisation that is more likely to succeed on BPR initiatives is the one that already has a high degree of:

- Leadership that can articulate a vision, drive the values and create a harmonious climate in which business unit executives, managers, line personnel can all generate homogeneous tones and rhythms, grow, flourish and make a profound impact on the way work is carried out.
- share values;
- teamwork at all levels;

Based on the discussion so far, we now propose a model for BPR.

BPR Model

A total systems intervention is called for critically re-examining the existing business processes both in terms of depth and width by focusing upon competition, customers and change. An Organisational Development (OD) initiative is necessary to make a total systems intervention for creating organisational help mechanisms to identify problems, design business solutions and experiment them. We view here that, the reengineering is basically a multidimensional problem solving approach which must be undertaken by a cross functional team. We have scanned the BPR literature, but we could not

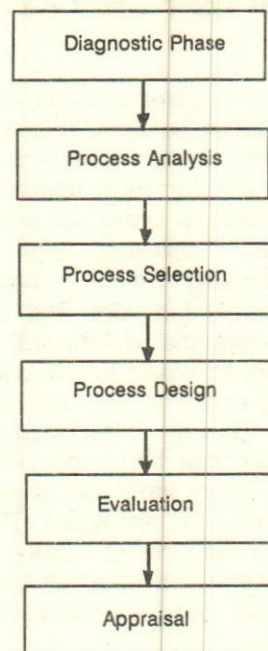


Fig. 2. A Model for BPR

find a well defined framework reported in the literature which can easily be adopted and used. This framework is depicted in Fig. 2. The implementation is through OD which is a structured intervention process that help organisations to improve themselves through facilitation. There are various phases involved in the administration of this model for reengineering. These include: Diagnostic phase, Process analysis, process selection, Process design, Evaluation and Appraisal after the implementation process. Each of these phases are described below.

Diagnostic Phase

The objectives of this phase is to critically analyse the business functions in view of the total systems context. The tasks involved in this phase included: definition of various functions, identification of the elements associated with it and their quantification. Through OD interventions such as brain storming sessions, Nominal Group Technique (NGT) sessions involving all the stakeholders in the organisation the identification and structuring of the problems can be done. The principal motivation for this may stem from the fact that any reengineering exercise, if it has to be successful, must have a great degree of commitment and involvement of the stakeholders so that implementation becomes easy. Initially the executives may be reluctant but later on as they progress in the exercise, there could be a sea change in their attitude, and discernible changes in their behaviour pattern could be noticed. This may be

reflected in enhanced interaction, sharing of knowledge, inquisitiveness of the people involved and application of the knowledge base to understand and appreciate the business functions in totality.

To achieve these objectives, it is necessary to identify and structure the problems through the analysis of Critical Success Factors (CSF), by which one can identify what problems are important to an organisation. CSFs are the vital and critical few where things must go right if the business is to flourish. For any organisations, there exists a limited number of areas in which results, if they are satisfactory, will ensure competitive performance for the organisation. Executives drawn from Materials, Design, Engineering, Customer support, Maintenance, Production and Accounts/Finance, Sales etc. may be involved to identify the CSFs. After a detailed but involved brain storming session, the team members could identify the set of CSFs.

Process Analysis Phase

All processes need not be considered for change. The objective here is to identify those key core processes which require change/redesign and which have maximum effect on the entire system.

Objectives of this phase are:

- (i) To identify key processes
- (ii) To analyse key processes
- (iii) To map these key processes (this could be done through the tools required for process mapping, such as Business Activity Maps, Flow chart, Cause-effect diagrams etc.)

The source of enterprisewide change may come from top management, or, it could also be guided by the corporate strategic plans. These changes would guide the selection of processes for redesign effort.

Process Selection Phase

The objectives of this phase are:

- (i) To identify a team responsible for process selection
- (ii) To investigate the processes selected in earlier phase

The tasks involved in this phase include: forming teams, initiating and actively engaging the team members in the design phase, identifying the non-value adding elements in a process and simplifying the same.

We have used various steps for effecting the organisational change. The approach is to break up the entire procedures into processes. These processes can then be redesigned or even be eliminated. The idea is to get quantum benefits which may be of the order of 100 per cent improvements over the existing processes. The procedure used for reengineering depends on the complexities and structures of the processes involved. The cross functional team may consist of people from purchase, stores, shop floor, accounts/finance and inspection.

Process Design Phase

It is important for management to look at all of these business goals when determining the direction of BPR effort for a number of reasons. First, not all the companies will find breakpoint opportunities in operation, even if they are achieving them is another matter. Second, not all companies will feel it is appropriate to put in the time, effort and the cost of trying to achieve the Breakpoint. And third, there are almost always opportunities for cost reduction in improving non core process and usually big opportunities to increase competitiveness by improving core business process. Fig. 4 shows the simplification process by using IT and eliminating non-value adding activities.

A process consists of an activity, or a set of interrelated activities, intended to transform one or more inputs—at least one of which represent customer requirements—into one or more outputs. Reengineering represent solution from the internal or external customer's point of view. These are often cross functional and involve flow of information and tangible items. However, it is not an easy task to identify processes requiring immediate attention for such an exercise, approach for BPR.

Evaluation Phase

The objectives of this phase are:

- (i) To quantify various attributes related to a process before and after the redesign
- (ii) To identify non value adding activities
- (iii) To simplify the process based on the (ii) above.

The activities of a process can have many metrics. Basically, a process is analysed in its full detail by partitioning it into value adding and non-value adding activities. By elimination the non-value adding activities, the process is redesigned. After simplification, use of Information Technology can be made to further expedite the activities. The combined

result of these efforts would enable to have a simplified process in its place.

Implementation Phase

The objectives in this phase are:

- (i) Based on the redesign processes devise an implementation plan,
- (ii) Carry out the implementation plan the implementation plan was identified by each individual group.

Appraisal Phase

The objectives of this phase are to appraise the BPR efforts through the benefits visualised so that the team members and top management can be convinced about the utility of such effort.

Concluding Remarks

BPR is a comprehensive change management programme. Companies introduce change management programmes without making proper preparation. Although, there is an urgency for transformation in organisations, most organisations lack common knowledge of applications of Industrial/Systems engineering in managing change. Even if in some organisations such knowledge exists, there is no forum for exchange of knowledge. BPR can succeed only in a learning environment.

Productivity gains are achieved through quality and conformance to correctly defined requirements satisfying user needs. The interconnection between quality and productivity is well known. Productivity and quality is an integrated process involving both management and employees with the ultimate goal of managing the design, development, production, transfer and use of various products and services in both work environment and market place. BPR adds value innovations in the productivity and quality interface by radically looking at the processes and questioning them forthrightly with a view of eliminating the non-value adding activities. Thus

Productivity gains are achieved through quality and conformance to correctly defined requirements satisfying user needs. The interconnection between quality and productivity is well known.

the gamut of BPR goes beyond simply improving quality/productivity. BPR requires a mindset of 'change'. BPR as a change management approach requires six different strategies that can work in specific situations.

1. Evolving a mind-set for BPR

This strategy focuses on the indirect and contextual factors such as values, structure, and performance measures—that can drive change through the existing authority structure of the organisation. This strategy works well in established companies with highly knowledgeable professionals.

2. Creating a sense of urgency for abrupt change

This strategy works well when the Organisation is prepared to shake up the existing power structure and delayer the existing top management and redefine business missions.

3. Following the industry leader

This strategy is used to bring quick changes by following the best industry practices through benchmarking (inter-firm comparisons: Klien (1993), Richards and Koontz (1993)). This strategy works well in aligning the attitudes of people and overcoming the barriers to change management.

4. Directing the efforts in multiple dimensions

Organisations having very strong core competencies plan their BPR efforts across a broad set of fronts. They design it top-down, focusing primarily on a number of direct issues: generate the maximum immediate financial impact, and then move forwards indirect and support issues. Such companies face steep challenges, are often driven by specific target and overall require high energy level to achieve change.

5. Redesigning systematically

This approach to change is a very planned intervention process where-in efforts are made to analyze, investigate and redesign issue by issue and then integration is sought for. This strategy is always time consuming but ensures big returns.

6. Mobilising front-line high performance action teams

The priority here is to promote change by means of front-line problem solving teams rather than top-directed management approach structured transactional processes are used to respond to the clients and bring improvements in deliver, cost, revenue and

asset utilization etc. This strategy works best in service organisations.

BPR like IE is supposed to address the application of scientific and engineering knowledge to the solution of organisational problems. However, BPR has a focused charter. The integration of knowledge throughout the total organisation as a source of sustainable competitive advantage is implicit in BPR. Knowledge is not the power, but ability to use knowledge for the benefit of the stakeholders is really the power. Therefore, BPR should be viewed as a strategic tool for knowledge management i.e acquisition, deployment, development, and delivery etc. of course with implications to multiple stakeholders. BPR in its very nature of process orientation requires executives to evaluate knowledge potential, inter-departmental cooperation and teamwork. However, executives have not developed appraisal systems to measure the so called unmeasurables.

Based on these observations as indicated above and drawing knowledge from the literature 5 broad phases of organisational change can be identified.

- Organisational impetus for BPR
- Initiating Inside—in changes
- Selecting critical success factors for enabling change
- Evaluating implementation conditions
- Directing the change effort in: Structural, people, arrangement and system dimension.

BPR is an umbrella which encompasses information and communication technologies that strives to attain organisational transformation with a sense of urgency. Therefore IE needs a jolt and refocus to restructure itself in terms of context and content to position under the broader framework for promoting innovation across the entire value creation in the context of competition and change. We have to recognize that skills and motivation of people and clarity and efficiency of information are important key aspects for improvement. We must enhance the 'value' of the products and services in order to sus-

BPR is an umbrella which encompasses information and communication technologies that strives to attain organisational transformation with a sense of urgency.

tain the competition. BPR recommends various value innovations in this pursuit.

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"American Management has problems as deep as the Grand Canyon, but there are a handful of companies—from Hewlett-Packard to Johnson & Johnson to 3M—that really are doing it right."

—Tom Peters and Bob Waterman

Motivation Levels Among Personnel Executives in Public Sector

Sunil K. Dhawan

This paper elucidates the factors influencing the motivation levels of personnel executives. The significant factors as obtained from a factor analysis of survey data are growth, performance profile of lower staff and stress. Factors and forces which contribute to the motivation of personnel executives are also examined. These factors and forces are found to vary across different units of public sectors. The study was carried out in nine units of five public sectors in India.

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Introduction

A reading of the available literature in the field of personnel and industrial relations indicates that there exists a definite need for studying the motivation levels of employees of the personnel department (Ling, 1965; Milton, 1970; Nash and Miner, 1973). However, few studies have dealt with this aspect. For example, Patten (1972) hypothesized that the net result of these "non-managerial" posts within an organisation have been to produce "managers" who lack the will to manage. Miner (1976) examined the rating of motivation items of 234 managers who had spent a majority of their careers in the personnel field. His results indicated that the motivation to manage is relatively low among personnel and industrial relations managers. Other studies have also shown low level of motivation among the personnel executives.

Table 1: Background Information of Five Units

Type of Unit	Manpower	No. of executives in P.D.*	No. of Trade Unions	Financial Position
Mining	13,000	16	4	Profit Making
Heavy Engineering	12,000	17	4	Profit Making
Fertiliser	7,160	45	15	Loss Making
Mining	12,000	16	4	Loss Making
Manufacturing	3,256	20	2	Loss Making

* P.D.: Personnel Department

The present paper examines the factors influencing the motivation levels of personnel executives in the Indian context. Its aims are, first, to determine factors and forces which significantly contribute to the motivation of personnel executives and secondly, to examine these factors and forces across different units of public sectors. The study was carried out in nine units of five public sectors in India. Some key background information of these units are presented in Table 1.

Motivation Process: An Overview

Kleinginna and Kleinginna (1981) have gathered no fewer than 140 definitions of motivation that have appeared in the literature. Some of these definitions are hopeful and others are skeptical. For example, Vroom (1964) defines motivation as "a process governing choices made by person or lower organisms among alternative forms of voluntary activity". On the other hand, Bolles (1975) suggests that motivation seems to be neither a fact or a behavior, but rather an idea or concept we introduce when we undertake to explain behaviour". This definition places the motivation construct in the role of a heuristic device, useful only for communication. In a decidedly more negative vein, Dewsbury (1978) proposes that the "concept of motivation tends to be used as a garbage pail for a variety of factors whose nature is not well understood".

In general, effort, expenditure, absenteeism, satisfaction, job choice, career choice, and performance have been considered, by some, to be motivated behaviours, because they assume the role of dependent variables in motivational research.

It is found that there is a general agreement among social scientists that motivated behaviour consists of any or all of the following behavioural elements: initiation, direction, persistence, intensity and termination (Staw & Cummings, 1990). In spite of this general agreement, however, different theorists and researchers are more interested in one aspect than in others. One researcher might be interested in only the motivational foundations for employee absence (e.g., Chadwick-Jones *et al*, 1982); a second might be concerned with how an individual chooses between two courses of action (Vroom, 1964), and a third might be concerned with predicting self-reported intensity or effort (DeLeo & Pritchard, 1974).

It is felt that five-cluster working taxonomy of motivation as suggested by Staw & Cumming (1990) with the following categories will be useful: need theory, reinforcement theory, balance theory, expectancy theory and goal-setting theory. This taxonomy has been useful in earlier reviews of motivational theory and research also (Landy & Trumbo, 1976, Landy & Trumbo, 1980; Landy, 1985). These five categories are sufficient for including most of the research and theorizing that characterize modern motivation theory.

Further, one should note that almost all the research suggests that people need more from their work than their pay packets, and value interesting work. A study by the MOW International Research Team (1986) showed that between 65 per cent and 95

per cent of employees in Belgium, Britain, Israel, the Netherlands, Japan, Germany, and the United States told that they would continue working even if they had enough money to live comfortably for the rest of their lives.

Similarly, Nicholson and West's (1988) survey of 2,300 members of the British Institute of Management shows that although managers aged 25 to 40 are switching jobs on average every 3 years, money and high position are not their prime motives for making the change. These factors are well down a list of 17, below a quest for challenge, recognition, learning opportunities and creativity.

Although managers aged 25 to 40 are switching jobs on an average every 3 years, money and high position are not their prime motives for making the change. These factors are well below a quest for challenge, recognition, learning opportunities and creativity.

And research conducted in the United States in 1946 and 1986 by Kovach (1987) showed similar results among industrial employees—ranging from unskilled blue-collar workers to skilled white-collar workers.

The under 30 group chose good wages, job security, and promotion and growth as their first three choices. This could indicate that these new workers have not yet fulfilled their basic needs as proposed by Maslow need hierarchy theory. When the under 30 group is compared with other groups, it is interesting to note that the 31-40 group still place job security high on their hierarchy of values but that this basic need becomes less important as one moves up through the age groups. Kovach (1987) also reported on rankings made by these employees' direct supervisors. The supervisor were asked to order job rewards as they believed that their employees would rank them. Supervisors' assumption about employees' values changed very little over the years.

A comparison between this ranking and employees' ranking for themselves demonstrates that supervisors often have inaccurate perceptions of what motivates their subordinates. Similar discrepancies between management perceptions and self-reported needs are found by Gluskinos (1970), Dhawan (1995), etc. Of course what goes into the pay packet is the responsibility of top management, and not of line supervisors. And so it seems that supervisors nominate

as most significant those motivators (good wages and job security) for which they have least responsibility for providing, and the absence of which reflects least on their own performance.

Finally, the failure to correctly assess subordinate needs has implications in situations where individuals have different experiences, including cultural experiences. The data show that management can easily make mistakes in identifying the needs of their own work force, within their own culture and with similar values. Hence we should expect even greater error to occur when management has to analyze the needs of employees with different values and expectations.

In general, the greater the level of poverty, the greater the importance attached to the resources needed to sustain life. Singh and Wherry (1963) showed that in Indian companies, the lower the worker's rank and income level the more importance given to satisfying basic physiological needs. But at a later stage, Jaggi's (1979) study of Indian managers found that experience was a significant factor. Younger managers, below the age of 35, showed much greater needs for esteem and autonomy in their work than did their less dynamic elders, who attached greater importance to job security.

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Methodology of the Study

A set of seven questionnaires were used to obtain ratings of personnel executives on motivational items. The questionnaires were developed by England (1979). All questions were on 5-point scale with 1 indicating 'to a very little extent' and 5 indicating 'to a great extent'.

Questionnaires were distributed to personnel executives of the rank of assistant personnel officer and above of eight units of different public sectors. Anonymity of the respondents was maintained. However, the return of filled questionnaires was not very high and only 30 per cent of the respondents filled the questionnaires. Because of small sample size, we have clubbed three manufacturing units. For reference, we are classifying the units as A, B, C, D and E. The num-

ber of filled questionnaires (unit/cluster-wise) are presented in table 2.

Table 2: Unit/Cluster wise returned questionnaires

Unit/Cluster	Type	No. of Filled questionnaires
A	Mining	11
B	Heavy Engineering	16
C	Fertiliser	14
D	Mining	11
E	Manufacturing	10
	Total	62

To understand the various results more meaningfully, the authors selected two units for the purpose of case studies. These studies are based on personal interviews with various managers, union leaders, etc. All questions were open ended and content analysis methodology was used to codify them.

Analysis

For the purpose of analysis, Statistical Package for Social Sciences (SPSS) developed by Chicago University was used. First factor analysis with varimax rotation was used to test the reliability of the questionnaires and to determine cluster of variables indicating similar items. This helped identify the significant factors influencing the motivation levels of personnel executives and also, percentage of contribution made by each of these factors to overall motivation. The inter-factor correlation coefficients were calculated to examine the interrelationship among the factors obtained from the factor analysis.

For comparison across the units of public sectors, mean scores for each unit and for each factors have been computed. Comparison is then made using Analysis of Variance (ANOVA) technique. Further, inter-factor correlations are calculated for each unit and results are then examined with some of background information of the units. It should be noted that our analysis will be only for factors obtained from factor analysis.

Results

Three significant factors were obtained from factor analysis. These are Growth, Performance Profile of Lower Staff and Stress (Fig. 1). Growth contains nine variables/questions. All the nine questions were of the form, 'to what extent your job contains'—responsibility, ability to use knowledge and training, use of innovative

measures etc. High scoring for these questions indicates high opportunities in the work system whereas low scoring means low opportunities.

Performance Profile of Lower Staff gives the views of personnel executives on characteristics of lower level employees of personnel departments. This factor contains eight variables relating to ability of the lower level staff to set own goals, job control, flexibility of work etc. High scoring for say, goal setting, means that the personnel executives feel that lower staff is capable of contributing meaningfully in setting their goals.

Stress includes three variables relating to workload, physically strenuous work and mentally strenuous work. The results of factor analysis are presented in Table 3. From this table we find that Growth explains maximum variance in job characteristics (28.6 per cent) followed by Performance Profile of Lower Staff (15 per cent) and stress (11.2 per cent). The three factors combinedly explain 54.8 per cent of the variation in job satisfaction/motivation of the personnel executives.

Table 3: Results of Factor Analysis

Indicator	Eigen Value	% of Variance	Cumulative %
Growth	8.56	28.6	28.6
Performance Profile of Lower Staff	4.50	15.0	43.6
Stress	3.34	11.2	54.8

Inter-factor correlations are given in Table 4. One significant correlation between growth and performance profile of lower staff is obtained. The sign of the correlation is negative which indicates that personnel executives have perceived that better performance of lower staff will reduce their growth opportunities. The causes may vary from one public sector to another. Two points are important. First, the types of work which different levels are performing in a personnel departments are of similar nature. Giving freedom to lower level in terms of setting goals, job control etc. may have been seen as threat by personnel executives for their own positions in the department.

This may be one reason for the personnel executives, in addition to their work, also performing the job of lower level employees. Secondly, personnel executives have a high level of responsibility in their job. Also, their dependence on lower level is high as the records and files are maintained by the lower staff. A pressure for information from higher-up on the personnel executive requires immediate support of lower staff. Loose job control may create delay in furnishing that information.

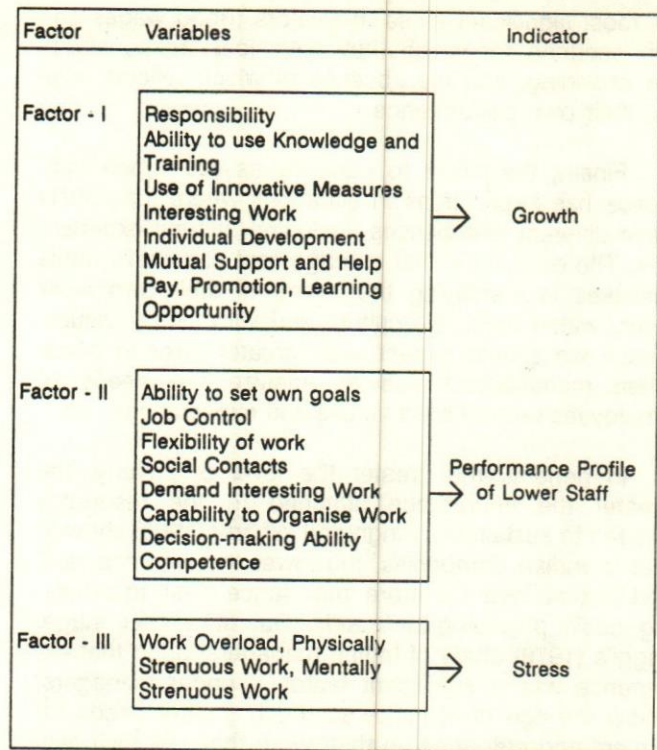


Fig. 1. Variables and Indicators of Perceptions of the Employees of Personnel Department

Table 4: Inter-factor Correlations (N = 62)

Factors	Growth	Performance Profile of Lower Staff	Stress
Growth	-	-	-
Performance Profile of Lower Staff	-0.31*	-	-
Stress	-0.11	0.10	-

*Significant at 5% level

Table 5 gives the inter-factor correlations unit-wise. Some interesting results are as follows:

- Relationships among the three factors are different for the four units. For A, first and third correlations are significant, for B, no correlations is significant, and for D only second correlation is significant. Thus the three factors behave differently in these four units.
- Negative significant correlation between Growth and Performance Profile of Lower Staff found in Table 4, is also found in A. For C & D, the correlation is negative but not significant.
- For C & D, Growth is positively related to Stress indicating that increase in growth opportunities can lead to high stress of personnel executives.

- For A and C, Performance Profile of Lower Staff is positively related to Stress. This indicates that better performance of lower staff can also increase stress for the senior personnel executives.

Table 5: Inter-factor Correlations Unit-wise

Relationships	A (N = 11)	B (N = 16)	C (N = 14)	D (N = 11)
Between Growth and Performance Profile of Lower Staff	-0.59*	0.09	-0.14	-0.36
Between Growth and Stress	0.20	0.09	0.61*	0.75*
Between Performance Profile of Lower Staff and Stress	0.54*	0.05	0.89*	0.36

*Significant at 5% level.

Comparison of the unit on existing perceived ratings given by personnel executives are given in Table 6. It provides the means and standard deviations on the three factors for five units. Analysis of variance is used to compare these means. F-values of analysis of variance are given in the last column of the table. One significant factor is found, namely stress. From mean scores, we found, stress is high in A and B, and is medium for other units.

To test differences in mean score for two units at a time, t-test was used. Following results were obtained:

- Growth opportunity is significantly low in Unit A.
- Growth opportunity is comparatively high in Unit B.
- Performance profile of lower staff is significantly low in Unit D.

Case Study-1

Unit 'A' is a mining enterprise, with three different

establishments, located some 10 to 30 kilometers from each other. Two of these establishments were under foreign control for more than 45 years, whereas the third establishment, often called a project was under government control. During private ownership, the personnel activities were restricted to recruitment of workers and welfare of management particularly the foreigners. The company was nationalized in early 1972 and a formal personnel department started functioning at different establishments. People from other public sectors were also recruited in the personnel department.

At present 20 officers are looking after personnel management, industrial relations, welfare and administration of about 12,000 workers. The organisational structure of the personnel department is given in Fig. 2 (establishment-wise). The dark dotted lines indicate the informal functional relationships among different executives.

To understand low growth opportunities as perceived by personnel executive, first, let us consider the extrinsic variables. A large majority of employees of this department are working from the private ownership period. Promotions during that period were based on personal loyalty to the company. With the result, many people have reached their maximum of pay scale. Some amount of stagnation has taken place for them. Further, Fig. 2 suggests that the organisational structure is somewhat flat. Promotions are not time-bound but based on vacancy. Therefore, the promotion prospects are also limited for the personnel executives.

Coming to job related growth opportunities (Fig. 2), it is found that interaction within as well as between establishments is limited. This restricts their learning opportunity from their own organisation. Further the mines are located at a distance from the personnel department. The personnel executives do not usually visit the mining area. The problems which could be solved at the work place itself, receives attention only when related papers reach the personnel department. Thus, part of the low growth is also due to lack of employees initiative/involvement in the organisation.

Table 6: Results of Statistical Analysis of the Three Factors

Factor	A (n = 11)		B (n = 16)		C (n = 14)		D (n = 11)		E (n = 10)		F-Values
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Growth	3.71	1.15	4.80	1.11	4.60	1.04	4.51	1.68	4.39	0.99	1.27
Performance Profile of Lower Staff	4.12	0.66	4.40	0.81	4.02	0.81	3.24	1.44	4.28	0.85	2.37
Stress	5.27	0.79	4.21	1.31	3.67	0.71	3.79	1.51	5.42	0.95	4.06*

*Significant at 5% level

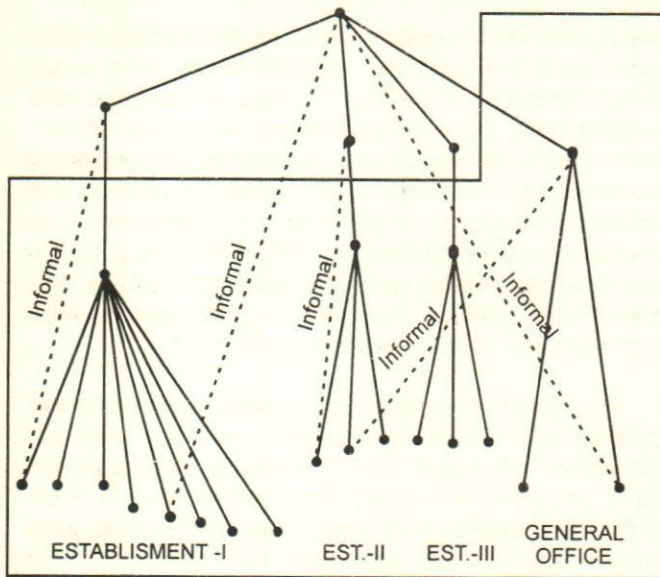


Fig. 2. Organisational Structure and Functional Relationships for Unit A. Box indicate the personnel department of A

Perceived performance profile of lower staff is medium. If one examines the functional relationships among different levels and employees of personnel department, it is found that many employees report directly to higher-up and ignore some levels between them. In a way, this reduces the delay in work. But further investigation will reveal that these jumps of levels exists between employees working from the foreign ownership period. Some sort of "faith" has been developed between old employees and this, to a great extent, decides the job allocation and performance profile. In fact, there are two groups in the unit—one consisting of old employees; and the second recruited from other public sectors. Thus perceived performance profile depends on functional relationships and faith/loyalty.

Some sort of "faith" has been developed between old employees and this, to a great extent, decides the job allocation and performance profile.

Stress is high in unit A mainly because of following reasons:

- (1) The size of the department is small as compared to size of the work force and the widespread location of mines.
- (2) The industrial relations situation is drastically changing. Workers have seen both private as well as public sector functioning system. They

have organised themselves into a number of trade unions. Various political parties have also shown interest in the area. These changing industrial relations have not found a proper attention from the management. The conflicts between management and union are also increasing.

- (3) Personnel executives feel high responsibility in the work system but the chances of using their knowledge and skill is low. This indirectly increases their stress.
- (4) High workload is also due to improper recording and maintenance of files.

Case Study-II

"B" is a heavy engineering unit of a large public sector. The Personnel Department has a matrix structure. Four cells have been created under each of functional heads. These cells are headed by a coordinator who looks after all personnel affairs like establishment, industrial relations, welfare etc. relating to his cell. In addition, the coordinator is an expert in one of the personnel activities. Whenever other cells face problem in that area, the expert has to provide assistance and guidance to that cell.

Perceived growth opportunities is high. Now if one looks at the functional relationships of four cells (Fig. 3).

Now responsibility is high because each coordinator and his colleagues are responsible for all day to day issues of their cell. Further, the coordinator who is, say expert in industrial relations, has to provide assistance in industrial relations to other cells. The mutual interactions among the four cells also increase the mutual support and help among employees of personnel department. If vacancy exists in any cell, employees from other cells are also eligible, which indirectly increases the promotion prospects in the organisation.

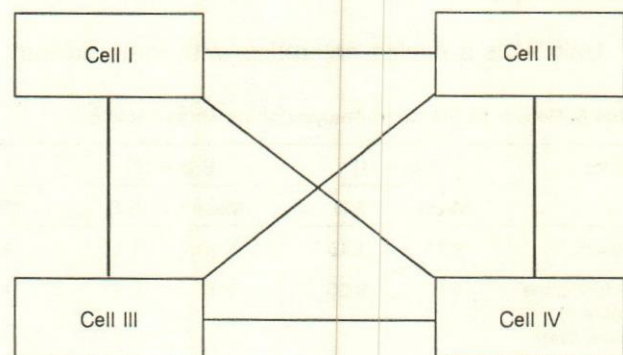


Fig. 3. Inter-cell Relationships in Unit 'B'

Further, promotions are time-bound. Finally, with all these variable combined plus variety of work make the job interesting and enjoyable. Thus we find that growth depends on: (i) Structure of personnel department; (ii) Functional relationships of different sections/cells; and (iii) Mutual support and help.

High performance profile of lower staff is being seen as threat by the personnel executives and also because of high responsibility, the personnel executives do not want to give complete control to lower staff. Consequently, performance profile of lower staff is medium. Again stress is medium in unit B. The location of personnel department is inside the factory building; therefore routine problems are solved at the workplace itself. Though there are four unions, major industrial relations problems are dealt at the apex level with union leaders of all the units. Proper maintenance of records and mutual support and help is yet another item which probably lowers the stress.

High performance profile of lower staff is being seen as threat by the personnel executives and also because of high responsibility, the personnel executives do not want to give complete control to lower staff.

Discussion

Results of the analysis indicate three major areas of motivation amongst personnel executives: Growth, Performance Profile of Lower Staff and Stress.

Growth deals with two aspects: extrinsic satisfaction like pay, promotion etc. and intrinsic satisfaction in terms of learning, ability to use knowledge etc. In a way growth covers career planning/development of personnel executives.

Performance profile of lower staff brings out the opinions of personnel executives about the work system and performance of junior staff. The concept of job enrichment, job redesign is covered under this heading.

Stress in a work system can be due to many reasons. We have considered only three key items: overload of work, physically strenuous work and mentally strenuous work. The consequent effect of stress has been found on items like work attitude and absenteeism from work place.

Further the analysis indicates that relationships among these factors and motivation levels of individuals

differ from unit to unit. We selected two case studies which provide following dependence of parameters:

(a) Growth

- (i) History of the department and organisation
- (ii) Structure of personnel department
- (iii) Functional relationships among different sections
- (iv) Location of personnel department
- (v) Mutual support and help

(b) Performance Profile of lower staff depends on:

- (i) Functional relationships among employees of personnel department
- (ii) Loyalty/faith of lower staff
- (iii) Threat to own growth.

(c) Stress

- (i) Size of personnel department
- (ii) Industrial relations situation
- (iii) Mutual support and help
- (iv) Location of personnel department
- (v) Maintenance of records and files
- (vi) High responsibility.

Note that some items appear in more than one factor, this is because of inter-linkages of these factors.

Constraints

There are some limitations of the present study. From Table 3 it is found that the three factors explain only 54.8 per cent of the needs of personnel executives. Thus 45.2 per cent of needs are explained by some other factors which we have not included in our questionnaires. It is proposed that two more factors which are important for personnel executives motivation, viz., 'images' of personnel executives and the 'role' of personnel department/executives be included in future studies.

The images as reflected by the study of nine units are very depressing. A CPM (Chief Personnel Manager) was referred to as "Chief Post Master" by some managers and union leaders. Personnel Department was often referred as "Callous" and "Politicized"

department. Such phrases, in fact, reflect the differing expectations of various groups. To quote an example, the state government decided to go in for five-day week due to petrol and diesel shortage. The union representatives expected the management to implement what was negotiated with them. "Implementation" was the expectation of the government, while "negotiation" was the expectation of the union. The role or activity of personnel department may be to satisfy such conflicting expectations. The role of personnel department is defined as well as not defined due to differing and often conflicting expectations. This is probably the fifth important factor influencing motivation of personnel executives.

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"For technologists, the lesson from reengineering is a reminder of an old truth: Information technology is only useful if it helps people do their work better and differently. Companies are still throwing money at technology—instead of working with the people in the organisation to infuse technology."

— Davenport

Revitalising Educational System in Uttar Pradesh

R.S. Tyagi

The present paper is based on a survey of educational administration recently conducted by NIEPA in Uttar Pradesh, for highlighting the social and economic factors responsible for the State's educational backwardness. It also addresses some of the major issues of educational planning and management that are confronting the state in achieving the goal of universalization of elementary education and literacy for all. While emphasising the need for better coordination and speedy implementation of the educational programmes at the district level, it is suggested that different aspects of educational planning and management in the state should be strengthened. The study also suggests that there is a need for creating awareness about education among the masses and for empowerment of people by making their participation in planning and management of education at grassroots.

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Introduction

The state of Uttar Pradesh has remained for centuries the heartland of India. Its geo-political situation has not only determined its own history but the history of the whole country. Whether it was the Turks, Moghuls or the British, anyone who occupied this heartland became ultimately the master of the entire country. Uttar Pradesh being the most populous state (13.91 crore persons in 1991) comprises about one sixth of the total population of the Indian Union and possesses the largest education system among all the states and union territories in the country.

In 1991, there were 13 administrative divisions, 63 revenue districts, 294 tehsils, 897 development blocks, 1,12,661 villages and 710 statutory towns. The state is, however, considered not only economically but educationally backward too since almost all economic and social indicators are unfavourable to it. The main factors responsible for the state's backwardness among others being inadequate investments and insufficient growth of human skills as well as inadequate exploitation of its rich natural resources and potentials of high growth. As a result, its per-capita state domestic product declined over the years as compared to the per-capita income of the country as a whole. It was Rs. 3072 at current prices in 1989-90 in the state, which accounts for 27.8 per cent less, as compared to Rs. 4258 at national level. The other factors include: its primary producing economy, rise in growth of population, more than three-fourth of its work force depends on agriculture etc. The human development index of the state, as per the state government estimates, which entails life expectancy at birth, literacy and the per-capita income, remained lowest (0.07) among 14 major states in the country and was 5 times lower in terms of overall national position (0.36) in 1989-90. According to the 1991 census, the state recorded a crude birth rate of 37 per 1000 persons (the highest in India) an infant mortality

rate of 118 per 1000 births (30 per cent above the national average), high maternal mortality and an abnormally low gender ratio of 880 females to 1000 males.

The main factors responsible for the State's backwardness among others being inadequate investments and insufficient growth of human skills as well as inadequate exploitation of its rich natural resources and potentials of high growth.

The plan expenditure on education of the State Education Department declined by a huge margin of 20.7 per cent from 25.9 per cent in 1973-74 to 5.2 per cent in 1993-94 as compared to 17.1 per cent and 8.9 per cent for the country as a whole in these years. It also spends less per-capita funds on education as compared to the overall national position.

Growth of Education

As a result, the growth of education in the state over the years remained below the desired level. For example, the gross enrollment ratio remained lower in the state, that is, 89.1 per cent for all children; 104.3 per cent for boys; and 72.0 per cent for girls as compared to 104.3 per cent for all children; 114.5 per cent for boys; and 93.3 per cent for girls at national level in 1995-96 at the primary stage for the age group 6-11. At upper primary stage for the age group 11-14 these figures were 54.7 per cent for girls in the state as against 67.6 per cent for all children; 79.5 per cent for boys; and 54.9 per cent for girls for the country as a whole.

However, the state had made concerted efforts as the size of its school education system particularly at the primary and middle stages witnessed tremendous growth from 1975-76 to 1995-96, as far as the number of institutions, enrollment and teachers is concerned. The number of primary schools increased by 31.86 per cent from 65,552 in 1975-76 to 86,436 in 1995-96 whereas upper primary schools increased by 80.20 per cent from 10,626 institutions in 1975-76 to 19,148 in 1995-96. Enrollment of children in this period increased from 119.64 lakh to 162.65 lakh at primary level and from 24.87 lakh to 56.29 lakh at upper primary level. The number of teachers in primary schools increased from 2.38 lakh to 2.70 lakh and in upper primary schools from 59 thousand to 97 thousand during the corresponding period.

Disparity in Educational Facilities

This large scale expansion of educational facilities could not narrow the gap of disparities which persist among the districts, as far as the number of schools is concerned. For example, district Moradabad had a population of 41.21 lakh where primary schools per lakh population in 1991 were 45, middle school 6 and, high and senior secondary schools were 3 whereas district Bijnore had comparatively lower population of 24.55 lakh and comprised 51 primary schools, 8 upper primary schools, and 3 high and senior secondary schools per lakh population. Bijnore also comprises smaller area than Moradabad. Similarly, in case of the districts of Varanasi, Allahabad and Devoria, where the population was more than 40 lakh in each district, primary schools per lakh population were 36, 41 and 49, respectively, whereas in case of some smaller districts like Rampur and Mathura where total population was 11 lakh and 19 lakh, respectively, primary schools per lakh population were 51 and 56. It has also been found that district Allahabad, despite being the education capital of the state, has the lowest number of primary schools per lakh population whereas district Mainpuri has the largest number of primary schools per lakh population, that is, 101. Besides, in 1992 there were 6,595 unserved habitations where educational facilities at primary stage were not provided as per norm of 1.5 kms. within the radius of a habitation in plains with a population of 300 or more. Similarly, there were 3,626 habitations or places in the state where educational facilities at upper primary stage were needed within the radius of 3 kms of a habitation with a population of 800 or more.

The large scale expansion of educational facilities could not narrow the gap of disparities which persist among the districts, as far as the number of schools is concerned.

This situation calls for a careful assessment and opening of new primary and upper primary schools in already identified areas in those districts of the state where the schooling facility is lacking. The school mapping and micro-level planning techniques should be the base for providing new educational facilities as these have been adopted in the districts that have already been covered by the Basic Education for All Project in the state.

Out-of-School Children

As per the MHRD estimates, about 59 lakh children

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in the age group 6-11 and about 58 lakh children in the age group 11-14 were out of the education system in the state in 1995-96. It is also important to mention that out of total population of children not enrolled in schools in 6-11 and 11-14 age groups, more than 50 per cent were girls. For instance, at primary level 41.50 lakh girls of age group 6-11 constituting 70.41 per cent of the total out-of-school child population in this age group and 34.9 lakh girls which constitute 59.5 per cent of total non enrolled children in the age group 11-14 were out-of-school. However, the trend of enrollment of children in schools indicates that on an average about 5 lakh children in classes I-V and about 2 lakh children in classes VI-VIII are enrolled every year but since increase in the population of school-age children is higher than their pace of enrollment, the number of children who remained out-of-school is always higher. It is apparent that the education system does not have the capacity to absorb all the school-age children in schools.

Enrollment of Scheduled Caste Children

Apart from this, enrollment of scheduled caste children in the State is also a cause of concern, as out of total 1.18 crore non-enrolled children in the age group 6-14, more than 30 per cent, that is, 37.24 lakh children belong to the scheduled castes. Therefore to attract and retain SC/ST children in school, it is suggested that there is a need to enhance the present rate of scholarships to the students of classes I-XII. The book assistance should be extended to at least 20 per cent scheduled caste students. The recruitment of more scheduled castes, and female teachers would help in attracting children of disadvantaged groups to schools.

The high dropout rate of children from school at primary and upper primary stages, particularly of girls and scheduled caste children is also a major cause of concern. For example, the dropout rate in the state in 1988-89 was 40.89 per cent at primary stage and 50.06 per cent at upper primary stage. In case of girls, it was 48.96 per cent and 65 per cent at primary and upper primary levels, respectively.

Teacher-Pupil Ratio

The ratio of pupil per teacher is also very high in the state which shows that classes in schools are already overloaded and there is a need to provide adequate number of teachers in view of the increasing enrollment. The teacher-pupil ratio was 59 children per teacher in primary schools and 40 children per teacher in upper primary school as compared to 47 children and 38 children in primary and upper primary schools, respectively, at national level in 1995-96.

Low Literacy

Continuous efforts of the state government is, therefore, required not only in providing access to children to school and their retention and achievement but in achieving the goal of education and literacy for all. Since about 60 per cent of total population remained illiterate in 1991, the literacy rates in the state remained lower, that is, 41.60 per cent for all persons; 55.73 per cent for males and 25.31 per cent for females as compared to the overall national position of literacy, that is, 52.21 per cent for all persons; 64.13 per cent for males and 39.29 per cent for females. The problem is all the more serious since illiteracy in the state during 1981-91 increased by 10.05 per cent as compared to 7.27 per cent at national level which indicates that with the present rate of increasing literacy, it would take about 7 decades to make the state fully literate—making the already alarming situation worse than dangerous.

This discouraging picture of the state prevails in spite of the herculean efforts of the state government by conducting various programmes of educational development, like the Operation Blackboard, several incentives and scholarships to children, 'Basic Education For All' Project and the Mahila Samakhyā. The EFA programme which envisages area-specific approach for universalisation of elementary education is at present being conducted in 10 districts of the state and also proposed for 17 more districts as District Primary Education Programme.

Administrative Machinery

The state has been able to set up over the years an adequate educational administrative machinery at secretariat, directorate, regional, district, and block levels for revitalising education. There is an urgent need to equip educational administrators with newer skills and expertise in their work. The educational functionaries at different levels need to be provided with regular and recurrent training by organising orientation and staff development programmes and conducting

Participation in training programmes should be made compulsory for each functionary at district and at block levels. Better coordination is required not only between the basic education office and the office of the district inspector of schools but also with other departments like Zilla Parishad.

refresher courses in respect of preparation of educational plan, financial management including formulation of budget, management of information and in the techniques of better personnel management. Participation in training programme should be made compulsory for each functionary at district and at block levels. Better coordination is required not only between the basic education office and the office of the district inspector of schools but also with other departments like Zilla Parishad, PWD, Planning Office, etc.

Local Level Support

The U.P. Basic Education Act, 1972 envisaged to establish a three-tier structure at district, block and village levels. Accordingly, *Gaon Shiksha Samitis* (Village Education Committees viz., VEC) were formed in each village or in a group of villages in the state with Pradhan of the village as president of VEC to supervise schools and to make necessary recommendations to the Zilla Basic Shiksha Samiti at district. These samitis in the initial stage were constituted with only 3 nominated members (guardians). Thereafter, the state has restructured the Village Education Committees by increasing the number of members from 3 to 8 by nominating 5 more members in the committee. These committees should be made more democratic and need to be formed by the process of election for VEC members (about 7-15 with 50 per cent female participation and others for SC/ST persons) by organising a general meeting of the villagers and should have representation of all groups in the village. The Village Education Committees were made active only in those villages where school buildings were constructed. These VECs lack the democratic representation of people since these are formed by nomination of members rather than election. VECs also lack clearly prescribed guidelines and instructions about their roles and functions. They also do not have any statutory administrative or financial powers and, over and above, the members of VEC do not receive any training.

The president of VEC should not necessarily be the

Pradhan of the village but any person interested in VEC activities. The Village Education Committees formed on these lines should organise their monthly meetings regularly and be responsible for conducting enrollment drives, creating awareness among the parents and general public, supervision of regular attendance of teachers as well as students in schools, etc. They are also to take care of maintenance of school building and arrangement of funds for this purpose as well as for other facilities like drinking water, toilet, gardening, upkeep of school campus, and construction of boundary wall etc., if required in schools, VECs should also be encouraged for mobilising and utilising local resources—the human, financial and physical.

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Planning at District Level

The National Policy on Education (1986) and the Programme of Action (1992) have emphasised the decentralised planning at the district level. For initiating the process of decentralised planning a diagnostic analysis of the educational situation at the block level needs to be carried out identifying factors that help or deter the progress of education in terms of the target groups that have (a) lower participation in education (b) high dropout and stagnation rates and high illiteracy rates and particularly in areas predominantly populated by scheduled castes, minority or other backward castes. Planning at district level should be a participatory approach by participation of other departments to ensure convergence of services. The participation of elected representatives of local bodies like Zilla Parishad and Gram Panchayat, academic and resource organisations such as DIETs, university education departments to provide technical and professional inputs to the plan preparation process should also be made compulsory. Participation of educational functionaries at all levels including headmasters, teachers and non-government organisations, members of VEC, Mahila Samooh, Youth Groups etc., should also be ensured in the planning process. To make the district-level planning more effective and responsible, more financial and administrative powers should also be devolved to the district level education officers.

Planning at district level should include not only planning in terms of opening of new schools, enrollment of out-of-school children and reducing dropout, but also take the note of organising in-service training programme and adequacy of teaching-learning material in schools.

Enhancing the Non-government Efforts

Private aided institutions play an important role in school education in the state. They are managing about 50 per cent middle schools and more than 80 per cent high schools and intermediate colleges. The educational facilities created by these organisations are, however, under utilised. To achieve the distant goal of universalisation of elementary education these institutions should be encouraged to mobilise peoples for sending their children in the age group of 6-14 to schools.

It would also be an innovative practice if the privately managed middle and high schools, and intermediate colleges are allowed to start primary classes (I-V) since these institutions have demonstrated their ability in managing education efficiently from upper primary to senior secondary level. Since the Basic Shiksha Parishad primary schools are already overcrowded with a teacher pupil-ratio of about 60, it would supplement the government effort if these institutions are allowed to start primary classes to tap the increasing population of school-age children and thereby meeting the demand of education in their respective catchment areas.

The voluntary organisations should also be encouraged to start their institutions in rural areas. However, mushrooming growth of nursery schools in the villages has adversely affected the education of children since they are charging exorbitant fees from parents without providing quality education to their children; on one hand, these schools do not have proper buildings, qualified teachers and even textbooks and other reading materials of standard, on the other.

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Mobilisation of Financial Resources

In spite of the priority given to elementary education by allocating more than 50 per cent of the total funds of the state education budget to this sector, the situation of education development in the state has not changed to any appreciable level. The main reason being the availability of total plan budgeted expenditure on education was only about 5 per cent. Per-pupil expenditure on education at all stages except primary stages except primary stage in 1988-89 also remained lower as compared to the country as a whole. Apart from this, meagre resources are made available for the maintenance of school buildings as well as development of other infrastructural facilities and teaching-learning aids. For instance, more than 97 per cent funds are spent on salaries at primary stage. It is therefore necessary that to supplement the government efforts, additional resources for education should be mobilised from the community. In several states, for example, in Madhya Pradesh an education cess is levied to mobilise additional funds for education. This practice also needs to be introduced in Uttar Pradesh. However, as per the present practice, the land for construction of school building in almost every village is donated by the community or any individual or the school is constructed on the land owned by the gram sabha in the village. But for maintenance of the school building and other facilities in schools, financial resource should be mobilised by strengthening the Village Education Committees who could encourage the community to donate cash or kind for the development of schools.

The System of Inspection and Supervision

The survey of educational administration shows that the number of schools to be inspected varies from district to district between 60 to 80, and inspecting officers are not able to visit every institution under their jurisdiction even once a year. Besides, inspecting officers are over-burdened with work other than the education including development work in the village, census and election work etc. The non-availability of conveyance to go to the field have also added to their problems. During the first survey of educational administration which NIEPA conducted in 1973-74, the inspecting officers used to devote much time on visits and inspections, that is, 24 per cent in a month. They could find only 15 per cent time to inspect schools in the present survey.

It has also been found that out of 263 sample institutions from primary to intermediate colleges selected for the survey, about half of the heads of institutions of primary, upper primary and intermediate colleges desired that inspection of schools should be done fre-

quently. All the heads of high schools suggested that surprise inspections should be conducted by inspecting officers and that inspection should provide guidance and counselling to the teachers, rather than concentrate on fault-finding. There is therefore a need not only for strengthening of inspecting machinery in terms of their skills and expertise by organising training and orientation programmes but for an assessment of work and the strength of inspecting officers district-wise should be done for making inspection and supervision processes more efficient and effective which would help in improving the quality of education in schools.

Better Personnel Management

The study shows that the state does not have a specific transfer policy for teachers and there is no established system for redressal of grievances of teachers and administrators. It has been found that when the representation/appeal of aggrieved teachers are not attended to and disposed of expeditiously, they tend to approach their unions or file cases in courts. Most of the suits are filed in the high court through writ petitions. Fewer legal suits are filed with the lower courts. Interestingly, most of the cases relate to appointment, promotion, salary, pension, transfer of teachers and management dispute in case of aided private management schools. Very few cases relate to admissions, examinations and almost negligible number of cases relate to curriculum, planning, methods of teaching, etc. In 1990-91, 6,000 cases related to secondary education and 3,300 cases related to elementary education were registered with the high court of the state. Educational administrators find it difficult to cope up with the problem of contesting the court cases. Considerable time and energy of officers is consumed in litigation. This is also having a demoralising effect on working efficiency of education officers. A mechanism to sort out grievances of teachers in time at district level needs to be developed.

Management Information System

The study reveals that as a result of the time lag in collection, collation and publication of information right from the institution to secretariat level, and the lack of special statistical machinery for this purpose, adequate information and data is not available in the Education Department on several points. Apart from this, district-wise information on local body schools, educational facility in schools and data related to quality of education are hardly available.

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This calls for urgent assessment by the state government to provide training to the staff dealing with statistical information particularly in the area of quantitative techniques. Such training programmes of short duration need to be organised periodically at the state, zonal, district and block levels. To remove the timelag in data collection, collation and publication of information, there is a need to develop computerised information system to help educational planners at directorate, regional and district levels.

A Holistic Approach

In spite of efforts made by the state government during the last four decades, educational backwardness of Uttar Pradesh continues to be a challenge to educational planners and administrators. The education system has so far attached too much importance to enrollment, with educational progress measured mainly by the percentage of enrollment in the relevant age group. No wonder a majority of the children are dropping out before they complete primary education.

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A holistic view of education is called for in which education is seen as an instrument of social change, as a means of reducing inequalities, and as the most important investment in people. Such a holistic view of education would call for a systematic revamp of the entire content and process of education, with significant implications for teacher training, planning and management.

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Multicultural & Multilingual Environment of MNCs in India

R.P. Saxena & Mala Srivastava

Multinationals can transfer their knowledge of total market experience as the marketing effort in a country is largely environment sensitive. Marketer has to face different challenges and problems in a new market. The culture of a country shapes the marketing strategy and market communication of an organisation. The multinationals have a bright future with the emergence of new markets in the developing countries. The investment of multinational corporations in world trade is increasing rapidly and this trend is expected to continue with the expansion of international markets. Multinational corporations in India have contributed significantly in the economic development of the country. Since India has a multicultural and multilingual environment, therefore, environmental scanning emphasising on cultural factors becomes a pertinent study for multinationals, who wish to enter Indian markets. The efforts of multinationals in understanding this area will decide the degree of their success. The present paper highlights the challenges faced by multinationals in Indian markets due to diverse and dynamic culture of the country.

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Introduction

Economic liberalization: an opportunity for MNCs

The opening up of the economy has brought global competition to the Indian industries and business. The entry of multinationals in Indian economy has aroused a great controversy about its impact on the economy of the country. If at one end, the entry of MNCs is considered as a mechanism for the transfer of technology to our developing economy, at the other end, it is considered as a clever strategy of the developed countries to penetrate into the economy of our country in different ways so as to gain control over some essential areas of organized production. Mostly the multinationals are guided by the profit maximization motive, thus it results in drawing away of resources through repatriation of profit, royalty payment, commissions and technical consultancy fees. Therefore, due to these reasons, the development of MNCs is as neo-colonialism or neo-imperialism extended to various developing countries of the world. In the era of free economy the MNCs are exercising a huge control on the business of the world economy. Due to its possession of huge capital resources latest technology and worldwide reputation, these MNCs are diversifying the market of their products in various developing countries. MNCs, the huge industrial organisations, were delighted with the opportunities offered by Indian government and entry of MNCs rose significantly during the last decade. But all MNCs were not successful. Many of them failed in Indian market although they had succeeded in many markets of the world. Now the question arises why did these MNCs register different results, while few of them got mega success, many failed? Is this because of the multicultural and multilingual environment of our country?

India: The best emerging market in South Asia

India is the 5th largest market in the world. By the year 2001 AD it would have around 500 million middle

class buyers. India's new prosperity and market potential are attributable to the governments ongoing commitment to economic reforms introduced in 1991. These reforms-deregulation, liberalization, privatization—have allowed India to rebuild its economy and foreign exchange reserves, reduce inflation and most importantly improve competition and efficiency in the market place by relaxing substantially economic, trade and investment controls. The result has been a sharp rise in income and private consumption, especially among the India's growing middle class (not only in urban but also in the rural areas) and similar growth in the affluent class. Private consumption in 1991 was around Rs. 4000 billion (\$ 125 billion), 15 per cent increase over the previous year and fourfold increase over 1981. By the year 2001 the total private consumption may exceed Rs. 8000 billion. However, though our consumer market is estimated to be the 6th largest in the world, the total private consumption at present is quite low by any measure. Of course, this state of low consumption indicates that potential of the Indian market is quite remarkable and marketers in India have ample opportunity to exploit this potential with the help of modern tools of advertising and sales promotion.

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For marketers, the ever-growing urban and rural markets in India represent an unprecedented opportunity. The return of MNCs to India such as Coca-Cola and IBM and entry of many other MNCs such as General Electricals, Pepsi, Motorola, Proctor & Gamble and Japan's electronic giants clearly prove that India has a vast market, rising incomes, a booming middle class, rising rural elite with adequate purchasing power offering long term opportunities for Indian as well as foreign industries for profitable marketing and distribution even in the buyers market. India and China have emerged as most potential markets in South Asia due to continuing efforts of economic liberalization. India has much more cheap labour to offer and has enormous pool of skilled and professional labour. India is today recognized as one of the best emerging markets in the world. The cyclonic changes in the Indian marketing environment preceding the advent of 21st Century ought to be intelligently forecast through marketing research so that enlightened marketer can prepare himself for the big help in 21st Century. But the multicultural and multilingual environment of India gives an impression that it is not a country it is a continent

in itself. It has 4200 towns and 5,76,700 villages. 25 per cent of the total population lives in urban areas while 75 per cent in semi-rural areas. As per 1991 census—the population of India is 850 millions in round figures and it is growing at the rate of 2.25 per cent per year. Indians speak 16 different recognized languages and belong to seven different religions namely, Hinduism, Islam, Sikhism, Christianity, Zorostrainism, Buddhism and Jainism. The sex ratio works out as 930 females for 1000 males. They differ in their costumes, food habits, language, literacy, religion, castes, festivals and living standards. Today the world is looking at India as an interesting proposition, as never before, because India has thrown open its door of liberalisation. It is an attempt to join industrialized and free market economies of the world. Therefore, on the one hand the emerging market of India offers opportunities and on the other hand the multilingual environment poses many challenges to MNCs in India.

Significance of environmental analysis

The functioning of an organisation depends on micro-factors like suppliers, customers, competitors and public and on macro factors like demographic, economic, political, legal, technical, ecological and cultural factors. These factors vary from country to country and make it difficult for an international marketer to cope with different situation of different nations. There are several factors which influence marketing decisions. MNCs see bright future in developing countries and their success lies in proper co-ordination and integration of strategies to maximize synergies and minimize cost, thereby optimizing profitability in the host country market. Multinationals can not transfer their total market experience learned in domestic or other markets, as the marketing effort in a country is largely environment sensitive. The marketer has to face different challenges and problems in a market emerging as micro and macro environmental factors. Therefore the scanning of international environment becomes the key task for MNCs. Comparatively the task of scanning of political, legal, economic and technological environment is easier than the study of socio-cultural environment of the country. Culture which is the most intriguing and perspective environment factor is defined as a set of traditional beliefs and values that are transmitted and shared in a given society. Because of differing cultures world wide consumers homogeneity does not exist. Indian is known to have a multicultural and multilingual environment and there are difference in consumers in India. In order to understand these diverse groups of consumers a particular culture must be examined and the focus should be on the various sub groups within the society. Thus it should investigate the various subcultures. A subculture is a distinct and identifiable cultural group that has

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values in common with the overall society but also has certain characteristics that are unique to itself. Culture affects people behavior in diverse ways through logic, communication and consumption. In fact, the culture of the country shapes the marketing strategy and market communication of an organisation viz., language, religious and moral beliefs, habits, knowledge, attitudes, values and other behaviours of the people. Seeing this diversity, even the domestic industries face severe challenges in studying such environment, selecting the segments and formulating the marketing-mix strategies suitable to each segment as the product ranges and taste ranges differ from north India to south India and consumers like differences in product features and packaging. Like in domestic marketing, knowing your customers becomes the foremost step in designing the marketing strategies in an international market. The in-depth study of social-cultural factors in a foreign market needs lot of sincere efforts and patience. The efforts of MNCs in understanding this area will decide the degree of their success.

A subculture is a distinct and identifiable cultural group that has values in common with the overall society but also has certain characteristics that are unique to itself.

The task of marketing manager is to mould his controllables in the light of un-controllables. Each person is unique and each country is unique. This reality of differences means that we cannot always directly apply experiences from one country to another. If customers, competitors, channels of distribution and available media are different, it may be necessary to change our marketing plan. The strategic concept of marketing shifted the focus of marketing from the customer or the product, to the customer in the context of the broader external environment. A clear focus on customer needs, wants and on the competitive offers is required to mobilize the effort needed to maintain a differential advantage. IBM succeeded globally because it was more clearly focused on customer needs and wants than any

other company in the emerging data processing industry. One of the reasons that IBM found itself in crisis in the early 1990s was because its competitors had become much more clearly focused on customer needs and wants. Moreover, these competitors were giving the same computing power at lower prices. Companies venturing abroad usually make mistakes based on their ethnocentric thinking. It becomes essential to consider the fact that customers abroad are different rather than similar to the home customers. Some of the examples cited by Kotler of the blunders made by MNCs while entering foreign markets are: Philips started earning profits in Japan only after it reduced the size of its coffee makers to fit into the smaller Japanese kitchens and its shavers to fit the smaller Japanese hands. Coca-Cola had to withdraw the two litre bottle in Spain after discovering that few Spaniards owned refrigerators with large enough compartments.

Key success factors for MNCs in India

The multinational marketing has bright future with the emergence of many developing countries in the World. The number of MNCs in the world trade is increasing day by day, but there remains a big question mark on their success in the foreign market. Global competitiveness becomes a key factor for MNCs to be successful in the world market. The world today offers tremendous opportunities for potential MNCs, but their success lies on the right strategic decisions which should be taken after proper environmental analysis in the host country. Environmental analysis would help MNCs to have a clear vision leading to designing of the mission driven strategies in the foreign market. The right strategy should make a commitment to quality and a multinational corporation should enter the market of host country with high speed while sticking to core competency. For designing the powerful speedy strategy, the marketer must have full knowledge of the market in terms of technological and marketing factors. He should have a clear understanding of the buyers i.e., how a Chinese or an Indian buys. He should deeply understand the culture of these buyers and should try to develop the international culture. For providing maximum value to customers and gaining the competitive differential advantage in the market MNC must go for decentralizing or regional management with key business strategies driven by corporate management.

Nestle is the world's largest food company and earns as much as 99.2 per cent of its revenues outside its native country. A simple case of a macro factor, population, being unfavourable to growth in the parent country, Switzerland—hence the decision to explore other markets. The growth strategy was multi flavoured—ranging from takeover (Rowntree) to diverse marketing

strategies in a different context (Maggi is Tureen in Europe). Intel is a vital force to reckon with within the microprocessors market. The strategy is simple-constantly innovative and lead the market through technological developments that translate themselves into a tangible end-user benefit or advantage. Their global nature is there not only in across-the-world operations, but also in transplanting global skills. Heineken refers to itself as a marketing company with production facilities. It believes that it is the brand name that sells the product, irrespective of where it has been manufactured. The universal nature of its product facilitated its decision to go global. Sony corporation is a virtual leader in its chosen market. The basis of success is the continuous customer-centric innovations—the ability to change and innovate constantly. The mark of a learning organisation. Although most of the MNCs first analyze the key success factors while entering in a foreign market, then why many of them fail in Indian market? Perhaps it is true that most of them did not do the environmental analysis when the first came to India. The competitive advantage in the home country markets may be derived by companies and institutions, from its familiarity with the local culture, customs, language and market characteristics. Therefore, even for attaining success in domestic or multinational, irrespective of their size, influence or style of operation can venture to ignore or forget the influence of its environment. It is evident from Dalal Street Investment Journal that out of the top ten brands only a single corporate is that of Indian origin, while all the rest are MNCs. For a second consecutive year, Indian Shaving Products topped the list. Table 1 indicates that good brand should not only be profitable but also generating good flow for the company.

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The sample of ten firms highlighted several characteristics like rapid internationalization, long term thinking and planning, a global mind set, beach head in critical markets, emphasis on quality, global scale and rapid growth, building on distinctive capabilities, mobilizing funds, an international outlook, joint ventures, strategic alliances and acquisitions, changing product portfolio and backward integration.

These companies were able to realize the fact that India has a multicultural and multilingual environment, accordingly they first studied the environment and results of this analysis were used as inputs in designing the marketing strategies. For long term success in the market, they have added the sixth P, the probing (continuous research) in their marketing mix (the five Ps-Product, Prices, Physical distribution, Promotion and Packaging). The continuous research or environmental analysis helps them in understanding the fast changing dynamic environment in the context of consumer behaviour, shift in demand, role of competitors, ways of communication and promotion and the growth rate.

Strategy of MNC in India

Cultural differences have an impact on marketing decisions affecting product, price, distribution and promotion. To undertake business successfully across national boundaries, marketers must first scan the en-

Table 1: Performance of Top Ten Corporate Brands of the Country during 96-97

Company	Eqty	NP	Sales	EPS	Comp-PE	Ind-PE	Price
Indian shaving	12.87	6.51	120.79	5.06	106.75	56.61	540.00
Novartis	31.90	15.69	611.36	4.92	67.03	19.55	329.75
Hind. Lever Ltd.	199.17	400.43	7121.81	20.10	66.76	56.61	1342.25
Ponds India	29.86	43.94	395.21	14.72	65.08	56.61	957.75
Reckitt & Colman	32.91	20.34	300.75	6.18	59.84	56.61	369.75
Nestle India	96.42	54.19	1207.32	5.62	51.42	31.04	289.00
Castrol India	61.75	92.94	902.40	15.05	47.36	41.52	712.75
Infosys Techno	14.52	35.92	140.21	24.74	46.94	17.12	1161.25
ITC Ltd.	245.41	325.04	5868.77	13.24	44.13	41.37	584.50
Glaxo India	59.78	51.10	703.85	8.55	40.94	14.54	350.00

vironments. The product decision is among the first decisions that a marketing manager makes in order to develop a marketing mix. MNCs can either offer a standard product worldwide or adapt it to local requirements. This decision must be based on the nature of the product, market development, cost/benefit considerations, legal requirements, competition, support system, physical environment and market conditions. Generally companies try to market a standardized product internationally because it saves cost and time but many times it leads to missed opportunities. Therefore, it becomes essential for an international marketer to take this decision very carefully. Whether to standardize or to customize is a vexing question that multinational marketers need to answer for making a successful marketing strategy. Strategic evaluation of environment contributes the desired inputs for deciding market segments to be targeted, product attributes to be offered and competitors to be challenged. When results of the environmental analysis confirm more and more similarities in the home country and the host country, then a multinational marketer may take decision in favour of standardization. It is urged on the grounds that a product that has been proved to be successful in one country should do equally well in other countries that present more or less similar markets and similar competitive conditions.

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Multinationals like Sony, IBM and Coca-Cola initially opted for standardization and adopted uniform product and marketing strategies making an assumption that consumers around the world are similar. But later on they realized the fact that marketing environment varies from country to country. This cultural diversity influences the customer buying behaviour, their product preferences and consumption pattern. Accordingly these MNCs shifted their strategies from standardization to customization and adapted necessary changes in their offers making country specific marketing mix policies. Thus, the standard products originally conceived and developed in the home countries may not really match the environmental conditions in foreign markets. Therefore standardization can lead to substantial opportunity loss. Although standardization offers the benefits of cost savings and development of worldwide products, but too much attachment to it can be counter-productive. It would be appropriate for MNCs to take this crucial decision of standardization or customization

after the strategic environmental analysis of foreign markets. Standardization should be based on the extent of similarities and customization to the degrees of differences in the home country and foreign markets.

Research on the subject shows that standardization is more feasible in the case of industrial goods than for consumer goods. Among consumer goods, fast moving consumer goods (nondurables) require greater customization than durables, because FMCGs appeal to tastes, habits and customs. Cadbury altered the taste of its chocolates according to the preferences of Indian customers. Seeing the lack of freezers in the support system, they made the product suitable to Indian climate, saving it from melting for a longer period of time. Leo Mattel's Barbie doll was happily accepted in Indian market, but in Japan it could succeed only when its features were changed to look like a Japanese girl. Johnson and Johnson used customized approach and enjoyed rapid diffusion in Indian market. On the other end, Real Values Vacuumisers failed in Indian market, because their standardized communication could not convince Indian customers. In India people are not habitual of storing eatables for a longer period of time. They wish to consume the fresh eatables and store only the leftovers. Because of this reason, frozen foods and vegetables of MNCs were not welcomed here, when they introduced a line of dehydrated vegetables, it got comparatively satisfactory response. By using customized approach in Indian market, many MNCs registered good success and high growth, for example Proctor and Gamble, Nestle, Hindustan Lever, ITC, Reckitt and Colman and Indian Shaving Products. Therefore, it becomes essential for MNCs to understand Indian customers first than selecting the strategy of standardization or customization. They should select such strategy which offers higher value and compatibility matching to their social and cultural needs.

Joint ventures, mergers and take-overs

With increasing integration of economies around the world, attainment of global competitiveness has become the most important element for survival and sustained success of MNCs. For attaining and sustaining competitiveness in foreign market, these MNCs search for those critical factors which assure success to them. The environmental analysis of the host country can only provide the critical success factors to MNCs for making a successful marketing strategy and a safe entry in new market. Understanding consumers and competitors in a new market, brand building and reaching customers with most competitive offer by applying functional and emotional approaches, becomes a real tough task for MNCs, especially in the multicultural and multilingual environment of India. The selection of an appropriate

strategy in complex environment becomes a more complicated task for MNCs and it always involves risks and uncertainties. Many times the MNCs don't go for the full exercise of environmental scanning because it is time consuming and exhaustive in nature. It also needs lot of expenditure on R&D and requires higher degree of patience.

This ability of competing in the new market needs complete research which describes quality differences, competitive pricing, manufacturing, distributing and marketing costs, ability and efficiency in communicating and the ultimate positioning and benchmarking of the brand. For attaining success, the MNCs have to concentrate in understanding the value perception of the Indian consumer. Realising the complexity of the Indian market and seeing the failure rate of MNCs here, now MNCs have found a new mantra for success in the form of joint ventures. MNCs feel very comfortable and profitable in establishing a joint venture with an established and reputed business house in India who provide them ready-made route to drive with lesser risks, for the purpose of getting economies of scale, understanding the markets, quick access to markets through well established channels of distribution and communication. These MNCs prefer vertical integration with the well known Indian partners who provide them knowledge and service in various fields and an emotional relationship with customers. With this adjustment they get the opportunity to understand Indian market and other factors at very low cost. At the same time they save lot of time and energy which they would have otherwise put in carrying out the proper environmental analysis and research. Indian companies also show their interest in the establishment of joint ventures with MNCs because of the technology, knowhow and capital. Indian Government, in view of its economic reform policies, also encourages the establishment of joint ventures which facilitate MNCs and attract them for investing in India. This mutual dependence between India and MNCs has taken the shape of Joint Ventures and establishment of such joint ventures in India has become now a normal practice. No doubt, joint ventures are fine partnerships of finance, technical know-how, marketing abilities and communication but their impact on Indian partners, promoters and most importantly on the economy, must be viewed very carefully. Many examples of such joint ventures provide enough evidence of the gradual firming up of the business of the takeovers and mergers by these MNCs. The latest example of such takeovers and mergers is shown once again by Hindustan Lever which merged with Ponds besides the complete buy out of Lakme. The merger of Thumps up with Coke is another example, where Thumps Up lost its glory. If these mergers and takeovers are healthy and allow growth potential, they

are tolerable but if they are for booking profits and asset stripping, certainly the sign is not healthy for the Indian economy.

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Building Brand Image

Today, Indian consumers have become more demanding. They choose a brand because it has an intrinsic value. This value can be offered to market after understanding the social and cultural needs and with the support of suitable communication it can be conveyed to its consumers in an effective manner. Hence, effective communication becomes a prerequisite. A brand will end up a loser, if it fails to convey the end-benefit to its consumers telling that this product is a better satisfier than its competitors. Mainly consumers look for a good price-value equation in product offers. The moment consumer finds a better satisfier in terms of its price-value equation ($V = B/P$, Where V is Customer Value, B stands for Benefits offered and P for Price charged), he will accept that brand very happily.

These days many MNCs give top priority to brand building and focus less on production and distribution aspect of the brand. For example, the MNCs like Mac Donald, Nike, Rebook, who franchise these brand names have better expertise in building brands as compared to producing the brand. Therefore, they pass on the responsibility of manufacturing to franchisees and involve themselves on brand building and developing new products. Thus with very little investment in the host country they are able to capture large market shares.

Companies which are able to create and communicate the personality of their brand in a way that it offers more value to customers as compared to existing competitors are successful in building their image and a good share in the market place. This difficult task becomes easier if the strategic marketing approach is adopted after understanding the consumers i.e., after the environmental analysis. There are many MNCs who have diffused their products so successfully in Indian environment that many people are unable to identify

them as MNCs products. For example, the products of Bata, Hindustan Lever, Nestle, Brooke Bond Lipton etc. Today the consumer in India demands world class products at the most competitive prices. Now the consumer is not driven only by price, but expects much more from a product. Customers look for real value in the offer in terms of quality, service, comforts, fun and status. The success of MNCs products in multicultural and multilingual environment of India depends on the degree of their compatibility and communicability. Products will diffuse more rapidly if they are matching to the tastes, values and behaviours of customers and the product attributes are communicated to customers in such a manner that they are visible in their culture. This is because the product could communicate values which are deeply held and widely shared among Indians and hence found quick diffusion in the markets. In east their preferences are different, while in west they are more westernized. In such a diverse environment the task of marketer becomes more challenging because of the multiplicity of languages and dialects. His success depends on communication mix he develops and used in marketing efforts. Kelloggs introduced its products as a replacement to breakfast, which had very little compatibility and lacked in effective communicability here the communication projected values which were narrowly shared by the Indians and hence the product acceptance is low. Ultimately the products of Kelloggs could not do well in Indian market and now the Company says that it needs long gestation period in Indian market so as to change the breakfast habits of Indian customers.

Some MNCs first establish their brand names as combined brands viz., Maruti-Suzuki, Hero-Honda, Modi-Xerox, DCM-Toyota, Kinetic-Honda, TVS-Whirlpool and TATA-Sierra. Indian partners obtain new technologies and equity shares from MNCs and design effective marketing strategies for making the offer more competitive and building the brand equity. As soon as MNCs get enough understanding of the Indian market and their brand names get registered in the minds of the consumers recognizing high quality and value added offer, the importance of Indian partner and the support in the brand name becomes least important to them. Like Honda can survive today in Indian market without Hero or Kinetic, or Whirlpool without TVS, and Toyota without DCM. In many cases, the tie-ups also break-up

when MNCs feel that they can do well even without any partner now, like Proctor & Gamble broke its tie-up with Godrej after gaining a firm control in the market. The tie-up with Godrej helped Proctor & Gamble in establishing its products in the market in competition to the Hindustan Lever. But when it succeeded in building the brand equity in the market, it simply decided to part away. Even the foreign partners like Lehar and Pepsi decided to break their tie-up after consolidating their positions in the Indian market. This erosion of Indian brands needs to be stopped as the need of the hour is to build India's brand equity and reposition Indian products in world market.

Conclusions

No doubt, India has the vast potential for giving countless opportunities to MNCs. The economic reform programmes of India have attracted lot of MNCs to its markets during the last decade, but most of them have a big question mark against their success. Many of the MNCs, who entered in Indian market during the last 5 to 6 years, have realised now that their marketing strategies are turning out to be inappropriate in the context of multicultural and multilingual environment of India. The companies who were able to clearly understand the factors of diversity in Indian culture and the characteristics of different segments have designed their marketing strategies successfully that offer unique value to customers and differentiate them with the competitors. For example, Nestle, Kodak, Revlon, Reckitt & Colman, who did proper scanning of the Indian environment, developed customized products and communication and made special efforts before formulating their marketing mix strategies. MNCs are realizing now that Indian market is quite different from the western market. The deeply rooted cultural values of Indian customers are the biggest hindrance in the success of these MNCs. The strategic evaluation of Indian environment provides ingredients of success to MNCs in adapting elements in product planning and effective communication, meeting the needs of target customers and attracting them towards the offer respectively. Many MNCs are still in the process of redesigning their strategies suitable to Indian environment. There are some who have hoisted their flags in attaining remarkable success in this multicultural and multilingual environment. □

Regulatory Vs Market Incentive Approach to Industrial Pollution Control

M. Ravichandran & Chellam Balasundaram

State versus market is one of the growing controversies in economics and more so in the recent years in the area of environmental economics. Both the strategies appear to have merits and strength in tackling the problem of industrial pollution. But the controversy arises only when any one of these states a claim more than the other. A research probe revealed that market instruments per se may not work without a regulatory backup. Conversely, regulations do not have adequate teeth to curb industrial pollution effectively without the support of market and fiscal incentives. Hence synergy of these two is an appropriate solution. The policy makers concerned should incorporate feasible market instruments into the existing regulations.

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Introduction

Regulation vis-a-vis market incentives is one of the unresolved controversies in environmental economics. Much of current literature supports economic/market approach towards pollution control. Even the World Bank's perception of "New environmentalism" emphasises that whenever and wherever possible, market based initiatives should be used instead of command and control regulation to induce industry to pollute less. The developed countries have already built into their fiscal structure some market based incentives for highly polluting units.

The fact remains that India seldom employed incentive approaches but followed regulation/physical control/command and control method until 1992. This approach has been duly backed by legislations such as India's Water (Prevention and Control of Pollution) Act of 1981 and Environment Protection Act of 1986, towards combating pollution (Table 1). The *modus operandi* of these regulations is to specify pollution standards and penalties for non-compliance, even to the extent of closing down erring units.

There is no gainsaying the fact that market instruments alone would not be sufficient to achieve effective pollution control, nor will regulatory process by itself be adequate to win the purpose. The critical question is whether or not to give more weightage to market instruments. Is it necessary to combine market with regulatory procedure? To answer these questions, it is

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necessary to discuss the various types of instruments such as fiscal, market and regulatory procedures in detail. The present paper primarily aims to address the dichotomy between market and state in the light of relative merits of different instruments.

Table 1: Environmental Laws

S.No.	Title
1.	The Air (Prevention and Control of Pollution) Act 1981, amended in 1987.
2.	The Water (Prevention and Control of Pollution) Act 1974, amended in 1988.
3.	The Water (Prevention and Control of Pollution Cess Act 1977).
4.	The Environment (Protection) Act, 1986.
5.	The Factories Act 1948, amended in 1987.
6.	The Motor Vehicles Act 1972, amended in 1988.
7.	The Wildlife (Protection) Act 1972, amended in 1991.
8.	The Forest (Conservation) Act 1980, amended in 1991.
9.	The Public Liability Insurance Act, 1992.

Regulation

Regulatory method envisages fixing up of standards which are also called maximum permissible level or tolerance limit to which the erring industrial units shall comply with (Tables 2 and 3). These are not across-the-board standards but does vary for different medium of disposal. Generally the prescribed standards range from 80 to 90 per cent of pollution to be abated. Though pollution standards are set in India at a level comparable with the standards in the advanced countries, particularly UK, the pollution control policy appears to be easily borne by the industry, or even if passed on to consumers in the form of an increase in price, such a price rise is only marginal.

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The Central Board for the prevention and control of water pollution prepared in the year 1984, an industry wise Comprehensive Industry Documents to help in evolving industry-specific minimal National Standards based on the cost of various levels of effluent treatment. Normally, the 3 per cent level of annual turnover of the specific industry is accepted as the appropriate level of

treatment to be installed by each industry.

Table 2: Ambient Air Quality Standard/Concentration mg/m³

Area	Category	SPM	SO ₂	CO	NO _x
A	Industrial and mixed use	500	120	5000	120
B	Residential and Rural	200	80	2000	80
C	Sensitive	100	30	1000	30

SPM - Suspended Particulate Matter

CO - Carbon Monoxide

SO₂ - Sulphur Dioxide

NO_x - Oxides of Nitrogen

Table 3: Tolerance Limits for Discharged Industrial Effluents

Parameter	Surface Water	Land for Irrigation	Marine	Public
Suspend solids	100.0	200.0	100.0	600.0
Bio-chemical oxygen demand (Bod) (5 days at 20°C Max)	30.0	100.0	100.0	350.0
Chemical oxygen Demand Mg/L Max	250	Not prescribed	250.0	Not prescribed
P Value	6.0 to 8.5	6.0 to 8.5	6.0 to 8.5	6.0 to 8.5

According to the comprehensive Industry Document, the annual burden of treatment at prevailing standards as percentage of annual turnover remained within 1-2 per cent in many industries such as sugar, oil refinery, synthetic fibres, breweries, pesticides, etc.

Fiscal Incentives and Disincentive

This approach envisages economic disincentives such as charges or taxes and fiscal incentives such as depreciation allowance, exemption of capital gains, reduction in import tariff and reduction in union excise duty towards pollution control (Purohit and Rao, 1994).

An important fiscal incentive is to provide accelerated depreciation allowance for the use of pollution control equipments. In the union budget of 1993-94, the rate of depreciation on plant and machinery meant for environmental protection and control was raised from 40 to 100 per cent. Another fiscal incentive built into the tax system is the exemption of capital gains arising from transfer of

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Table 4: List of Pollution Control Equipments Taxable at the Concessional Rate under Union Excise Duties (Tax Rate 40%)

S.No.	Description of Goods
1.	Electrostatic precipitation system including Automining Spray Nozzle, CO Analyser, Emitting Electrode.
2.	Folt-filter systems including Pulse Valve, Filter Bag.
3.	Dust collector systems.
4.	Scrubber-counter current/venturi/packed-bed/cyclonic scrubbers.
5.	Air Sampler (CO, SO ₂ , NO _x , H ₂ , SO ₃).
6.	Continuous analyser for CO, SO ₂ , NO _x .
7.	Halogen detector.
8.	Mechanically skimmed oil and grease removal systems.
9.	Mechanical flocculators.
10.	Diffused air/surface aeration systems for activated sludge systems.
11.	Surface aeration system for aerated lagoon systems.
12.	Bio-filters rotating arms.
13.	Methane recovery anaerobic digester system.
14.	Air floatation systems.
15.	Marine outfall systems.
16.	Centrifuge and vacuum filters for dewatering sludge.
17.	pH meter (digital as well as analog type).
18.	Conductivity meter.
19.	Turbidity meter.
20.	Water pollution test kit.
21.	Water flow meter.
22.	BOD Incubator.
23.	Mercury analyser.
24.	Spectrophotometers (UV-VIS and VIS-IR digital).
25.	Continuous flow recorder with integrator.
26.	Continuous pH recorder.
27.	Fly-ash handling system.
28.	Air sampling bags
29.	Resistivity measuring kits to analyse characteristics of flyash at different elevated temperatures.
30.	Total organic carbon analyser.
31.	Fluorimeter
32.	Dissolved oxygen meter.
33.	COD meter (chemical oxygen demand meter).
34.	Niskin water sampler.
35.	Sediment sampler.
36.	Ultra Centrifuge Micropore Filtration Units.
37.	Ion Selective Electrodes for Fluorides, Cyanides, NO ₃ and NH ₃ .
38.	Chassis and engine Dynamometer.
39.	Carburettor Flow Bench.

Note: The items at the serial number 19, 21, 22, 26 and 27 enumerated above have since been omitted.

Source: Notification No. 78/90-C.E., dated 20-3-1990 as amended by Notification No. 61/93-C.E., dated 28-2-1993.

Table 5: Concessional Custom Duty on Pollution Abatement Equipment (Tax @ 5 per cent)

S.No.	Description of Goods
1.	Monitoring Instruments of various ranges suitable for ambient air and stack monitoring for toxic/hazardous chemicals.
2.	Gas detectors/alarms for measuring concentration of toxic/hazardous gases.
3.	Personal samplers with re-chargeable battery units.
4.	Toxic gas monitoring kits containing personal samplers, sampler with filter head, filter holders, membrane filter of different pore sizes, small cyclone for respirable dust monitoring and activated carbon tubes for collection of specified chemical pollutants.
5.	Direct reading calorimetric indicator tubes with accessories for monitoring toxic gases/vapour.
6.	Long term direct reading detector tubes with peristaltic pump, for monitoring toxic gases/chemicals.
7.	Direct reading instruments for monitoring and evaluation of air borne particles.
8.	Direct reading instruments for air borne gases vapours incorporating the principles of ultra violet or infrared absorption, chromatography with flame ionisation or photo-ionisation detector or micro-processor control solid state circuitry.
9.	Platinum based catalyst and systems to incinerate formaldehyde in gaseous emissions.
10.	Special incineration system for various toxic gases/solids.
11.	Condensing heat exchangers for reducing thermal pollution through stack gases.
12.	Self contained and compressed air/blower based breathing apparatus.
13.	Full Body protection suit for dealing with emergencies created due to leakage/spillage of highly toxic chemicals.
14.	Hypalon suits for emergencies for hydrofluoric acid.
15.	Ultrasonic or irradiation type thickness testers.
16.	Instruments for liquid effluent control, namely: (a) Ion chromatograph for anions (b) Atomic absorption spectroscope for metal analysis (c) Differential pulse polarograph for metal analysis
17.	Plate type compact clarifiers
18.	Sulzer or equivalent high efficiency packing for distillation columns for pollution control.
20.	Special plastic media for fixed film technology used in Anaerobic treatment of high strength organic waste effluent.
23.	Analysers for carbon monoxide and Hydrocarbon.

immovable property as well as machinery for establishing business in a less congested place (normally outside a city). Both these concessions are a part of the Income Tax Act, 1961. In regard to commodity taxes, there is a reduction in import tariff to 40 per cent. This concession is given for specified list of approximately about thirty nine equipments (Table 4). On domestically

produced goods, the union excise duty is levied on about twenty three items at a lower rate of 5 per cent (Table 5).

Another significant prescription for the problem of externality of pollution is charges/taxes. The justification for a pollution charge is fundamental in theory. The charge is a price extracted from polluters for using the environment and is intended to discourage them from doing so. To accomplish this goal, the tax cannot be nominal like India's water cess, but a true tax. The general economic solution to ensure sustainable use of the environment is to price the use of environmental resources high enough to reflect the cost imposed on other proximate, distant and future users.

Pollution abatement costs are lower for the society as a whole under a tax than with regulation. In the real world, effluent charges have been rated successful only in the field of water pollution control policy; they do not play an important role in air pollution control.

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Market Approach

This approach introduces certain market incentives for firms to make mutual adjustments among themselves in such a way as to achieve desired goal at the least cost. Also the market approach does allow firms to decide on their own in selecting the type of technology, etc., to overcome the drawbacks of regulatory method. The point to note here is that market incentives would not supplant the regulatory process but would only allow certain financial incentives to supplement control mechanism.

The incentive schemes consists of "bubbles", "offsets" and "emission banks". The bubble concept is designed to take account of the different incremental costs of controlling pollution both across the process within a particular plant and across plants and firms. A figurative bubble is placed around an entire plant, or area, treating it as a single source of emission rather than as a series of independent sources.

The bubble programme considers for instance, an industrial plant which constitutes multiple sources of emission as single unit and treats all its sources. The aim of the method essentially is to control overall emission level. The incentive in this programme is that the

factory owner is encouraged to concentrate only on those sources where the additional costs of pollution control are low and reduce pollution control where additional costs are high thereby keeping down the total pollution control cost.

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The 'offset' programme is developed mainly to encourage new plants to open and old ones to expand without deteriorating air quality. The offset programme allows such concentration and expansions if the new emissions that result are more than offset by reductions in emissions from existing sources. In this process, the new entrant negotiates with existing firms by offering to buy emissions reduction for them. The main difference between 'bubble' and 'offset' programmes is that while the former may not necessarily reduce the amount of air pollution in the area, the latter does. Besides, while the 'bubble' applies only to existing sources, the 'offsets' cover new sources as well.

The offset programme allows such concentration and expansions if the new emissions that result are more than offset by reductions in emissions from existing sources.

The 'emission bank' programme is to supplement 'offset' programme in terms of timing the trade of emission reductions. This envisages that "if a firm reduces its daily emissions below mandated levels, it can bank those reductions that is, hold them in reserve at a clearing house, for trade at some future date. It means that reduction of emission over and above the permissible level will be kept as reserve for sale for those big polluters whose abatement cost of pollution is very high. This programme simply means the offset scheme is more efficient by help, making potential polluters to straight away contact the clearing house inventory for trade, and they need not incur any expenditure in trying to locate offset partners.

Above mentioned programmes like 'bubble', 'offset' and 'emission bank' would call for sophisticated

electronic equipments for monitoring emission levels. Their adoption in developing countries like India could encourage the growth of electronic industries to create a strong base to make this adoption viable.

Another alternative approach uses marketable emission permits (tradable permits) to reduce environmentally damaging activities. Under this system, which has been used in the United States more than anywhere else, firms apply for emission permits, which are issued at a level so that aggregate emissions comply with regional pollution standards. These permits can be traded among users, from those firms with low costs of pollution abatement to those with high costs.

Another alternative approach uses marketable emission permits (tradable permits) to reduce environmentally damaging activities.

All the above mentioned market instruments are no rhetoric but formed the language of environmental economists in the recently concluded conference on climate change, held in Kyoto, Japan during December 1997.

Most of these market options were taken up for discussion by the participating countries. There was a conflict between US and the European union over the proposal of "Bubbling" reduction targets. The proposal was that the 15 members from the European Union as a whole would meet a target regardless of whether Germany and UK were required to reduce emissions or Portugal and Luxembourg being allowed to increase them by as much as 40 per cent over 1990 levels.

Reference was also made about 'Basket approach'. Under this the US proposed all six main greenhouse gases to come under review as against the Japanese and European union proposals that excluded the three secondary gases such as hydrofluoro carbons, perfluorocarbons and sulphur hexafluoride. Each one has a global warming potential between 4000 to 24,000 times that of carbon dioxide. Basically the basket approach envisages across the board gas cuts, rather than a gas by gas approach. The three main gases are CO₂, Methane and Nitrous oxide.

Synergy of Regulation and Market

Notwithstanding the fact there are arguments coming up not in favour of regulation that this is purely an en-

It is the pollution tax, more than a regulatory approach, which is consistent with a unified analytical framework for arriving at a solution to the environmental problem.

vironmental engineering method. This does propose many incentives for adoption of pollution control. On many counts pollution tax scores over command and control method.

It is the pollution tax, more than a regulatory approach, which is consistent with a unified analytical framework for arriving at a solution to the environmental problem.

Environmental regulations can have an educational effect that market-based approaches might miss. Anti-pollution publicity campaigns can accompany legal restrictions so that over time the idea that pollution is wrong is instilled in people. If the incentive were entirely economic, people might reduce pollution in response to price signals but they would not be made to feel that pollution is wrong (Kerr *et al*, 1997).

A proper fiscal intervention for the developing countries such as India is the need of the hour. It is important to combine all the instruments such as regulation market incentive and if possible public expenditure on Research and Development.

In February 1992, the Government adopted a policy statement for abatement of pollution. It indicates the government's commitment to prevent further deterioration of the environment and asserts that it would make use of a mix of instruments including legislation and regulation, fiscal incentives, voluntary agreements, educational programmes and information campaigns. Further, the constitution amendments of 1992 assign the environmental protection and conservation functions to local bodies. It is hoped that such initiatives result in a better environment in the days to come.

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Vulnerability Analysis with Analytic Hierarchy Process Modelling

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Analytic Hierarchy Process (AHP) has been used as a multi-objective multi-criterion system for Decision Support and it has found wider applications in areas such as Accounting, Finance, Marketing, Energy Resources Planning, Policy and Strategy Decisions. In this paper, the author has suggested an application of AHP model for undertaking Vulnerability Analysis among the competing brands of a product. The framework has been used for determining the brand vulnerability, where the product features as well as the competing brand perceptions are evaluated by the respondents. The framework could be used both for a closed group setting such as Focus Group Meetings as well as for open audience setting such as distance marketing survey undertaken through Internet. The paper suggests an approach to conduct a more reliable market survey through electronic medium from the respondents unknown to the marketing researchers.

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Introduction

Brands compete for a limited market in a competitive environment and it becomes rather critical for marketers to ascertain which one of the competing brands is the major threat to their specific brands. Technological advances in virtual reality offer new hope, offering opportunities in marketing research, where market researchers can recreate—quickly and inexpensively—the atmosphere of an actual business scenario with varying structures [Burke, 1996] and recent advances in computer graphics and three dimensional modelling promise to bring simulated test marketing to a much broader range of companies, products, and applications. In this context, marketing strategies to gobble up the market share of a particular competing brand and safeguard own brand could be better understood and developed by undertaking a vulnerability analysis. The present paper suggests a framework for such an analysis through the application of a well established model namely Analytic Hierarchy Process (AHP).

Vulnerability Analysis

In a competitive industry, weaker brands keep on losing their market shares to competitors and marketers are ever keen to find out such potential under-the-belt-hitters. Various techniques of marketing research are employed by market watchers to ascertain the trends of the marketplace, one among which is the Focus Group Interview. In this technique, the respondents are asked to sit together in the form of a group and discuss out the features and parameters which would be critical for their intended purchase decisions. Parameters are also defined by the researchers and sometimes the researchers keep the question of parameter definition open. In all such cases, freedom to express attitudes might not be possible to be brought out by the researcher as participants in such focus group exercises

may not be able to agree upon the parameters and their relative importances. The Analytic Hierarchy Process, which is used as decision support tool for multi-objective multi-criterion systems could be meaningfully used for ascertaining vulnerability of the specific brand to other brands and relative importance of product features. Tables 1 and 2 outline the key concepts of vulnerability analysis. The data given in these tables is based on two research projects carried out to assess the market potential for home appliances such as Washing Machines and Refrigerators. It is seen that 89.1 per cent of the owners of Videocon would recommend Videocon, whereas 66.7 per cent of Greysham owners would recommend Greysham and none of the owners of Maharaja washing machine would ever recommend Maharaja. Other brands had rather low brand loyalties. For instance, only 39.3 per cent of Sumeet owners were in favour of recommending Sumeet. Videocon was the most favoured brand as would be clear from Table 1 and hence could be considered to be lesser vulnerable.

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Table 1: Brand Loyalty of Washing Machines

Owners of ↓	would recommend (percentage of owners)					
	Sumeet	Racold	Videocon	Greysham	Maharaja	Others
Sumeet	39.3	3.6	42.9	3.6	-	7.1
Racold	-	30.8	61.5	-	-	7.7
Videocon	-	-	89.1	2.2	-	4.3
Greysham	-	-	16.7	66.7	-	16.7
Maharaja	-	-	37.5	-	-	37.5
Others	6.0	0.5	51.4	1.1	-	38.3

From this analysis it was realized that a total of 55.1 per cent of the owners of a washing machine would like to recommend Videocon as against 7.6 per cent for Sumeet and 2.3 per cent for Racold. Saviour, Magic Wash and Trak owners were also not satisfied with their washing machines and had mostly recommended Videocon. In short, excepting Videocon, all other brands, particularly Maharaja and Saviour were found to be vulnerable.

From Table 2, it is seen that 50 per cent of the Allwyn refrigerator owners would like to recommend Allwyn whereas 78.3 per cent of Godrej refrigerator owners would like to recommend Godrej to their friends and relatives. Only 31.6 per cent of the Leonard owners would recommend Leonard, whereas none of the Zenith and Mec owners would recommend their relatives and friends to buy Zenith or Mec respectively. Interestingly 14.0 per cent of Godrej owners would recommend Voltas. 16.0 per cent and 10.7 per cent of Kelvinator owners would recommend Godrej and Voltas respectively, which means that Kelvinator brand is highly vulnerable. It is also clear from Table 2 that Voltas has been recommended by owners of almost all brands of refrigerators viz, Godrej, Kelvinator, Voltas, Leonard and Mec.

Table 2: Brand Loyalty of Refrigerators

Owners of ↓	would recommend (percentage of owners)					
	Allwyn	Godrej	Kelvinator	Voltas	Leonard	Gem
Allwyn	50.0	14.0	12.5	-	-	-
Godrej	-	78.3	-	14.0	-	-
Kelvinator	-	16.0	35.5	10.7	-	-
Voltas	-	-	-	76.7	-	-
Leonard	-	15.8	15.8	15.8	31.6	-
Gem	-	-	-	-	-	34.1
Mec	-	28.0	1.4	15.9	-	-

It is important for marketing strategists to understand which of the brands is vulnerable to competition and market researchers may like to base their evaluations on primary data collected from a large number of respondents. The market researchers may also like to provide an additional degree of freedom to the respondents by allowing them to rank various features on which they evaluate the products, while collecting data on consumer preferences regarding the product feature. Product vulnerability could be ascertained by conducting any such market survey as the results above indicate. With marketing function itself undergoing a major transition from physical marketplace to electronic market-space, it becomes imperative that there should be an appropriate method to undertake such analysis through distance market surveys from a larger unknown respondent audience. With virtual shops being setup by marketers on the net, alongside collecting data on shop-setup, marketers can also collect data on brand vulnerability.

AHP Modelling

In a decision making situation where there are multiple objectives important to a decision maker and the

alternative solution offers a varying degree of satisfaction of these objectives, decision making becomes difficult. Analytic Hierarchy Process (AHP) provides a powerful framework (Saaty, 1986) that can be used to make decisions in situations involving multiple objectives. The advantage of a multi-criteria decision method (Weber, 1993) is that it can account for both financial as well as non-financial impacts. The general approach of the AHP is to decompose the problem and to make pairwise comparison of all elements on a given level with respect to the related elements in the level just above (Kodali & Ranjit, 1995). AHP is best suited for situations where direct comparison among the pairs of alternatives is possible for each of the decision criterion. AHP modelling can provide a better solution in situations where there are:

(a) *numerous decision contributors*: Group Decision Support System (Jessup & Valacich, 1993) War room scenario is a good example of this;

(b) *each one of the decision contributors has a different set of objective criterion*: Judges evaluating contestants of beauty pageants for Miss India, Miss World or Miss Universe contest is a good example of this;

(c) *each one of the contributors has got independent decision making capacity*: Such as heads of different functional groups in a business organisation evaluating different strategies before a final choice is made; and

(d) *the decision is a weighted average value of the contributions of each individual*: As we normally analyze results of a marketing survey, the same could be extended to market survey for a virtual departmental store on Internet.

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AHP modelling has been very successfully used for building Decision Support Systems so as to facilitate multi-level, multi-objective problem structures by attempting the problem at the macro and micro level of decision situation. As per the literature available, AHP has been used for applications such as Accounting, Finance, Marketing, Energy Resource Planning, Policy and Strategy Decisions.

To recapitulate the basics of the working of AHP modelling, let us consider the example of a household going in for the purchase of a home appliance such as a Microwave Oven. There are three leading brands available in the market—B₁, B₂ and B₃. The household is being asked to evaluate these three as a part of a focus group meeting. The objective criteria that the researcher chooses to use for evaluation of these alternatives are (termed O₁, O₂, O₃ and O₄) :

- Brand Name
- Colour Shades
- Price
- Capacity

Using Saaty's interpretation of entries (Saaty, 1994) in a Pairwise Comparison Matrix, i.e., preference values of 1 through 9 between two objectives or alternatives, suppose the household attaches the following values to the objective criterion chosen:

$$[A] = \begin{matrix} & \begin{matrix} O_1 & O_2 & O_3 & O_4 \end{matrix} \\ \begin{matrix} O_1 \\ O_2 \\ O_3 \\ O_4 \end{matrix} & \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \end{matrix}$$

In this matrix, the values of a₁₁, a₂₂, a₃₃ and a₄₄ should be equal to 1.

The values of a_{ij} (i and j being the row and column numbers respectively) could be any integral values from 1 thru 9 (or their reciprocals) and a_{ij} being equal to 1 means that both i and j are equally important to the household. The value of a_{ij} being 3 means objective i is 3 times more important than the objective j. Then one obtains the normalized matrix, A_{norm}, in which the sum of the entries in each column is 1. It can be achieved by preparing a new matrix by dividing each element in the column by a column total, so that it gives a matrix:

$$[A_{norm}] = \begin{matrix} & \begin{matrix} O_1 & O_2 & O_3 & O_4 \end{matrix} \\ \begin{matrix} O_1 \\ O_2 \\ O_3 \\ O_4 \end{matrix} & \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \\ b_{41} & b_{42} & b_{43} & b_{44} \end{bmatrix} \end{matrix}$$

where :

$$b_{ij} = a_{ij} / \sum_{n=1}^4 a_{in} \quad \text{with} \quad \sum_{i=1}^4 b_{ij} = 1$$

always hold good. An approximation to the non-trivial solution, also called relative weights (Zahedi, 1986), can be obtained by computing :

$$W_i = \sum_{j=m}^{j=1} b_{ij} / m$$

where i = row number
 j = column number
 m = number of columns
 n = number of rows.

These W_i values will be the weights to be used for a non-trivial solution, also referred to as eigen values (Stern, 1988) for each of the objectives O_i . In the matrix below, W_1, W_2, W_3 and W_4 are the eigen values computed by using the formula for the objectives O_1, O_2, O_3 and O_4 respectively, the highest value indicating the highest preference for the objective.

Objectives	O_1	O_2	O_3	O_4	Weights
O_1	b_{11}	b_{12}	b_{13}	b_{14}	W_1
O_2	b_{21}	b_{22}	b_{23}	b_{24}	W_2
O_3	b_{31}	b_{32}	b_{33}	b_{34}	W_3
O_4	b_{41}	b_{42}	b_{43}	b_{44}	W_4

Similarly, the eigenvalues, i.e. V_{ij} , could be computed for each of the alternatives. For example, for each of the brands B_1, B_2 and B_3 , the relative weights matrix could be prepared as under:

For objective O_1 :

Brands	B_1	B_2	B_3	Weights
B_1	O_{11}	O_{12}	O_{13}	V_{11}
B_2	O_{21}	O_{22}	O_{23}	V_{12}
B_3	O_{31}	O_{32}	O_{33}	V_{13}

For objective O_2 :

Brands	B_1	B_2	B_3	Weights
B_1	O_{11}	O_{12}	O_{13}	V_{21}
B_2	O_{21}	O_{22}	O_{23}	V_{22}
B_3	O_{31}	O_{32}	O_{33}	V_{23}

For objective O_3 :

Brands	B_1	B_2	B_3	Weights
B_1	O_{11}	O_{12}	O_{13}	V_{31}
B_2	O_{21}	O_{22}	O_{23}	V_{32}
B_3	O_{31}	O_{32}	O_{33}	V_{33}

For objective O_4 :

Brands	B_1	B_2	B_3	Weights
B_1	O_{11}	O_{12}	O_{13}	V_{41}
B_2	O_{21}	O_{22}	O_{23}	V_{42}
B_3	O_{31}	O_{32}	O_{33}	V_{43}

From these eigenvalues both for objectives as well as the alternatives, one can synthesize these values to determine which alternative is best preferred by an individual decision maker. The tabulation for this example will be done as under:

Brands	Objectives			
	O_1	O_2	O_3	O_4
B_1	V_{11}	V_{21}	V_{31}	V_{41}
B_2	V_{12}	V_{22}	V_{32}	V_{42}
B_3	V_{13}	V_{23}	V_{33}	V_{43}
Weights	W_1	W_2	W_3	W_4

To decide which alternative is most preferred by the evaluator, we compute the score:

$$S_j = \sum_{i=1}^{j=m} V_{ij} * W_i$$

where j = column number
 i = row number
 m = number of columns.

Whereas W_1, W_2, W_3 and W_4 indicate relative importance of the objectives O_1, O_2, O_3 and O_4 respectively, we get brand preferences of respondents from S_1, S_2 and S_3 for brands B_1, B_2 and B_3 respectively.

Operationalisation of the Framework

The suggested framework could be used for determining brand vulnerability through computer based Analytic Hierarchy Process Modelling. There are various software products available which could help in

conducting the same. One such software is *Expert Choice*, for determining the objective and alternative hierarchies. The technique could be used by incorporating questions which require responses on various product features—both in terms of features desirability as well as on ranking of different brands on these features. The framework could be used as a closed setting similar to a Group Decision Support Room from conducting Focus Group Meeting through a LAN setting, so that the responses are captured on-line. Alternatively, the large market research surveys could incorporate the framework in an open networked setting where the data is being collected from unknown population through a medium such as Internet.

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In both the cases, the researcher will be able to collect data on feature preferences and on the brand preferences as ranked on these features. The data collected from such a survey could be further analyzed for statistical validation.

Conclusion

AHP provides a very powerful framework for undertaking brand vulnerability analysis by way of collecting data from closed setting such as Focus Group Meetings or from an open network setting such as having a market survey done through a virtual marketplace on Internet. In both the cases, the framework can be used for ranking the features or

the brands in a Pairwise Comparison Matrix. When this data is used alongwith the demographic data on the ownership profile, it will provide us data on brand loyalty and brand vulnerability. The marketers will be able to establish through vulnerability analysis the potential share snatchers. The suggested framework could be a potential research tool for distance market surveys on Internet.

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Agricultural Marketing Infrastructure: The Case of Cold Storage Industry in Gujarat

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Marketing infrastructure adds value to the primary produce by way of time, place and form utilities. The cold storage industry is one such (capital intensive) infrastructure system in India that still has not played its complete role in agricultural development due to various reasons. This paper examines the growth, structure, dynamics of operations and the performance of this industry in Gujarat state. Growth of cold storage industry is a phenomenon of the 1980s and is directly linked to the growth of potato production in the state. The industry is largely in the hands of farmer-turned agro-industrial entrepreneurs, that too from the dominant Patel community. The industry plays an important role by co-ordinating between the producers and the consuming markets not only by providing basic storage facility, but also through market information monitoring and its supply to the farmers who then decide to sell or not to sell their produce. The industry seems to have good prospects in view of the increasing production of fruits and vegetables in the presence of high and increasing temperatures in the state, potential growth of the food industry, and the emerging futures markets in agricultural commodities in the country. But, an integration of a set of activities in the agro-marketing chain is essential for this industry to be viable.

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Introduction

Marketing infrastructure is an important pre-condition for agricultural development as it adds time, place and form utilities to the agricultural/rural produce. This is more so in the case of horticultural crops which are more perishable and high value. It serves as a link between producers and consumers. As an important component of the agribusiness chain, it helps in attaining viability of agribusiness operations right upto the farmer level. Both producers as well as consumers can avoid exploitation which results from too low prices for the producer at the time of harvest and too high prices for the consumer in off-season. And there are many commodities in which price variations across seasons are very large, e.g. lime. But, this kind of infrastructure can not be created by individual farmers, due to large costs involved, especially fixed costs.

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This paper looks at the growth, structure, and dynamics of the cold storage industry in one of its centres—Anand taluka in Kheda District. It is found from a survey of secondary sources that there has been no systematic study of this important infrastructural industry in the country. Therefore, it was thought fit to understand this industry in the framework of structure, conduct, and performance model so that inter-linkages between structure, conduct and performance are clearly understood. The issues of entrepreneurship and integration are also looked into in order to assess the level of integration and its implications for the efficient functioning of the industry.

The information for this study was collected, besides secondary sources, through a series of discussions with a number of cold storage owners, and a (focus) group discussion with eight of them, which provided many insights into the working of the industry; these persons are members of the Kheda District Cold Storage Association. Besides, a separate interview with the Chairman of the Gujarat Cold Storage Association was conducted.

Growth and Structure

The first cold storage in India was set up in 1892 at Calcutta. There were 2659 cold storages in India in 1988 with capacity of 55 lakh tonnes. At present, there are more than 5000 cold stores in the country. The cold storage industry in India is largely located in six states i.e., U.P., Bihar, Punjab, West Bengal, Maharashtra, and Haryana. These states account for 70 per cent of the total storage capacity of this industry in India. Nearly 90 per cent of the facility is used for potatoes alone the production of which takes place largely (90 per cent) in rabi season and is predominantly located (80 per cent) in the states of Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal. This seasonally concentrated production requires cold storage facility.

The existing storage facility is taking care of only 44 per cent of potato production. There is a mismatch between demand and supply of cold storage infrastructure. This not only leads to spatial, but also seasonal price variations. In the 1990s, it has been reported that the price gap between lean season and farm harvest ranges from 36 per cent to 56 per cent. But, it is important to remember that the supply-demand gap arises also because of the fact the potato is short-harvest period crop, a semi-perishable product, and has somewhat inelastic demand. Most of the cold storages are owned by private firms, though there are a few co-operative and public sector cold storages in some states. And there are only 23 organised sector potato processing units which process only 1.6 per cent of the total production of potato in the country.

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The first cold storage unit in Gujarat was set up in 1962 at Ahmedabad. Gujarat, Known for its better marketing infrastructure, today has more than 100 cold storage units, of which about two thirds are in the districts of Kheda (15), Ahmedabad (20), Surendarnagar (10), and Baroda (9). The other centres of this industry are Rajkot (7), Jamnagar (6), and Mahesana (6). Whereas the stores located in potato producing areas like Anand, Nadiad (Kheda district), Ahmedabad, Jamnagar, and Deesa (Banaskantha district) largely store potatoes, others like those in Mahesana and Surendarnagar store marine products most of time (NHB, 1992). Most of the stores are in private sector except a significant chunk under the co-operative sector which are largely used for storing milk products produced by the owning milk producers' organisations. There are some cold stores set up by the fisheries department and a few by the Gujarat Agro-Industries Corporation (GAIC) as a part of creating marketing infrastructure for agricultural commodities.

In Kheda district, the number of cold storages increased from two in 1974 in Charotar region (comprising of Anand, Nadiad, Borsad and Petlad talukas of Kheda District) to 13 by 1984, 45 by 1995 and 56 by 1997. The mushrooming of cold stores took place in the 1980s. The capacity of the cold stores varies from 25,000 bags (of 82 kgs. each) to as much as 75,000 bags. In terms of tonnes, it ranges from 2,000 tonnes to 6,000 tonnes. Every year 3 or 4 new cold stores come up in Kheda district.

In the 1970s, potatoes cultivated in Charotar region had to be sent to Bombay for storage. The increase in area under and production of potato and the mushrooming of cold storage units in this area seemed to be reinforcing each other. The increase in area seems to have come from the loss in area under and the productivity of the other dominant crop of the region, tobacco, which declined in importance in the 1990s as against in 1970s and the 1980s, as it became relatively less remunerative due to the price fluctuations in distant markets and lack of any marketing and processing facilities in the state. Even the state tobacco federation failed to make any improvement in the situation.

Even in the mid 1980s, as much as 65 per cent of the potato production was cold stored in some villages of this region. The large farmers lease in land from small farmers to grow potatoes (Rutten, 1995). Through this practice of cold storing their potato produce and therefore postponed sale, the large farmers were able to earn a price difference of as much as 100 per cent.

Conduct and Dynamics of Business

Though the cold stores also resort to storing other

commodities like gur, turmeric, tamarind, mango pulp (Aamras) and chillies some times, but 90 per cent of the capacity is used for potatoes only. And during the season, the demand for cold storage outstrips capacity available. Within potato crop, there are two types: vegetable potato and seed potato. Whereas the first ones are generally stored for six months, the seed potato is kept in the store for as long as nine months. There is hardly any competition in this industry as the demand for the facility is more than the supply of cold storage space. The competition is more in terms of the facilities and quality of service provided.

Potato is a semi-storable commodity. It is somewhat like storable commodities such as grains because it is stored for consumption later in the crop year. However, it is different from such commodities as it can not be stored economically from one crop year to the next. The loss due to shrinkage goes up when potato prices are high because the value of the lost weight would be larger. In this sense, they are somewhat like non-storable commodities like livestock (Kahl, 1997).

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Ahmedabad and Bombay are two major markets for selling potatoes grown in this area. By telephone or post, middle and large farmers keep themselves informed of the prices and price fluctuations. In some cases, the cold storage units perform this job. The farmers are able to earn about 15 per cent margin on the season price by resorting to cold storage of their produce. The cold storage owners also provide market information to the clients, and arrange to get the produce cleaned, graded, packed, and labelled for storage purposes, the payment for which is made by the client. This is important as different markets value different grades and varieties of potato differently. The labelling of produce (branding of commodities!) helps to have an edge in the market and earn a premium on price.

Similarly, for the disposal of the produce, the cold stores provide facilities like loading for a charge. All these services are provided in order to earn the loyalty of the farmers. To pay for these charges and for meeting other working capital and consumption needs, farmers and traders obtain bank loans against the stored

produce at the rate of interest of 14 per cent per annum. About 90 per cent farmers make use of loan facility for cold storing their produce.

Renting out cold storage facility on a per sq. km. basis was the usual practice in the mid 1980s. At that time, only farmers with sufficient financial strength were able to make use of cold storage for their crops. More than 90 per cent of the space in the Gujarat Agro Industries Corporation (GAIC) cold store was hired out to farmers with land holdings of more than 10 acres each (Rutten, 1986). At present, though majority of the users are farmers of different classes, middlemen and traders also use this facility. It takes about 15-30 days for a store to get to full capacity.

Since it is a highly capital intensive industry (A Cold Storage costs from Rs. 1 crore to as much as Rs. 3 crore depending on the capacity, or as much as Rs. 270 per bag space), the rates need to recover fixed cost as well. But, a large part of the costs is variable and that too electricity (50 per cent) and supervision. It takes about 7-8 years to repay the loans by an average cold storage unit. The charges for a bag of 82 kgs. is Rs. 65. The charges can not be raised beyond a point as that will dissuade the farmers from making use of the cold storage facility. In the early 1990s, the charges in different parts of the state varied between Rs. 33 and Rs. 36 per bag of 85 kgs. for 6 months, excluding labour charges. Further, the charges were much higher for seed potato (Rs. 55) as it had to be stored for 9 months. Now, 70 per cent of the seed requirements are met from locally stored seeds due to the cold storage facility. These seeds are also more relevant for the local area, and prove to be cost effective. Earlier, the farmers used to go to Punjab and other north Indian centres to buy required quantity of seed-potatoes, where due to the availability of cold weather, it is possible to grow seed-potatoes.

The cost of storage for the farmer has two components: physical storage cost, and the opportunity cost of storage. The physical costs include the cold storage fees, insurance charges, handling charges and the like. The opportunity costs include the value of money foregone because the commodity is stored rather than sold (i.e., the interest rate multiplied by the commodity value). These costs change in response to the changes in the interest rate or the commodity price. The net benefit from storage is the convenience yield which is the value that the commodity conveys to the holder minus the above two types of costs (Kahl, 1997).

The industry has organised itself into state level association and district level associations for policy lobbying purposes. The state level association also co-ordinates with various developmental agencies for

different agricultural extension and marketing activities like seed extension, introduction and demonstration of seed drills, and visits of farmers to new places and activities within and outside the state. This has a business sense in that a higher and better output of the farmer means larger business for these storage units as they are largely dependent on one crop (potato).

Entrepreneurial Background

Most of the cold storage owners belong to the dominant Patel community and have partnership form of ownership. They invest in this low return yielding industry as it is considered relatively safe. Many of the cold stores have been set up with funds which came from remittances from relatives and family members abroad. Also, among the farming community, it is considered, sometimes, a status symbol to own a cold store.

This entrepreneurial ability of the Patels is also evident in the capital intensive cash crops they grow which require not only high cost inputs, but also access to market information, and updated agricultural knowledge (Rutten, 1986). Agrarian surplus obtained by the farmers of this region were invested in agriculture in the early 1970s, but later on they started participating in other agribusiness activities like trading and processing of agricultural produce (tobacco, paddy, pulses, etc.). Though started with tobacco trade, it spread to other crops and activities, and cold storage was no exception.

Performance of the Industry

Despite the low returns from the activity per se, many of the owners are able to run the cold store viably as they integrate it with other activities like commission agency, trading in agricultural commodities and own agricultural production. This agribusiness chain allows the owner/s to manage the costs across a set of activities. When storage space is available, many stores resort to buying of low price produce from other regions and states for storing it and selling it later at a higher price in a different market. Also, many stores locate close to the production centres and to each other in order to provide economies of agglomeration to the buyers who would like to have variety in crop, flexibility in quantity, and large enough purchases. An important point to be noted while looking at performance is the role these stores play in bringing price stability to the market both for producers as well consumers. They may not be giving very high returns to the owners, but they certainly prove very helpful for the producers in avoiding distress sale and in reaping the better markets. This is evident in the higher net prices realised by the producers after cold storage of produce.

Concluding Remarks

The rise in temperature and growth of irrigation will help the growth of this industry as the necessity of cold storing upcoming commercial vegetable crops in this area will increase. Since potato is neither too water and labour intensive nor has a long duration, and gives better returns compared to crops like tobacco, it is likely to grow in importance, especially in Gujarat where water is already a scarce commodity. The voluminous nature of the crop also makes it more desirable from the marketing point of view. This gives a constant business to the cold storage industry.

Also, the growing processed food industry, which depends on cold stored vegetables for many products will give a fillip to this industry. The mushrooming of hotels can prove to be a boon for this industry. Further, there is no major hassle in this industry so far as day-to-day functioning is concerned. Therefore, new comers to business as well as farmers tend to invest in this business. But, in order to enhance the viability of cold store as a unit, it will be important for owners to get into related activities like trading, processing, and procurement.

Further, as and when futures markets in agricultural commodities including potatoes become more developed and better organised in India, these stores will provide a very crucial service for these markets. Since futures in commodity markets are not far away now, this industry stands to benefit.

Acknowledgement

The author is thankful to Pankaj Shukla, Manish Ranjan, J. Krishna Kumar, and K. Karunakaran, (participants of the 2-year Programme in Rural Management (PRM) at IRMA) for permitting him to use the insights from the focus group discussion with the cold storage owners organised by them at IRMA.

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Drip Irrigation for Sustainable Agriculture

A. Narayanamoorthy

Environmental problems in agriculture have been increasing at a fast rate in the recent years. The main factor responsible for most of these problems is the conventional method of irrigation which is widely practised in Indian agriculture. It results in over-use of irrigation water and brings many negative externalities in agriculture. Keeping in view the growing needs of irrigation water and the multi-faceted impact of the present method of irrigation, many regulations have been introduced to arrest the profligate use of water in both surface and groundwater irrigation. However, the measures introduced so far could not bring any impressive change in the present use of irrigation water. The newly introduced drip method of irrigation is providing to be very effective in reducing the over-exploitation of groundwater and other environmental problems associated with irrigation. Although drip method of irrigation has the power to reduce the environmental problems associated with irrigation water, studies have not attempted to bring out the effectiveness of this technology using field level data. This present study aims to focus on the aspect of water saving capacity and economic viability of drip irrigation technology.

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Introduction

Environmental problems in Indian agriculture have been increasing at a fast rate in the recent years. The main factor identified for most of the environmental problems is the flood method of irrigation (FMI), which is widely practised in Indian Agriculture. This conventional method of irrigation not only leads to inefficient use of irrigation water due to enormous losses in evaporation and distribution, but also results in over-use of water and brings many negative externalities in Agriculture (Nadkarni, 1996). While the over-use of irrigation causes damage to soils in the form of water logging and salinity on the one side, it also reduces the yield of crops on the other side (Chopra, 1996). Groundwater irrigation also has its own share of problems although the magnitudes are different from major and medium irrigation (MMI) system. With the fast increase in the density of wells, the rate of exploitation of groundwater is increasing at a rapid rate (Bhatia, 1992; Shah, 1993; Vaidyanathan, 1994; Dhawan, 1996; Saleth, 1996). As a result of over-exploitation of water, problems like sea water intrusion, progressive lowering of water table, increase in fluoride level in groundwater, groundwater mining et., have been noticed across the country (Vaidyanathan, 1994). Keeping in view the growing needs of irrigation water and rapid decline of available irrigation potential, many programmes/regulations have been introduced to arrest the profligate use of water in both the surface and groundwater irrigation. However, these programmes introduced for improving the existing water use pattern could not achieve anything impressively so far.

As the flood method of irrigation (FMI) is responsible for most of the water related environmental problems, they can be reduced by adopting an alternative method of irrigation. The newly introduced drip method of irrigation (DMI) is proved to be very effective in reducing water and its related environmental problems (Narayanamoorthy, 1996 and Narayanamoorthy & Deshpande, 1997). In this method, water is supplied at the root zone of the crops through a network of

pipes with the help of emitters at regular intervals. Since water is supplied through a network of pipes, controllability of water is very high and as a result, evaporation and distribution losses are negligible. As the problems like water logging, salinity etc., are negligible under DMI, this method can be used efficiently in all kind of areas.

The newly introduced drip method of irrigation (DMI) has proved to be very effective in reducing water and its related environmental problems.

Although it has many resource and economic related advantages, studies have not attempted to bring out the importance of drip method of irrigation particularly its water saving capacity and economic viability, using field level data. It is in this context, the study aims to focus specifically on (1) water use pattern including water use efficiency, (2) consumption of electricity and (3) the economic viability of this technology using both experimental as well as field level data.

Data and Method

As the drip method of irrigation is a new irrigation technology in Indian agriculture, many research institutions have been involved in experimenting the viability of this method in different crops in their research farms. We have collected these experimental data of different research stations on drip irrigation from the *Status Report on Drip Irrigation* published by the Indian National Committee on Irrigation and Drainage (INCID, 1994).

As the drip method of irrigation is a new irrigation technology in Indian agriculture, many research institutions have been involved in experimenting the viability of this method in different crops in their research farms.

For field level study, two districts were selected, namely, Nasik and Jalgaon in Maharashtra where DMI is being used extensively, based on the area and number of adopters. List of adopters of drip irrigation have been collected from drip irrigation cell, Commissionerate of Agriculture, Government of Maharashtra, Pune. Since water use and productivity varies from crop to crop, we selected two dominating crops one from each district for an indepth study. The two selected crops are banana

from Jalgaon district and grapes from Nasik district. While the adopters have been selected randomly from the adopters list of 1992-93, the non-adopters have been selected purposively with the help of the village accountants. In each district, 50 farmers—25 drip adopters and 25 non-drip adopters have been selected. Thus a total of 100 sample farmers have been selected altogether for field level survey. Since it is essentially an impact study, comparison has been made between the farmers who cultivate crops under DMI and FMI to understand the water use efficiency and economic viability.

Water Related Environmental Problems: A Review

As mentioned earlier, a substantial amount of area has been affected by the water and other associated problems in India. According to an estimate of Central Water Commission about 141 mha, out of 329 mha of geographical area is subject to water and wind erosion (Table 1). In addition to this, about 34 mha is affected by land degradation problems like water logging, alkaline and acidic soil, salinity, ravines and gullies, shifting cultivation, riverine and torrents etc. That is, only about 47 per cent of the total geographical area can be considered as unaffected land resources. The major causes for land degradation are water logging and salinity and estimates indicate that over 40 per cent of the land area is affected by such problems. Out of 8.5 mha of the land affected by water logging in the country, nearly 2.46 mha is estimated to be caused by inadequate drainage system in the command areas (table 1). Similarly out of 5.5 mha of the land affected salinity, as much as 3.06 m. ha comprises of the area affected due to irrigation related problems. Maximum problems of water logging is reported to be concentrated in the states of Bihar, Uttar Pradesh, Andhra Pradesh, Haryana and Punjab which account for nearly three-fourth of the total area affected in the irrigation commands in the country.

According to various studies, the main reason for the water logging is the over-use of irrigation and negligence of drainage part of the irrigation system. In this connection Vaidyanathan narrates, "injudicious use of canal water—typically arising from over-irrigation and neglect of drainage—causes water logging and a rise in the water table which if uncorrected, eventually leads to salinisation" (Vaidyanathan, 1996, p. 83). While discussing about groundwater problems, he mentioned, "practically all districts of the Punjab and parts of Haryana are reported to be extracting more—in some cases by as much as 100 per cent—than the estimated usable discharge. The average depth of the water table is estimated to falling by 1 to 33 cm per annum in different districts of Haryana" (p. 48). Similarly a study related to

Gujarat indicated that the water table practically all (87 out of 96) observation wells monitored by the Central Groundwater Board has been in the declining trend during the 1980s, the average decline for districts ranging from 0.5 meters in one case to a high 9.5 meters in the worse case (Bhatia, 1992).

Table 1: Distribution of Estimated Areas under Different Soil Erosion, Land Degradation and Land Utilisation Problems (million ha)

Affected Area/Problems Area	With 1976-77 LUS and Reports till 1980-81		With 1981-82 LUS and Reports till 1984-85	
	Area	Per cent	Area	Per cent
1. Area subject to water and wind erosion	150.00	85.68	141.25	80.69
2. Area degraded through special problems:				
i. Water logged area	6.00	3.43	8.50	4.86
ii. Alkali soils	2.50	1.43	3.58	2.05
iii. Acid soils	-	-	4.50	2.57
iv. Saline soils including coastal sandy areas	5.50	3.14	5.50	3.14
v. Ravines and Gullies	3.97	2.26	3.97	2.27
vi. Area subject to shifting cultivation	4.36	2.49	4.91	2.80
vii. Riverine and torrents	2.73	1.56	2.73	1.56
Total problems area	175.06	100.00	174.95	100.00

Source: CWC. (1996), Water Related Statistics, Central Water Commission, New Delhi.

Another study related to Gujarat (Coastal areas of Saurashtra region) showed the adverse condition of the effect of over-exploitation of groundwater. Tubewells development in these areas shifted the crop pattern from food crops to sugarcane to larger extent. As a result, water table in this region fell by 3-10 meters over a period of seven or eight years. In 1970, a majority of the farmers in this area suffered reduced crop yields, and found well water brackish; some farmers continued to irrigate with the saline water thereby ruining their top soils. In fact, the unfettered exploitation of groundwater in this region impound largely irreparable damage on land resources and affected a large number of families (Shah, 1993, p. 133).

Although the examples quoted above are very few, every major state has been facing these kind of problems. What is clear from the above is that a lot of cultivable area has been facing problems like water logging, over-exploitation of groundwater and other water

related problems because of the uncontrolled and over-use of irrigation. With the present method, namely, surface or flood method of irrigation, it is difficult to overcome these problems as the controllability of irrigation is very less under conventional method of irrigation. Unlike surface method of irrigation, under drip method of irrigation these water related problems can be minimised as it can be controlled easily.¹

Review of Research Station Results

Drip method of irrigation being a new technique for Indian agriculture, detailed studies based on field level data are hardly available. Most of the available studies are based either on the data of research station or on some individual farmers. Given the limitations, the results of experimental stations would be useful to understand the effectiveness of this technology to some extent. Therefore, let us understand results of the experimental data before going to analyse the field level data. The comparative results of DMI and FMI with regard to water use efficiency and productivity gains are presented in Table 2. It is clear from the table that DMI saves enormous amount of water compared to the flood method of irrigation in almost all the crops reported in the table. Water saving varies from 30 per cent in tomato to over 80 per cent in lady's finger. Saving of water is in the range of 48 to 77 per cent among the water intensive crops like grapes, sugarcane and banana. It clearly indicates the importance of drip method of irrigation in reducing the consumption of water. Besides water saving, productivity of crops is also significantly higher under DMI over FMI. However, water saving and productivity increase alone cannot be the sufficient grounds for judging the viability of this new irrigation technology.

For understanding any technology, one has to compare the investment with the total gain of the project. As drip method supplies water for crops through a network of pipes, it requires a considerable amount of initial investment to irrigate every hectare of land. Therefore, farmers consider this as a capital intensive technology. Capital cost of the drip system varies depending upon the nature of crops and space. Narrow spaced crops require relatively more capital than the wide spaced crops as the narrow spaced crops require more emitters as well as sub and main pipes (INCID, 1994). Estimates show that capital cost of the wide spaced crops like coconut, mango and orange varies from about Rs. 11000/ha to Rs. 20000/ha, while the capital cost for narrow spaced crops is in the range of about Rs. 23000/ha.

1. According to one estimate, water management under DMI is very simple and one labour can easily manage up to 10 ha of land (INCID, 1994).

Table 2: Comparative Advantage of DMI Over FMI: Results from Different Research Stations

Research Institute	Crop	Water Saving (per cent)	Yield Increase (per cent)	Water Requirement (mm/ha)		Crop yield (Mt/ha)	
				FMI	DMI	FMI	DMI
MPAU, Rahuri	Sugarcane	30	20	2310	1620	122.00	146.00
TNAU, Coimbatore	Sugarcane	47	29	1360	921	92.00	119.00
MPAU, Rahuri	Cotton	43	40	895	511	2.25	3.14
TNAU, Coimbatore	Cotton	79	25	700	150	2.60	3.25
MPAU, Rahuri	Tomato	30	05	297	208	1.64	1.72
TNAU, Coimbatore	Lady's finger	84	13	535	86	10.00	11.31
MPAU, Rahuri	Brinjal	47	-	900	420	28.00	28.00
MPAU, Rahuri	Chilli	62	44	1097	417	4.23	6.09
TNAU, Coimbatore	Radish	77	13	464	108	1.05	1.19
TNAU, Coimbatore	Beet	80	56	857	177	0.57	0.89
TNAU, Coimbatore	Sweet Potato	61	40	631	252	4.24	5.89
HAU, Hissar	Potato	-	46	200	200	23.57	34.42
HAU, Hissar	Onion	-	31	602	602	9.30	12.20
TNAU, Coimbatore	Banana	77	-	2430	580	-	-
TNAU, Coimbatore	Papaya	68	77	2285	734	13.00	23.00
Jyoti Ltd., Vadodara	Lemon	81	35	42	8	1.88	2.52
Jyoti Ltd., Vadodara	Groundnut	40	66	500	300	1713.00	2841.00
Jyoti Ltd., Vadodara	Coconut	65	12	-	-	-	-

Notes: MPAU—Mahatma Pule Agricultural University, TNAU—Tamil Nadu Agricultural University, HAU—Haryana Agricultural University.

Source: Compiled from INCID (1994).

in grapes to rs. 33000/ha. for banana. Although the initial requirement of capital cost is more for DMI, it is not very exorbitant when compared to the requirement of investment for creating one hectare of irrigation under major and medium irrigation sector in India.²

Generally, for judging the economic viability of a technology which involves fixed investment, benefit-cost (B-C) ratio will be taken into account. Normally, any project can be treated as economically viable, if the B-C ratio of the project is more than one. We have presented the B-C ratio for different crops cultivated under drip irrigation compiled from the publication of INCID in table 3 (INCID, 1994). The B-C ratio under drip irrigation is normally computed by two ways—including water saving and excluding water saving. It is evident from the table that B-C ratio is in the range of 1.31 in sugarcane to 13.35 in grapes when it is computed excluding water saving and the same is varied from 2.78 in Sugarcane to 32.32 for Grapes when water saving is included for computation. This means that this technology is also

economically viable apart from water saving and productivity gains.

Table 3: Benefit-Cost Ratio of Different Drip Irrigated Crops

Name of the Crop	Spacing (m×m)	Capital Cost (Rs/ha)	Benefit- Cost Ratio	
			Excluding Water Saving	Including Water Saving
Coconut	7.62 × 7.62	11053	1.41	5.14
Grapes	3.04 × 3.04	19019	13.35	32.32
Grapes	2.44 × 2.44	23070	11.50	27.08
Banana	1.52 × 1.52	33765	1.52	3.02
Orange	4.57 × 4.57	19859	1.76	6.01
Pomegranate	3.04 × 3.04	19109	1.31	4.40
Mango	7.62 × 7.62	11053	1.35	8.02
Papaya	2.13 × 2.13	23465	1.54	4.01
Sugarcane	Between biwall 1.86	31492	1.31	2.78
Vegetables	Between biwall 1.86	31492	1.35	3.09

Source: Compiled from INCID, (1994).

2. Estimates show that the investment required to create one hectare of irrigation under major and medium irrigation sector during the Seventh plan was nearly Rs. 60 thousand (For more details in this regard, see Narayanamoorthy, 1995; Gulati et al, 1994).

Analysis of Field Level Data

Although it is clear from the experimental data that

DMI has substantial advantages in terms of productivity gains and water saving over the method of flood irrigation, the results arrived at from the field level data may differ from the experimental stations where crops are cultivated under controlled conditions. Moreover, as mentioned earlier, not many studies are available relating to drip irrigation, especially on the water saving and productivity of crops using field level data. The real advantages of drip method of irrigation can be understood only by analysing farmer's field level data.

Water Use Pattern Under Drip and Flood Methods of Irrigation

It is a well known fact that water use pattern varies with mode of irrigation – tank, canal or groundwater. Control and management of irrigation are also substantially vary with the sources of irrigation (Dhawan, 1988). While tanks and canal irrigation are predominantly managed by public authorities, the groundwater structures are predominantly owned by individual farmers. Since groundwater structures are owned by individual farmers, management of irrigation is relatively better in groundwater than other sources of irrigation (Vaidyanathan, 1996). Although water management in groundwater area is relatively better than tank and canal irrigated area, still enormous water losses occur through evaporation and distribution mainly because of the adoption of flood method of irrigation. Pattern of water use under DMI is entirely different from the FMI as the water is supplied through pipe networks under the new method. To understand the water use pattern, we have calculated the number of irrigations used per hectare and hours of water used per irrigation under DMI and FMI. It is evident from table 4 that the number of irrigations used per hectare is significantly higher for drip adopters as indicated by earlier study (NABARD, 1989). For instance, for Banana, the drip adopters have applied about 82 irrigations more than the non-drip adopters. To maintain moisture level, farmers with DMI use water almost thrice a week which increases the actual number of irrigations for this group. However, this consumes less water when

Table 4: Pattern of Water Use under Drip and Flood Methods of Irrigation

Details	Grapes		Banana	
	Drip Method	Flood Method	Drip Method	Flood Method
Number of Irrigation/ha	187.03	104.37	139.14	66.19
Hours Used per irrigation/ha	6.95	18.89	5.33	16.44
Horse power of the Pump-set Used	4.98	8.94	9.82	10.82

Note: All the sample farmers are using electric pump-set for irrigation.

Source: Field level data.

compared to the surface method of irrigation. For instance, on an average per hectare, farmers with DMI have used the pump-set for about five hours for banana and seven hours for grapes for each turn of irrigation in spite of using lower HP pump-sets. But the same is 16 hours for banana and 19 hours for grapes under FMI. Farmers have to use more time for each irrigation in the case of surface method because of the following reasons. Firstly, FMI supplies water not only for the crop zone but also the non-cropped area, consuming substantial quantity of water. Secondly, uneven land surface and water conveying channels also consume considerable quantity of water in surface method of irrigation. Evaporation losses are also very high in open water conveying channels which increases the requirement of time in using water. But these problems are completely absent in DMI as it supplies water through pipe network (Narayanamoorthy, 1996 & 1997).

Many factors determine the water requirement of a crop at field level. These factors also vary considerably across the farmers. Pump-sets with higher horse power (HP) usually take less time to irrigate a unit of land compared to the pump-set having lower HP. Most of the studies based on research stations data have measured

Table 5: Productivity, Water Consumption and Water Use Efficiency Under Drip and Flood methods of Irrigation

Method of Irrigation	Water Used (in HP hours/ha)		Yield (in quintal/ha)		Water Used/quintal yield	
	Banana	Grapes	Banana	Grapes	Banana	Grapes
Drip Method	7884.70	3319.36	679.54	243.25	11.60	13.61
Flood Method	11130.34	5278.38	526.35	204.29	21.14	25.84
Saving Over Flood Method						
In percentage	29.16	37.28	29.10	19.07	45.13	47.33
In absolute value	3245.64	1968.02	153.19	38.96	9.54	12.23

Source: Computed from field level data.

water consumption in terms of centimetre (cm) under DMI (INCID, 1994). In practice, measuring water in terms of cm is not an easy task at field level as HP of the pump-sets and water level of the well vary across the farmers. Because of these difficulties, we have measured water consumption by multiplying the HP of the pump-set with hours used in that pump-set. Table 5 presents the quantum of water consumption and water use efficiency of drip and non-drip irrigated crops. It is evident from that the consumption of water by crops under DMI is significantly lower than the crops which are cultivated under FMI. Water saving in terms of HP hours in 3245.65/ha and 1968.02/ha for banana and grapes respectively over the method of flood irrigation. In terms of percentage, the saving of water by DMI is about 29 and 37 per cent respectively for banana and grapes over FMI. The implication of the lower use of water is that the exploitation of groundwater can be reduced about 29 to 37 per cent in these two crops by adopting DMI.

With the saving of water by using DMI, it is also possible to increase the irrigated area, with given amount of water. Therefore, to understand this, we have estimated how much of additional area can be brought under irrigation through saving of water in both banana and grapes. The estimated results show that an additional area of 0.60 ha. (1.48 acres) in grapes and 0.41 (1.01 acres) in banana can be brought under irrigation by adopting DMI. This undoubtedly confirms the importance of drip irrigation in saving of water and bringing more area under irrigation.

Although water consumption per hectare is much lower in DMI, one cannot come to a conclusion that water is used efficiently under DMI. Normally, the efficiency of water use is measured in terms water consumed per one quintal or unit of produce. In order to compute this, we have divided per hectare consumption of water with per hectare yield of the crop (table 5). It is clear that water use efficiency is substantially higher in drip irrigated crops. For instance, banana under DMI consumes only 11.60 HP hours of water to one quintal of produce when compared to 21.14 HP hours under FMI. Similarly, in the case of grapes, DMI required about 13.61 HP hours of water compared to FMI, which consumed 25.84 HP hours. This clearly shows that DMI not only reduces the per hectare consumption of water but also the requirement of water per unit of crop yield.

Electricity Saving in Drip Irrigation

This new irrigation technology is also useful in reducing the consumption of electricity. We have noted earlier that the hours of water used per hectare under DMI is lower than in FMI. Therefore it follows simply that the consumption of electricity also reduces significantly

under DMI. In order to know the impact of drip irrigation on electricity saving, we have estimated electricity consumption based on the hours of pump-set operation for both drip and non-drip irrigated crops. For estimating the quantum of electricity saved, we have assumed that for every hour of operation, 0.75 kwh of power is used per HP (Shah, 1993). It is clear from table 6 that farmers using DMI utilise less electricity for both the crops compared to FMI. According to our estimates the saving of electricity by DMI is about 2430 kwh/ha in banana and 1470 kwh/ha in grapes compared to the same crops cultivated under FMI. Further, the estimate on money saved in electricity bill per ha shows that farmers who cultivate crops under FMI can save about Rs. 121/ha in banana and Rs. 738/ha in grapes. This indicates that the drip irrigation technology not only helps in saving water and increasing the yield of crop but also reduces the cost of cultivation enormously by reducing the cost of electricity.

Table 6: Consumption of Electricity in Kwh by Drip and Non-Drip Irrigated Crops

Method of Irrigation	Banana	Grapes
Drip Method of Irrigation	5913.53	2482.77
Flood Method of Irrigation	8347.75	3958.78
Electricity Saving by Drip Irrigation		
In Percentage	29.16	37.28
In Kwh	2434.00	1476.01
In terms of Rs.	1217.00	738.00

Note: A rate of 0.50 paise/kwh is assumed to estimate electricity cost in terms of rupees.

Source: Computed from field level data.

Economic Viability of Drip Irrigation Technology

It is clear from the above the DMI increases the productivity and reduces the water consumption substantially compared to FMI. However, with the saving of water and electricity and productivity gains alone one cannot judge the economic viability of technology. In order to judge the economic viability of a technology one has to consider the net gain arrived from the entire

With the saving of water and electricity and productivity gains alone one cannot judge the economic viability of a technology. In order to judge the economic viability of a technology one has to consider the net gain derived from the entire life period of that technology.

Table 7: Cost of Cultivation, Capital Cost, Gross Income and Subsidy Details of the Crops Cultivated under Drip and Flood Method of Irrigation

(value in Rs/ha)

Particulars	Banana		Grapes	
	Drip Method	Flood Method	Drip Method	Flood Method
1. Cost of Cultivation*	51436.66	52738.56	134506.19	147914.96
2. Gross Income	134043.75	102934.73	247817.02	211037.93
3. Profit (2-1) [§]	82607.09	50196.17	113310.83	63122.97
4. Capital Cost [@]				
i. Total Cost	33595.00	-	32721.00	-
ii. Cost after deducting subsidy	22236.00	-	20101.00	-
5. Subsidy	11359.00	-	12620.00	-

Note: * - including operation and maintenance cost of drip set and pump-set.

§ - farm business income (return over out-of-pocket expenses).

@ - excluding cost of pump-set.

Source: Field level data.

Table 8: Sensitivity Analysis of NPW and B-C Ratio Computed for Drip Irrigated Crops

Details	Without Subsidy Condition		With Subsidy Condition	
	Banana	Grapes	Banana	Grapes
Present Worth of Gross Income (Rs/ha)				
At 15 per cent discount rate	449449	1243794	449449	1243794
At 12 per cent discount rate	483228	1400166	483228	1400166
At 10 per cent discount rate	508026	1522588	508026	1522588
Present Worth of Gross Cost (Rs/ha)				
At 15 per cent discount rate	201696	703553	191814	692574
At 12 per cent discount rate	215431	789179	205287	777909
At 10 per cent discount rate	225484	856148	215159	844677
Net Present Worth (Rs/ha)				
At 15 per cent discount rate	247753	540241	257635	551220
At 12 per cent discount rate	267797	610987	277941	622257
At 10 per cent discount rate	282542	666440	292867	677911
Benefit-Cost Ratio				
At 15 per cent discount rate	2.288	1.767	2.343	1.795
At 12 per cent discount rate	2.243	1.774	2.353	1.799
At 10 per cent discount rate	2.253	1.778	2.361	1.802

Note: Computed by using discounted cash flow technique.

life period of that technology. If the net gain of a particular technology at the end of the life period is expected to be more than the cost, farmers would go for such a technology. Therefore, to evaluate the economic viability of an investment on drip system for the two selected crops, an attempt has been made to calculate Net Present Worth (NPW) and Benefit-Cost (B-C) ratio using Discounted Cash Flow (DCF) technique. As the

DMI involves fixed capital, one has to calculate income stream for the entire life period of the drip set. For estimating cash in-flows and cash out-flows of drip investment we have considered the following assumptions: (i) the life period of the drip set is five years for banana and ten years for grapes for calculating NPW and B-C ratio as followed by the INCID (1994) study (ii) There will not be any change in the cost of cultivation and income

generated by the drip irrigation during the entire life period, and (iii) the technology which is used for crop cultivation is assumed constant for both crops during the entire life period of the drip set. Differential rates of discount (interest rate) are considered to undertake the sensitivity analysis. These are assumed at 10 per cent, 12 per cent and 15 per cent representing the various opportunity costs of the capital.

Before proceeding to analyse the economic viability of drip investment, let us know about the cost of cultivation, capital cost of drip set and amount of subsidy of the two crops cultivated under DMI. These details are given in Table 7. As expected, the gross income and profit (farm business income) are significantly higher for the crops cultivated under DMI compared to the crops cultivated under DMI. However, this profit cannot be considered as a real profit of the crops because it does not include the capital cost of the drip set, its depreciation and interest accrued on the fixed capital while calculating the net profit of the crops. The life period of the drip-set is one of the important variables which determine the per hectare profit especially in the case of fixed investment. Therefore, we have computed NPW and B-C ratio using DCF technique for the entire life period of drip set for both the crops.

Based on the assumptions mentioned earlier, we have calculated NPW and B-C ratio under different discount rates for both the crops. Although all the sample farmers selected for the study have received subsidy from government schemes for installing drip irrigation systems, computation has been done for both with and without subsidy conditions. This is done primarily to understand the impact of subsidy on the economic viability of investment on drip irrigation. The results of sensitivity analysis of NPW and B-C ratio are reported in table 8 for both the crops. It is clear from the table that change in the discount rate significantly changes the value of net present worth in both the crops under both the conditions. For example, at 15 per cent discount rate, the value of NPW is Rs. 540241/ha, but it increases to Rs. 666440/ha when the discount rate falls from 15 per cent to 10 per cent under without subsidy condition. Similarly, with subsidy condition too, the NPW increases from Rs. 551220/ha to Rs. 677911/ha when discount rate falls from 15 per cent to 10 per cent in grapes. This means that farmers will get about Rs. 5.40 lakhs/ha to Rs. 6.66 lakhs/ha in grapes without subsidy condition and Rs. 5.51 lakhs/ha to Rs. 6.78/ha when they get subsidy for installing drip irrigation, at the end of the life period, after deducting all costs including interest on fixed investment. Similar results are arrived in banana as well. As expected, the influence of subsidy factor in increasing the viability of investment is very much noticed in both the crops. Under both with and without subsidy conditions and also at different discount rates used for

computation, the B-C ratio clearly shows that investment on drip irrigation is economically viable. Further, the calculation shows that farmers can realise the entire capital cost invested on drip system from the very first year in both banana and grapes. These sufficiently confirm that drip irrigation technology not only helps in reducing the over-exploitation of groundwater but is an economically viable technology too.

Conclusion

It is understood from both experimental and field level results that drip method of irrigation is very effective in reducing water related environmental problems. According to the experimental data, water saving under drip technology varies from 30 to 80 per cent in different crops compared to the same crops cultivated under flood method of irrigation. Similarly, the results of field level study also show that drip technology helps in saving water by about 29 per cent in banana and about 37 per cent in Grapes compared to the same crops cultivated with similar environmental condition under flood method of irrigation. The benefit-cost ratio and net present worth (NPW) computed using discounted cash flow technique also show that investment on drip system is economically viable and environmentally adaptable. Further, the computation of NPW shows that the farmers can realise the entire capital cost of drip system from the profit of very first year even without getting subsidy from government. Therefore, keeping in view the rapid decline of irrigation potential and the fast emerging water related environmental problems, especially in the over exploited groundwater zones, concerted policies should be formulated for promoting drip method of irrigation. Importantly, government should enact strict regulations which should not permit the farmers to cultivate water intensive crops under flood method of irrigation in the areas where groundwater depletion is already experienced.

The benefit-cost ratio and net present worth (NPW) computed using discounted cash flow technique also show that investment on drip system is economically viable and environmentally adaptable.

Acknowledgement

The author is thankful to his senior colleague R.S. Deshpande for his useful comments on the earlier draft of the paper.

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"We think 1999 will be the year when people make the move towards a "thin" infrastructure."

— Ed Petrozelli
General Manager for
IBM's Network Computer Division in CNet

Performance & Regional Variations in Indian Agriculture

Vijay P. Sharma

The present paper reveals that there has been a marked acceleration in the overall growth of agricultural production in India during the 1980s as compared to the 1970s. Improvement in foodgrains production was mainly because of improvement in crop yields, whereas, in case of non-foodgrains both yield and area increases were witnessed. Furthermore, the agricultural growth has become regionally much more diversified. The growth of agricultural production not only accelerated during this period of early Green revolution but also spread to eastern region which had hitherto been left out. The period of eighties was also characterised by important cropping pattern shifts away from low value coarse cereals towards commercial crops. However, during the nineties there was a deceleration in overall growth performance of agriculture as compared with the eighties. This raises the question, whether India would be able to achieve 4.5 per cent growth rate envisaged in agriculture during the Ninth Five Year Plan. The results of the study by the author clearly indicate that programme and policies to promote agricultural growth should primarily focus on problems and prospects of eastern region of the country. Further the growth performance of agriculture in the nineties indicate that the target of 4.5 per cent growth rate proposed for agriculture seems difficult to achieve unless policies and programmes for broadening the base of agricultural growth are strengthened. In this context, role of physical and infrastructure facilities such as rural roads, irrigation and other inputs, better extension services, input delivery system, marketing facilities, watershed management for development of agriculture and rural sector needs to be strengthened.

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Agriculture has been the most important sector in the Indian economy, in terms of its share of national income and the employment of labour force. In 1996-97 the share of agriculture in the nation's Gross Domestic Product (GDP) was about 29 per cent but engaged almost two-third of the labour force (Government of India, 1997). The performance of Indian agriculture has been remarkable and foodgrain output growth rate has remained ahead of population growth since 1970s. But the pace of agricultural growth in the recent years has been constrained by a number of factors, including relatively slow growth of foodgrains. The annual compound growth rate of foodgrains during the nineties is lower than the annual population growth (1.9%) during the nineties and therefore, a matter of serious concern.

Agricultural growth rate in India till the mid sixties which was 3.2 per cent, was marked mainly by expansion of area under cultivation. In contrast during the seventies a growth rate of 2.2 per cent was achieved due to increase in both area and productivity, while the rate of growth of agriculture during the eighties rose to around 3.4 per cent per annum and was mainly through further yield increases (Ranade and Dev, 1997). However, the deceleration of nineties, is more pronounced for foodgrains than for non-foodgrains since the late eighties (Mukherjee and Vashishtha, 1996). The question therefore is whether it would be possible to improve output growth in agricultural sector to achieve 4.5 per cent growth rate in agriculture during the Ninth Five Year Plan, as proposed in the approach paper to the plan. Do past growth trends in agriculture justify it? What steps/initiatives will be necessary to attain this growth rate?

Deceleration of nineties, is more pronounced for foodgrains than for non-foodgrains since the late eighties.

There is a great population pressure on land with average agricultural land holding a mere 1.54 hectares. Foodgrains account for 30 per cent of agricultural production with rice being the largest crop. Apart from rice which occupies about 23 per cent of Gross Cropped Area (GCA), oilseeds with about 15 per cent of GCA and fibres are major non-food crops. During 1980s oilseeds and sugarcane gained gross cropped area at the cost of coarse cereals. This implies that there is distinct trend towards higher land usage by non-food crops relative to food crops.

There is a great population pressure on land with average agricultural land holding a mere 1.54 hectares. Foodgrains account for 30 per cent of agricultural production with rice being the largest crop.

The performance of agricultural sector differs quite widely across the states/regions. The performance of individual crops also differs widely among the regions and within each region. Therefore, there is also a need to look into the trends of agricultural growth at the disaggregate level, that is which crops, in which states/regions indicate relatively higher growth potential and which are showing signs of saturation. It is equally important to identify the sources of output growth of different crops to find out whether it is the increase in area or yield or both which contributed to growth.

Performance of agricultural sector depends on numerous factors ranging from weather conditions to the use and optimum application of various inputs (like irrigation, fertilisers, seeds, insect pest and diseases control measures), besides institutional support through government price policies, organised marketing and credit supply. Therefore, there is a need to examine the role of these factors in explaining the divergent agricultural performance among the states/regions of the country.

Keeping in view the above mentioned broad objectives, the present paper analyses the growth and instability in area, production and yield per hectare of major foodgrain and non-foodgrain crops, sources of crop output growth and the impact of important factors on crop productivity at the national and state level using the most recent data. There are five sections in the paper.

Data Base and Analytical Framework

In order to study the comparative agricultural

growth performance, only post-green revolution period, that is to the years from 1970-71 to 1995-96 at all-India level and 1970-71 to 1990-91 for different states has been focused. The analysis is restricted only to major foodgrain and non-foodgrain crops, namely rice, wheat, total coarse cereals, total pulses, total foodgrains, total oilseeds and sugarcane, and covers 17 major states.

The states are classified under four regions in order to discuss the results at state level. The organisation of our regions is as follows:

Northern Zone: Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Uttar Pradesh

Eastern Zone: Assam, Bihar, Orissa, West Bengal

Western Zone: Gujarat, Madhya Pradesh, Maharashtra, Rajasthan

Southern Zone: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu.

To compute the compound growth rates of area, production and yield per hectare of principal food and non-food crops at the all-India and state level, exponential trend equations are fitted by Ordinary Least Squares (OLS). Compound growth rates are separately computed for different sub-periods for all the data sets and for the entire period in case of all-India data and state level. All the statistically non-significant growth rates are treated as zero growth rates.

In order to confirm the existence of statistically significance acceleration or deceleration in the growth of crop production, the differences between the 'b' values for the two periods were tested for significance using the formula of 't' test for the means of two independent samples (Alagh and Sharma, 1980; Desai and Patel, 1983). The test applied can be considered as first approximation as the two 'b' values are not really from two independent samples. When the test gives non-significant results, it may be erroneous as the covariance in the denominator is not taken into account but when the test gives significant results, it is likely to be true.

Several alternative measures are used in literature to measure the variations in year to year instability. In this paper the variability in area, yield and production was measured in relative terms by Cuddy-Della Valle Index, used in recent years as a measure of instability in time-series data (Weber and Sievers, 1985).

The growth of agricultural crops has been uneven across regions and over time. Whereas some states witnessed a substantial improvement in growth perfor-

mance of some crops, in other states performance of agriculture declined significantly and in still others performance was more or less stagnant. The question obviously arises as to what are the factors which have influenced the growth of agricultural crops in different regions during different time periods. In order to analyse yield response behaviour of important crops, namely rice and wheat, production function of the following form has been fitted to the data relating to the period from 1970-71 to 1992-93:

$$Y_{ti} = a_0 X_{1ti}^{a_1} X_{2ti}^{a_2} X_{3ti}^{a_3}$$

where Y_{ti} is yield per hectare for the year 't' in varies from 1 to 2; 1 = rice; 2 = wheat, X_{1ti} is fertiliser (NPK) use per hectare of total cropped area for year 't' for crop 'i' in kg., X_{2ti} is percentage of area under high-yielding varieties (HYVs) to total area under crop 'i' for year 't', X_{3ti} is percentage of irrigated area to total area under the crop 'i' for year 't'.

The growth of agricultural crops has been uneven across regions and over time. Whereas some states witnessed a substantial improvement in growth performance of some crops, in other states performance of agriculture declined significantly and in still others performance was more or less stagnant.

Multiple linear regression equation using OLS technique has been fitted in order to estimate the coefficients in the yield response functions. The analysis is conducted at state level and hence can throw light on the role of different factors in different regions which may not be possible if the analysis was at the national level only.

Performance and Instability of Major Foodgrain and Non-Foodgrain Crops: All India

Many attempts were made earlier to analyse and measure the growth in crop production in India as well in different states. Notable among the studies are Vaidyanathan (1977); Dandekar (1980); Krishnaji (1980); Alagh and Sharma (1980); Ray (1983); Sawant (1983); Nadkarni (1986); Rao and Deshpande (1986); Dev (1987); Ninan and Chandershekhar (1993); Sawant and Achuthan (1995); Dev and Mungekar (1996); Bhalla and Singh (1997). But the present study uses the most recent data (upto 1995-96) to study the performance and instability

of principal foodgrain and non-foodgrain crops at all-India level and across different states/ regions.

The annual compound growth rates in respect of area, yield and production for major foodgrain, non-foodgrain and all crops of all-India for the three sub-periods i.e., 1970s, 1980s and 1990s, and entire period (1970-71 to 1995-96) are shown in Table 1. A perusal of the table shows that the foodgrain production increased at a rate of 2.28 per cent per annum during the seventies. This growth was shared by significant expansion in both components of production, i.e., 0.41 per cent increase in area under foodgrains and 1.85 per cent in yield per hectare. In contrast area under foodgrains declined in the 1980s but the foodgrains output continued to increase at the rate of 2.92 per cent as the growth rate of yield per hectare of foodgrains exceeded 3 per cent neutralising the negative growth rate in area. The estimate of growth rate for 80's was higher (2.92%) than that for 1970s (2.28%). An obvious implication is that there was relative acceleration in the process of foodgrain production during eighties.

The performance of non-foodgrains is relatively superior in comparison to foodgrains during the recent period. During 1980s the compound growth rate of non-foodgrains (4.16%) exceeded significantly that of foodgrains. The increase in non-foodgrains production is attributed to the significant increase in area (1.46%) and yield (2.94%) in eighties. While the area under foodgrains declined during this period. This indicates that there has been an increasing shift of area from foodgrains to non-foodgrains in recent years.

The growth rate for all commodities also increased significantly from 2.10 per cent during 70s to 3.46 per cent in 80s. However, during 90s, there has been a deceleration (2.67%) in the growth performance of all commodities as compared to 1980s.

Changes in relative contribution of area and yield components during different periods indicate that the area under foodgrains, non-foodgrains and all commodities increased gradually during the 1970s. This positive trend in case of foodgrains was replaced by negative but statistically non-significant growth rate of 0.13 per cent in the 1980s and 0.64 per cent during 1990s. However, a significant increase in growth rate of yield, i.e., from 1.85 per cent in 1970s to 3.07 per cent in 1980s, more than offset for decline in area and increased output growth above the 1970s level. In contrast non-foodgrains showed acceleration in both area, i.e., from 1.05 per cent to 1.46 per cent and yield per hectare from 0.98 per cent to 2.94 per cent between 1970s and 1980s. The area under all crops increased at a growth rate 0.56 per cent per annum in the seventies and remained almost stagnant

Table 1: All India Compound Growth Rates of Area, Yield and Production of Major Foodgrain and Non-Foodgrain Crops

Crops	1970-71 to 1980-81			1980-81 to 1990-91			1990-91 to 1995-96			1970-71 to 1995-96		
	Area	Yield	production	Area	Yield	production	Area	Yield	production	Area	Yield	production
Rice	0.83*	1.44***	2.29**	0.53***	3.21*	3.76*	0.13	1.91**	2.06*	0.54*	2.47*	3.02*
Wheat	2.28*	2.20**	4.53*	0.50	3.15*	3.68*	1.44***	1.93**	3.44*	1.24*	3.11*	4.38*
Coarse Cereals	-0.81*	1.85**	1.27	-1.31*	2.13**	0.70	-2.35	1.67	-0.72	-1.31*	1.92*	1.01
Pulses	0.38	-0.80	-0.42	0.23	1.63*	1.87**	-0.31	0.62	0.35	0.11	0.90*	0.99*
Total Foodgrains	0.41***	1.85*	2.28*	-0/13	3.07*	2.92*	-0.37	2.26*	1.88**	-0.01	2.71*	2.70*
Oilseeds	0.48	0.17	0.66	2.91*	2.78**	5.99*	1.23	2.82**	4.09*	2.09*	2.04*	4.18*
Sugarcane	1.29***	2.61*	2.24***	1.75**	0.99	3.26*	1.54	1.41	3.06	1.66*	1.50*	3.19*
Cotton	0.41	2.72**	3.11**	-0.96***	4.15*	3.15*	3.15*	2.71	5.89*	0.04	2.88*	2.94*
Non-food Crops	1.05*	0.98*	2.04*	1.46*	2.94*	4.16*	1.63*	2.03*	3.91*	1.46*	1.98*	3.44*
All Commodities	0.56**	1.20*	2.10*	0.26	3.02*	3.46*	0.18	1.81*	2.67*	0.36*	2.01*	2.98*

*, ** and *** significant at 1 per cent, 5 per cent and 10 per cent level, respectively.

during 1980s and 1990s, however the growth rate of yield per hectare increased from 1.20 per cent in 1970s to 3.02 per cent in 1980s but again declined during 1990s. Improvement in performance of Indian agriculture in the 1980s was mainly because of rapid movement in yield growth across crops.

An examination of growth rates for major crops indicates that during the 1970s growth of wheat output has been higher than of rice output. One reason for higher growth rates of wheat production could be the early introduction of HYV in mid sixties as compared to rice (seventies). Another reason could be that wheat is mainly grown under irrigated conditions (about 84% of area under wheat is irrigated) while rice is having only about 47 per cent area under irrigation. Increase in output of foodgrains was due to increase in both area and yield.

During 1980s rice occupied a leading position among all the foodgrain crops with highest growth in production (3.76%), followed by wheat (3.68%) and pulses (1.87%). Improvement in output of crops was mainly because of increases in yield. Contribution of area was either non-significant (wheat and pulses) or significant and negative in case of coarse cereals. Only rice crop benefited marginally (0.53%) from expansion in area in addition to growth in yield. Pulses as group witnessed a statistically significant growth in output at the rate of 1.87 per cent during 1980s and increase in yield was solely responsible for growth in output.

In 1990s wheat again occupied a leading position among all the foodgrain crops with highest growth in production (3.44%), followed by rice (2.06%). Wheat benefited both from expansion in area (1.44%) and yield (1.93%), while the rice acreage remained stagnant and

the area under coarse cereals declined significantly (2.35%). Improvement in foodgrain production was mainly because of improvement in crop productivity.

A comparison of performance of foodgrains between two periods, i.e., 1970s and 1980s clearly shows that for rice and pulses as a group, the growth rates were significantly higher in the second period. Whereas, growth rate of wheat production decelerated from 4.53 per cent in 1970s to 3.68 per cent in 1980s. The decline in production of wheat was due to reduced expansion in area (i.e., from 2.28 per cent in 1970s to zero per cent in 1980s), however the yield per hectare increased from 2.70 per cent in first period to 3.15 per cent in second period. There was a jump in the yield growth of rice from 1.44 per cent in 1970s to 3.21 per cent in 1980s and of coarse cereals 1.85 per cent to 2.13 per cent and pulses zero per cent to 1.63 per cent. However, there has been a deceleration in the growth performance all the crops excluding cotton during 1990s as compared to 1980s which is a matter of concern.

A comparison of performance of foodgrains between 1970s and 1980s clearly shows that for rice and pulses as a group, the growth rates were significantly higher in the second period.

Oilseeds as a group registered high growth in production with a growth rate of 5.99 per cent in 1980s. Expansion in both area and yield per hectare contributed to the growth. The growth rates for area, yield and production during 1970s were non-significant as

against 2.91, 2.78 and 5.99 per cent, respectively in the eighties. This clearly demonstrates that this shift from low to very high growth in the oilseeds sector is mainly due to development of technology and government support in terms of assured and higher market price which needs to be continued in future too.

Production of cotton, the major fibre crop, recorded relatively higher growth rate (5.89%) in the 1990s as compared to moderate growth rate of about 3.1 per cent in the seventies and eighties. Cotton also registered an impressive growth in its acreage during the nineties i.e. from zero per cent in the 1970s to 3.15 per cent in the 1990s. Growth in productivity of cotton was responsible for its superior performance in the seventies and eighties, while area expansion contributed overwhelmingly to growth in production of cotton during the nineties.

Sugarcane is another major commercial crop. Production of sugarcane expanded rapidly at the rate of 3.27 per cent in the 1980s both due to the expansion in area and yield per hectare but much more so due to increase in its acreage. In contrast to good performance of sugarcane during the seventies and eighties, it represents stagnant growth in its output in the nineties.

The results clearly show that all the major crops except coarse cereals and pulses experienced high growth rates (i.e., about 3 per cent or more) in their output in 1980s and the improvement in foodgrain production was mainly because of improvement in yield per hectare. Whereas in case of non-foodgrains, the increase in output was due to increase in both area and yield. During 1990s only wheat crop registered a growth rate of more than 3 per cent per annum but this was lower than the growth rate achieved during the eighties.

The results clearly show that all the major crops except coarse cereals and pulses experienced high growth rates in their output in 1980s and the improvement in foodgrain production was mainly because of improvement in yield per hectare.

In order to examine the hypothesis of acceleration or deceleration in growth during different sub-periods 't' test used for significance of the difference between the means of two independent samples was used. The results of this analysis are reproduced in Table 2.

Statistically significant positive values of mean difference between 'b' coefficients for the two periods indi-

cate the acceleration in growth rate, whereas significant negative values indicate the phenomenon of deceleration. It may be observed that in 1980s the output of rice, total foodgrains, sugarcane, cotton, non-foodgrains as a group and all commodities increased significantly as compared to 1970s. In contrast, wheat registered a deceleration in growth of output during 1980s in comparison to the 1970s. However in 1990s all the crops except cotton witnessed a significant decline in output growth as compared to the 1980s which is a matter of concern.

Instability in Crop Production

Issues relating to fluctuations in agricultural production are important for several reasons. Wide fluctuations in agricultural production affect prices and bring about sharp fluctuations in prices. Many attempts were made earlier to measure the extent of instability in crop production. Notable among the recent studies are: Mehra (1981), Hazell (1982), Ray (1983), Parthasarathy (1984), Dev (1987), Dhawan (1987), Deshpande (1988), Mitra (1990). This section discusses the variations in instability indices during 1970s, 1980s, 1990s and for the entire period of the study pertaining to principal foodgrain and non-foodgrain crops and all commodities.

The results of estimated measures of instability of area, yield and production for principal foodgrain and non-foodgrain crops for the periods 1970-71 to 1980-81, 1980-81 to 1990-91, 1990-91 to 1995-96 and 1970-71 to 1995-96 are presented in Table 3. It may be observed that the output of pulses, sugarcane and cotton showed a greater degree of instability in first period.

The degree of instability in the output of majority of crops except coarse cereals, oilseeds and cotton was lower in the second period, i.e., in 1980s as compared to the first period. During 1990s coarse cereals witnessed increase in instability. The fluctuations in crop yields turned out to be the major factor responsible for this instability. It may also be observed from the table that the degree of instability was highest in case of oilseeds followed by cotton and coarse cereals and lowest for wheat during the period 1970-71 to 1995-96. The contribution of fluctuations in yield to output instability was higher as compared to fluctuations in area. The increase in degree of instability in case of coarse cereals, pulses and oilseeds can be attributed to the fact that these crops are mostly grown as rainfed crops and are mainly dependent on rainfall. The percentage of irrigated area under coarse cereals, pulses and oilseeds is 10.3, 10.4 and 23.9 per cent, respectively as compared to about 47 per cent of rice area and 84 per cent of wheat area under irrigation.

Table 2: Significance of Growth Rates in Production of Major Foodgrain and Non-Foodgrain Crops in India

Crops	1970-71 to 1980-81		1980-81 to 1990-91		1990-91 to 1995-96		Change in 1980's over 1970's	Change in 1990's over 1980's
	b ₁ [@]	SE (b ₁)	b ₂ [@]	SE (b ₂)	b ₃ [@]	SE (b ₃)		
Rice	0.0226	0.0094	0.0369	0.0075	0.0204	0.0079	A (3.9439 [*])	D (5.1421 [*])
Wheat	0.0443	0.0085	0.0361	0.0053	0.0338	0.0080	D (2.7150 ^{**})	D (0.6326)
Total Foodgrains	0.0225	0.0076	0.0288	0.0056	0.0186	0.0074	A (2.2133 ^{**})	D (3.4609 [*])
Oilseeds	-	-	0.0582	0.0130	0.0404	0.0059	-	D (3.8690 [*])
Sugarcane	0.0222	0.0104	0.0321	0.0073	0.0301	0.0193	A (2.5841 ^{**})	D (0.2445)
Cotton	0.0306	0.0113	0.0310	0.0152	0.0572	0.0123	A (0.0700)	A (3.8538 [*])
Total Non-Foodgrains	0.0202	0.0051	0.0408	0.0066	0.0202	0.0051	A (8.1913 [*])	D (7.2262 [*])
All Commodities	0.0208	0.0065	0.0340	0.0055	0.0208	0.0065	A (5.1416 [*])	D (4.2183 [*])

Figures in parentheses are the 't' values

A: Acceleration in growth rates; D: Deceleration in growth rates

@: Where trend growth rates are significant in both the sub- periods.

*, ** and *** significant at 1 per cent, 5 per cent and 10 per cent level, respectively.

Table 3: Instability in Area, Yield and Production of Major Foodgrain and Non-Foodgrain Crops in India

Crops	1970-71 to 1980-81			1980-81 to 1990-91			1990-91 to 1995-96			1970-71 to 1995-96		
	Area	Yield	production	Area	Yield	production	Area	Yield	production	Area	Yield	production
Rice	1.64	7.58	9.05	2.61	4.75	6.89	0.73	1.80	2.54	2.17	6.70	8.13
Wheat	3.61	5.53	7.87	2.75	3.27	4.94	1.83	2.29	2.44	4.02	5.07	6.16
Coarse Cereals	2.55	6.53	9.47	2.40	8.75	9.39	2.35	16.10	15.55	3.45	11.79	11.71
Pulses	3.89	8.56	11.05	3.01	4.49	6.91	3.31	3.28	5.55	3.88	7.28	8.93
Total Foodgrains	1.92	5.85	7.26	2.02	3.77	5.39	1.43	0.99	2.16	2.39	5.41	6.11
Oilseeds	2.65	7.90	9.44	4.39	10.05	12.96	3.04	3.30	2.47	7.79	9.44	16.34
Sugarcane	7.28	4.02	10.02	6.67	6.36	7.15	4.41	2.02	7.88	6.77	8.27	9.70
Cotton	4.14	8.37	10.28	4.93	10.88	14.63	2.68	3.87	5.78	3.28	10.88	14.29

The above discussion clearly demonstrate that the degree of instability as measured by the Cuddy-Della Valle Index for most of crops showed a declining trend in the eighties and nineties as compared to the seventies.

Performance of Major Crops at State/Regional Level

Trends in Production of Major Foodgrain and Non-Foodgrain Crops

The performance of agriculture differs quite widely

across the states/regions. Therefore, to examine growth performance of major foodgrain and non-foodgrain crops in 17 major producing states of India during 1970-71 to 1980-81 and 1980-81 to 1990-91 period, compound growth rates are computed separately for two periods. The results of this exercise are listed in Table 4. The results of state-wise analysis of foodgrain output show that for majority of the states the values of compound growth rates during 1980s are higher than the corresponding estimates for 1970s. This implies acceleration in output growth for foodgrains in the 1980s, though at different rates.

Table 4: Statewise Compound Growth Rates of Production of Major Foodgrain and Non-Foodgrain Crops

(per cent)

States/ Region	Rice		Wheat		Coarse Cereals		Pulses		Total Foodgrain		Oilseeds		Sugarcane	
	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s
Northern Zone														
Haryana	11.52*	3.03**	5.37*	5.93*	-5.45**	-2.00	-0.89	1.33	3.75**	4.39*	1.29	16.01*	-1.46	3.02**
Himachal Pradesh	0.04	-1.07	1.85	3.58	1.36	1.73	-1.44	-4.20	1.25	2.06	4.45	-2.62	@	@
Jammu & Kashmir	3.78*	-0.56	3.55**	3.70**	1.86***	-0.31	0.67	-4.13*	2.86	0.20	7.58*	-6.72*	@	@
Punjab	17.74*	6.46*	4.65*	4.17*	-3.95*	-6.52	-3.12	-4.63**	5.79*	4.35*	-5.02*	-1.96	-0.46	2.32**
Uttar Pradesh	2.83*	5.99*	5.97*	3.54*	-3.80	1.72	-3.08***	0.67	2.24***	3.68*	-1.76	-3.48***	2.46	3.83*
Eastern Zone														
Assam	1.69**	1.67***	12.06**	-2.05	7.59	0.56	2.09	0.31	1.54***	1.79**	4.63*	3.92*	5.22***	-2.22
Bihar	1.12	4.37**	1.93	4.70*	2.85	1.34	-0.02	0.99	0.84	3.69*	0.60	1.91***	-4.13*	6.43*
Orissa	-0.53	3.80***	13.26*	-8.67*	6.08*	-1.87	6.38*	2.01*	0.88	2.77***	5.39*	5.88*	5.50*	0.51
West Bengal	1.02	6.38*	-1.28	1.40	0.06	3.09	-2.50***	-1.34	0.97	5.81*	8.57*	13.21*	-3.68***	-2.74
Western Zone														
Gujarat	4.36	1.11	5.74*	-3.46	0.72	-4.20	5.41**	2.51	2.58	-2.60	6.97	-1.07	8.86*	6.06*
Madhya Pradesh	-1.17	2.90**	0.98	4.48*	-0.38	0.84	0.36	2.16**	-0.50	2.78*	1.16	13.78*	-1.73	2.51**
Maharashtra	6.16**	0.44	11.39*	-1.15	12.07*	2.48	4.41***	6.25*	9.81*	2.09	5.08**	5.14*	7.37	2.09
Rajasthan	3.76	-2.48	4.60*	-3.26**	-4.71*	2.71	-0.14	-1.81	-0.46	2.20	-2.05	16.54*	1.61	-5.39**
Southern Zone														
Andhra Pradesh	4.35**	2.80*	-2.42	-2.37	2.51**	-4.48*	-0.54	4.76*	3.55*	1.39*	-2.79	8.22*	-0.44	-0.55
Karnataka	1.45	0.59	6.17***	-5.81	1.67	0.71	4.13	0.18	1.19	2.39	0.04	7.63*	3.54*	5.24*
Kerala	-0.30	-2.81*	@	@	@	@	4.04*	-1.66***	-0.48	-2.52*	-2.23	-1.96	@	@
Tamil Nadu	-0.63	3.55*	-0.12	11.71*	0.74	0.92	2.62	9.87*	-0.22	3.22*	-2.56	4.12**	4.95*	3.90*

@: not a major crop

Northern Zone

Among the three main rice growing regions, viz., north, south and east, the introduction of HYVs led to increase in output of rice in north during the 1970s and in 1980s, the eastern region. The pattern of growth of production between north, east and south is also dissimilar. Growth of rice production decelerated in most of the states of north and south during the 1980s as compared to the 1970s, whereas the reverse has been the case with the eastern region.

In 1980s foodgrain output expanded at the rate of 4.39 per cent in Haryana, 4.35 per cent in Punjab, 3.68

per cent in Uttar Pradesh and remained stagnant with non-significant growth in Himachal Pradesh and Jammu & Kashmir. The comparison of growth performance of rice output between two periods clearly reveals deceleration in rice economy of the northern zone excepting Uttar Pradesh. In case of wheat an accelerated growth in output was noticed in Haryana and Jammu & Kashmir, while Punjab and Uttar Pradesh experienced deceleration in growth of wheat production during 1980s. Stagnancy or absolute decline in the production of coarse cereals during the 1980's was almost universal for all the states. Haryana performed extremely well with respect to growth in oilseed and cotton production. Punjab and Uttar Pradesh registered an impressive growth in production of cotton during 1980s.

Eastern Zone

There was a significant improvement in the growth performance of foodgrain production in all the states where zero growth rates during 1970s were replaced by higher growth rates in Bihar, Orissa and West Bengal. Improvement was exceptionally high in West Bengal (from zero to 5.81%), followed by Bihar (0 to 3.69%), Orissa (0 to 2.77%), and Assam (1.54 to 1.79%). An examination of performance of major foodgrain and non-foodgrain crops showed an accelerated growth in rice production during eighties in comparison with 1970s. But improvement in growth of wheat production was recorded only in case of Bihar. As for coarse cereals, stagnancy in production was observed for all the states of eastern region during 1980s. The situation with respect to pulses was not very different from that of coarse cereals. Thus, the major contribution to relatively accelerated increase in foodgrain production was mainly from rice during the eighties and from wheat during the seventies.

Among the non-foodgrains, oilseeds performed extremely well with respect to growth in production. Growth rates of oilseed production varied from 1.91 per cent in Bihar to 13.21 per cent in case of West Bengal during 1980s. The growth rates of sugarcane production dropped significantly in Assam and Orissa in 1980s. Only Bihar represented a remarkable increase in sugarcane production in 1980s.

Western Zone

Performance of foodgrains in this region was characterised by worsening of growth environment from the 1970s to the 1980s. The growth rate of foodgrain output declined from 9.81 per cent to zero per cent in Maharashtra. In Madhya Pradesh, zero growth rate realised in 1970s was replaced by a growth rate of 2.78 per cent in 1980s.

Oilseeds registered a high growth in production in 1980s with growth rates ranging from 5.14 per cent in Maharashtra to 16.54 per cent for Rajasthan. This represents a remarkable improvement in oilseeds production during the 1980s over the low growth in their output during 1970s. Performance of sugarcane was not satisfactory in 1980s. Only Madhya Pradesh, registered an increase in sugarcane production in the 1980s in comparison to 1970s. The growth rate of sugarcane declined from 8.86 per cent in 1970s to 6.06 per cent in 1980s in case of Gujarat State. On the whole the performance of agricultural sector was not satisfactory in the western region.

Southern Zone

Performance of foodgrains in the Southern region

too was characterised by deterioration in growth environment in 1980s as compared to 1970s. The foodgrain output increased at a low growth rate of 1.34 per cent in Andhra Pradesh, remained stagnant in Karnataka, declined significantly at a rate of 2.52 per cent in Kerala and increased at a high growth rate of 3.22 per cent in case of Tamil Nadu in the 1980s. The performance of oilseeds in all the four states in the 1980s was satisfactory and much better than in the 1970s.

In order to assess the production performance of states in respect of rice, wheat and total foodgrains, the states were categorised into three categories based on the typology of growth: states reporting significant and positive trends in production; states reporting significant decline in production (i.e., those with negative and significant trends); states whose production is stagnant (i.e., states with positive or negative trends but statistically non-significant). Classification of states based on the production performance of rice for 1970-71 to 1980-81 (1970s) and 1980-81 to 1990-91 (1980s) are presented in Table 5.

During 1970's Haryana, Jammu & Kashmir, Punjab, Assam, Maharashtra and Andhra Pradesh registered a significant increase in rice production and none of the state registered a decline in rice production. During the second period, the number of states showing a significant increase in rice production increased from six to ten. All the states of eastern zone reported a significant increase in rice production. Kerala had the dubious distinction of being the only state which recorded a significant decline in production of rice during 1980s, whereas in Himachal Pradesh, Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan and Karnataka the rice production was stagnant during the same period. It is interesting to note that bulk of increase in rice production was accounted by the eastern states during 1980s.

Table 5 presents the relevant information for wheat crop with states classified as above for the 1970s and 1980s. As evident, during the 1970s, ten out of 15 states, recorded a significant increase in wheat output, where the number of states reporting a significant increase in wheat production during the 1980s declined to six. Karnataka registered a significant decline in wheat production. The performance of wheat in eastern region showed a stagnancy in wheat production. Gujarat and Maharashtra showing a significant increase in 1970s recorded a stagnancy in production. The above discussion clearly indicates that during the 1980s the performance of wheat was unsatisfactory in comparison with 1970s.

The classification of states based on their foodgrain production performance are presented in Table 5.

Table 5: Classification of States According to Growth Trends in Rice, Wheat and Foodgrain Production During Seventies and Eighties

Typology of growth	Rice		Wheat		Foodgrain	
	1970-71 to 1980-81	1980-81 to 1990-91	1970-71 to 1980-81	1980-81 to 1990-91	1970-71 to 1980-81	1980-81 to 1990-91
Significant increase in production	Haryana, Jammu & Kashmir, Punjab, Assam, Maharashtra, Andhra Pradesh	Haryana, Punjab, Uttar Pradesh, Assam, Bihar, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh, Tamil Nadu	Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, Assam, Orissa, Gujarat, Maharashtra, Rajasthan, Karnataka	Haryana, Punjab, Jammu & Kashmir, Uttar Pradesh, Madhya Pradesh, Rajasthan	Haryana, Punjab, Uttar Pradesh, Assam, Maharashtra, Andhra Pradesh	Haryana, Punjab, Uttar Pradesh, Assam, Bihar, Orissa, West Bengal, Madhya Pradesh, Tamil Nadu
Significant decline in production	Nil	Kerala	Nil	Karnataka	Nil	Kerala
Stagnant production	Himachal Pradesh, Uttar Pradesh, Bihar, Orissa, West Bengal, Gujarat, Madhya Pradesh, Rajasthan, Karnataka, Kerala	Himachal Pradesh, Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan, Karnataka	Himachal Pradesh, Bihar, West Bengal, Madhya Pradesh, Andhra Pradesh	Himachal Pradesh, Assam, Bihar, Orissa, West Bengal, Gujarat, Maharashtra, Andhra Pradesh	Himachal Pradesh, Jammu & Kashmir, Bihar, Orissa, West Bengal, Gujarat, Madhya Pradesh, Rajasthan, Karnataka, Kerala, Tamil Nadu	Himachal Pradesh, Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka

During 1970s out of 17 states only 6 states namely, Haryana, Punjab, Uttar Pradesh, Assam, Maharashtra and Andhra Pradesh registered a significant increase in foodgrain production. During the 1980's the number of states showing significant increase in foodgrain production increased to nine, which clearly indicates that the performance of foodgrains was better during the 1980s as compared to 1970s and the substantial improvement in growth performance of foodgrain production in the eastern region has been widely noted. In Kerala, a rapid growth of high value plantation crops has declined the output of staple food crops i.e., foodgrains.

Trends in Yields of Major Crops in Different Regions

The level of output growth rate is jointly determined by the growth rate in area and growth rate in yield. Therefore the growth rates of these two factors (yield and area) have been studied independently. Compound growth rates in respect of yield for important foodgrain and non-foodgrain crops across the states during the 1970s and 1980s are presented in Table 6.

Northern Zone

The growth rates for rice yields during the 1980s were significant and positive for Punjab registered a significant positive growth in rice yield. There was a tendency of decline in growth of productivity in Haryana and Punjab during the 1980s compared to the 1970s. In case of wheat the growth rates of yields for the 1980s were higher in case of Haryana and Punjab as compared to 1970's. The yield of pulses

showed an improvement in Haryana and Punjab in 1980's.

Eastern Zone

Significant positive growth rates for total foodgrains during the 1980s in addition to of course rice and coarse cereals, vis-à-vis during 1970s suggest relative acceleration in growth of their yield in 1980s as against the 1970s for many states of the region. Wheat crop was lagging behind in the growth of yield per hectare. Pulses also registered an increase in their productivity in Bihar (2.27%) and West Bengal (2.57%) during the 1980s. The above results clearly show that a substantial improvement in the growth performance of agricultural sector in the eastern region was achieved during the 1980s.

Western Zone

In 1980s Madhya Pradesh registered a significant increase in the yield of rice, wheat, pulses, total foodgrains, oilseeds and sugarcane and the growth rates seem to accelerate in the 1980s compared to 1970s. In Rajasthan yield of wheat, total foodgrains, oilseeds, and sugarcane were higher in the 1980s in comparison to the 1970s. On the contrary, in Maharashtra and Gujarat there was tendency of decline in growth rate of yield for most of the crops excepting pulses in Maharashtra and cotton in Gujarat.

Southern Zone

Andhra Pradesh and Karnataka witnessed a decline

Table 6: Statewise Compound Growth Rates of Yield of Major Foodgrain and Non-Foodgrain Crops

(per cent)

States/Region	Rice		Wheat		Coarse Cereals		Pulses		Total Foodgrain		Oilseeds		Sugarcane	
	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s
Northern Zone														
Haryana	4.57*	0.31	2.36**	4.05*	-3.70***	1.88	3.60	5.14***	3.32**	4.90*	1.05	6.90*	-1.92	3.03**
Himachal Pradesh	0.19	0.43	0.88	2.97	0.57	1.40	-0.89	-2.11	0.60	1.95	3.74	-1.40	@	@
Jammu & Kashmir	1.46	-0.50	2.53**	1.68	2.08**	-0.91	-0.19	-1.32	1.96*	-0.38	3.60**	-9.23*	@	@
Punjab	4.71*	1.57***	2.26*	2.92*	1.08	0.77	-1.63	3.07**	3.17*	2.91*	-0.62	2.68*	3.09*	0.37
Uttar Pradesh	1.29**	5.72*	2.81**	2.76*	-1.05	3.83*	-0.56	0.32	1.92	3.61*	-1.85	5.39*	0.49	1.99*
Eastern Zone														
Assam	0.27	0.97	1.81	-0.64	0.86*	0.35*	-0.08	0.48	-0.13	1.21***	0.10	0.59	-1.15**	0.78
Bihar	0.48	4.37*	-0.06	2.68*	4.37	5.51*	-0.13	2.27*	0.76	3.70*	0.14	2.84*	-1.70***	5.18*
Orissa	0.45	3.33**	1.27	-1.58*	-1.28	2.29**	1.43	-0.01	0.66	2.21	-3.01*	1.44*	0.46	1.11*
West Bengal	1.29	5.05*	-2.64**	-0.63	2.93*	4.59***	-0.92	2.57*	1.07	4.84*	3.17*	7.25*	1.25	2.42*
Western Zone														
Gujarat	3.87	0.52	2.03**	-0.38	2.92	-1.84	1.67	-0.06	3.24	-1.33	3.94	-0.25	1.82*	6.53**
Madhya Pradesh	-2.16	2.46**	1.01	3.91*	-0.29	2.78	-2.68**	2.43*	-0.53	3.08*	1.09	6.29*	-0.70	2.86*
Maharashtra	4.50***	0.29	7.43*	2.45	10.47*	2.44	1.62	4.06*	7.80*	1.84	2.62	1.42	3.33*	-1.21*
Rajasthan	-1.09	1.89	1.54**	4.05*	-3.16	3.12	0.35	0.23	0.14	3.13***	-1.05	6.64*	-0.26	1.91***
Southern Zone														
Andhra Pradesh	2.65*	2.00*	-1.71	3.99	4.16*	1.85***	-0.52	3.70*	3.70*	3.11*	0.10	2.82**	-0.92	-1.33**
Karnataka	1.56***	0.20	4.78***	-1.34	2.06**	0.32	1.62	-0.68	1.68***	0.16	-0.86	-0.72	-1.43**	0.08
Kerala	0.80**	1.30*	@	@	@	@	4.93*	1.82*	0.69***	1.46*	-3.83*	-1.10	@	@
Tamil Nadu	-0.05	5.83*	@	@	2.60**	2.72**	1.72	4.35*	0.72	4.01*	-0.33	2.16**	2.59*	0.99

@: not a major crop

in the yield of total foodgrains in the 1980s as compared to the 1970s, whereas the growth rates of yield in case of Kerala and Tamil Nadu were higher in the 1980s compared to 1970s. Andhra Pradesh registered an increase in the yield of pulses and oilseeds during the 1980s, while Karnataka showed a deceleration in the growth rate of yields for all the crops during the 1980s. Tamil Nadu showed a dramatic increase in the growth rates of yield of most of the crops during the 1980s.

Growth in Acreage of Principal Crops at the State/Region Level

The compound growth rates of area under principal crops for the two periods: viz., 1970s and 1980s were calculated and are presented in Table 7.

Northern Zone

During 1980s, growth in area under total foodgrains received a setback. The trend in area under foodgrains was significant and positive in Jammu and Kashmir (0.59 per cent) and Punjab (1.43 per cent) and non-significant in all other states. Comparison of growth rates between the 1970s and 1980s reveals a deceleration in growth of acreage in all the states. Compound growth rates of area under rice declined from 6.63 per cent in the 1970s to 2.72 per cent in the 1980s in Haryana and from 12.37 per cent to 5.24 per cent in Punjab. The area under wheat also declined in all the states excepting Jammu and Kashmir during the 1980s as compared to the 1970s. Similar trends were observed for coarse cereals and pulses. In Haryana, the growth rate of oilseeds moved up

Table 7: Statewise Compound Growth Rates of Area of Major Foodgrain and Non-Foodgrain Crops

(per cent)

States/Region	Rice		Wheat		Coarse Cereals		Pulses		Total Foodgrain		Oilseeds		Sugarcane	
	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s
Northern Zone														
Haryana	6.63*	2.72*	2.95*	1.81*	-1.37***	-3.81*	-3.38	-3.62	0.34	0.47	0.74	7.97*	0.47	0.38
Himachal Pradesh	-0.23	-1.48*	0.95***	0.60**	0.78**	0.33**	-0.56	-2.16	0.63*	0.10	0.68	-0.46	@	@
Jammu & Kashmir	2.29*	-0.07	0.98*	2.09*	-0.21	0.60*	0.84	-2.85*	0.88*	0.59*	3.84*	2.79*	@	@
Punjab	12.37*	5.24*	2.33*	1.22*	-4.97*	-7.23*	-0.85	-7.52*	2.44*	1.43*	-4.43*	-4.52**	-3.46**	1.95
Uttar Pradesh	1.55*	0.26	2.98*	0.76*	-2.77*	-2.03*	-2.54*	0.87	0.29	0.15	0.07	-8.42*	1.12	1.82**
Eastern Zone														
Assam	1.42*	0.69**	10.09**	-1.42	6.68*	0.20	2.17*	-0.16	1.67*	0.56	4.52*	3.31*	4.42*	-2.99*
Bihar	0.63	0.37	1.99	1.96*	-1.46**	-3.93*	-1.88*	-0.98	0.08	-0.01	0.46	-0.92	-2.46*	1.19
Orissa	-0.97*	0.46	12.40*	-7.21*	7.45*	-4.06	7.99**	2.02*	1.55*	0.37	8.65*	4.38*	5.01*	-0.59
West Bengal	-0.00	1.27*	1.40	2.04	-2.80*	-1.82**	-1.61	-3.80*	-0.09	0.92*	5.24*	5.56*	-4.86**	-5.04**
Western Zone														
Gujarat	0.47	-0.99	3.69***	-3.09	4.69**	-2.04	3.68**	2.58	-3.05***	-0.69	2.92*	-0.83	6.91*	2.11
Madhya Pradesh	0.90*	0.42*	-0.03	0.54	0.05	0.04	1.04*	-0.22	0.52*	-0.31	0.06	7.05*	-1.62	-0.35
Maharashtra	1.59*	0.16	3.69**	-3.52*	1.45***	-1.92	2.74**	1.91*	1.87**	0.24	2.41**	3.68*	3.91*	3.33**
Rajasthan	4.91*	-2.93	2.98*	-0.76	-1.62	-0.39	-0.63	-2.05	-0.61	-0.90	-0.99	9.30*	1.87	-6.89**
Southern Zone														
Andhra Pradesh	1.58**	0.78	-0.72	-6.12*	-1.63*	-6.15	-0.03	1.02***	-0.17	-1.65*	-2.89*	5.26*	0.48	0.74
Karnataka	-0.11	0.38	1.32	-4.49*	-0.49	0.41	2.47***	0.87**	0.22	0.32	0.91	7.51*	5.04*	5.16*
Kerala	-1.08*	-4.04*	@	@	@	@	-0.86**	-3.35*	-1.15*	3.92*	1.65*	-0.87	@	@
Tamil Nadu	-0.59	-2.16**	@	@	-1.82	-1.69**	0.86	5.28*	-0.87	-0.76	-2.23**	1.92**	2.28***	2.87*

@: not a major crop

steeply from zero per cent in the seventies to 7.79 per cent in the eighties. The area under sugarcane remained stagnant in all the states excepting Uttar Pradesh.

Eastern Zone

During 1980s the growth rate in area under total foodgrains was positive and statistically significant (0.92%) in case of West Bengal only. In case of Assam and Orissa, where area expansion in total foodgrains took place in the seventies, remained stagnant during the eighties. The comparison of growth rates of area under rice, wheat, coarse cereals, pulses and total foodgrains between the two periods shows that area expansion has slowed down during the 1980s in the region for majority of the states.

Western Region

The growth rates for rice in the region were significantly lower during the 1980s than those of 1970s. The area under wheat declined significantly in Maharashtra (3.52 per cent) during the 1980s and remained stagnant in case of Gujarat, Madhya Pradesh, and Rajasthan. The area under coarse cereals also remained almost stagnant in the 1980s. Among the non-foodgrain crops oilseeds registered an increase in area during the 1980s in all the oilseeds registered an increase in area during the 1980s in all states excepting Gujarat. The comparison of growth rates for two periods show that the area expansion has increased during the 1980s. The total foodgrain acreage remained stagnant in the 1980s.

Table 8: Classification of States According to Growth Trends in Area and Yield Per Hectare of Rice

States showing	1970-71 to 1980-81			1980-81 to 1990-91		
	Significant increase in yield	Significant decline in yield	Significant increase in yield	Significant increase in yield	Significant decline in yield	Significant increase in yield
<i>Significant increase in area</i>	Haryana, Punjab, Uttar Pradesh, Maharashtra	Nil	Jammu & Kashmir, Assam, Madhya Pradesh, Rajasthan	Punjab, West Bengal, Madhya Pradesh	Nil	Haryana, Assam
<i>Significant decline in area</i>	Kerala	Nil	Orissa	Kerala, Tamil Nadu	Nil	Himachal Pradesh
<i>Area Stagnant</i>	Karnataka	Nil	Himachal Pradesh, Bihar, West Bengal, Gujarat, Tamil Nadu	Uttar Pradesh, Bihar, West Bengal, Orissa, Andhra Pradesh	Nil	Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan, Karnataka

Table 9: Classification of States According to Growth Trends in Area and Yield Per Hectare of Wheat

States showing	1970-71 to 1980-81			1980-81 to 1990-91		
	Significant increase in yield	Significant decline in yield	Significant increase in yield	Significant increase in yield	Significant decline in yield	Significant increase in yield
<i>Significant increase in area</i>	Haryana, Punjab, Jammu & Kashmir, Punjab, Uttar Pradesh, Gujarat, Maharashtra, Rajasthan	Nil	Himachal Pradesh, Assam, Orissa	Haryana, Punjab, Bihar	Nil	Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh
<i>Significant decline in area</i>	Nil	Nil	Nil	Orissa	Nil	Maharashtra, Andhra Pradesh, Karnataka
<i>Area Stagnant</i>	Karnataka	West Bengal	Bihar, Madhya Pradesh, Andhra Pradesh	Rajasthan	Nil	Assam, West Bengal, Gujarat

Southern Zone

The growth in area under foodgrains received a severe set back in the 1980s with the negative trend emerging in Andhra Pradesh (19.65 per cent) and Kerala (3.92 per cent). The growth rate for rice area also declined in Kerala and Tamil Nadu and remained stagnant for Andhra Pradesh and Karnataka. During the 1980s, southern zone experienced significant absolute decline in area under foodgrains leading to negative growth in output of foodgrains. In contrast the area under oilseeds and sugarcane registered an increase in 1980s in comparison to the 1970s.

In order to analyse the relative contribution of area and yield towards the observed growth in the production of rice, wheat and total foodgrains, the state have been categorised into different groups on the basis of their growth trends: states showing significant increase in area/yield (those with positive and significant trends); those representing significant decline in area/yield (those with negative and significant growth rates); state

reporting stagnation in area/yield (those with positive or negative growth rates but statistically non-significant).

Table 8 presents the relevant information for rice crop with states classified as above for the periods 1970s and 1980s. During the 1970s, out of 17 states only six states recorded a significant increase in yield. While the number of states reporting significant increase in yield increased to 10 in the 1980s. During the 1970s eight states reported a significant increase in area under rice, whereas the remaining nine states reported area to be more or less stagnant. During the 1980s there was a change in this scenario with only five out of seventeen reporting a significant increase in rice acreage. From the point of view of improvement in rice economy, the best situation is the first category with significant increase in area associated with significant increase in yield followed by stagnant area and significant increase in yield, whereas the situation of significant decline in both area and yield is the worst. None of the states was in the worst situation in both the periods. However, the number of states showing significant increase or stagnant

Table 10: Classification of States According to Growth Trends in Area and Yield Per Hectare of Foodgrains

States showing	1970-71 to 1980-81			1980-81 to 1990-91		
	Significant increase in yield	Significant decline in yield	Significant increase in yield	Significant increase in yield	Significant decline in yield	Significant increase in yield
<i>Significant increase in area</i>	Jammu & Kashmir, Punjab, Maharashtra	Nil	Himachal Pradesh, Assam, Orissa, Madhya Pradesh	Punjab, West Bengal	Nil	Jammu & Kashmir
<i>Significant decline in area</i>	Kerala	Nil	Gujarat	Andhra Pradesh, Kerala	Nil	Nil
<i>Area Stagnant</i>	Haryana, Andhra Pradesh, Karnataka	Nil	Uttar Pradesh, Bihar, West Bengal, Rajasthan, Tamil Nadu	Haryana, Uttar Pradesh, Assam, Bihar, Madhya Pradesh, Rajasthan, Tamil Nadu	Nil	Himachal Pradesh, Orissa, Gujarat, Maharashtra, Karnataka

acreage and significant increase in yield increased from five in the 1970s to eight in the 1980s, which indicates an acceleration in the rice output.

During the 1970s, eight states reported a significant increase in area under rice, whereas the remaining nine states reported area to be more or less stagnant. During the 1980s there was a change in this scenario with only five out of seventeen states reporting a significant increase in rice acreage.

Table 9, shows that Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, Gujarat, Maharashtra, and Rajasthan reported a significant increase in area and yield of wheat during the 1970s. During the subsequent period there was a dramatic change in this scenario with only three states, viz., Haryana, Punjab and Bihar reporting a significant increase in both area and yield. During the 1980s, Orissa was in the most unfavourable situation of significant decline in area associated with significant decline in yield. All the states reported either significant increase or stagnation in the acreage under wheat during the 1970s while Maharashtra, Andhra Pradesh and Karnataka witnessed a significant decline in the wheat area during the subsequent period. From our analysis it seems that rice has performed better as compared to wheat in the 1980s as evinced by significant expansion of area under rice and improvement in the crop yields.

Table 10 presents the summary information of the growth performance of the states in respect of area and yields per hectare of total foodgrains, classified on the basis of criterion mentioned earlier. It is evi-

dent that during the 1970s, only six states recorded a significant increase in yield and significant increase or saturation in the acreage under total foodgrains. During the 1980s, it is gratifying to note that eleven out of seventeen states reported a significant increase in the yield. From the table it is clear that during 1970s expansion in area and improvement in yields were responsible for increase in foodgrains production. However, during the 1980s the improvement in foodgrain production was mainly due to improvement in crop productivity because only three states reported an increase in area under foodgrains. Kerala witnessed a significant decline in area under foodgrains during both the periods.

Factors Influencing Agricultural Output

It is also important to examine the trends in crop yields and major yield increasing inputs, namely, irrigated area, area under HYVs and the average fertiliser consumption per hectare. Table 11 shows 1970-72 (triennium) to 1990-92 (triennium) trends in yields, irrigation level, and area covered by HYVs of rice. Fertiliser consumption is the average rate (in kg of the total cropped areas) on area under all crops because crop-wise consumption data is not available.

It is evident from the table that there has been an uninterrupted increase in the rice yield and use of all three inputs at all India level. The percentage of rice area irrigated increase from 39.2 in 1970-72 to 46.0 in 1990-92. The fertiliser consumption has increased more than four times during the same period. The area under HYV also increased from 18.9 per cent in 1970-72 to 65.2 per cent in 1990-92 and nearly two-thirds of this increment came in the period between 1970-72 and 1980-82 which dominated growth in yield. This period accounts for more than 70 per cent of the increment in rice yield.

Table 11: Trends in Rice Yield, Irrigated Area, Area under HYVs and Fertiliser Consumption in Different States

States	1970-72 (Triennium)				1980-82 (Triennium)				1990-92 (Triennium)			
	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Fertiliser consumption @	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Fertiliser consumption @	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Fertiliser consumption @
Haryana	1713	88.1	22.5	17.6	2560	97.7	87.5	45.6	2755	99.4	67.1	104.4
Himachal Pradesh	1047	47.6	37.9	7.3	999	51.8	86.5	18.8	1280	59.9	57.5	33.5
Jammu & Kashmir	1670	92.1	53.6	8.2	2090	90.3	85.2	25.2	1995	89.6	55.2	42.7
Punjab	1939	91.8	60.1	50.6	2945	98.2	94.3	123.1	3292	99.0	93.4	163.4
Uttar Pradesh	786	16.6	19.0	20.7	1087	25.9	48.6	54.1	1773	46.2	81.8	87.6
Assam	1009	26.6	10.1	3.2	1108	23.3	35.1	3.4	1295	21.2	44.5	8.9
Bihar	903	29.5	8.1	9.9	830	34.3	28.5	18.1	988	36.5	30.5	57.2
Orissa	877	19.8	6.1	5.5	902	28.9	33.4	10.1	1300	35.8	58.7	21.1
West Bengal	1223	27.0	12.9	13.7	1193	26.3	35.2	33.9	1973	21.7	58.3	88.5
Gujarat	893	33.5	14.2	17.1	1223	46.0	64.1	37.2	1362	57.1	88.9	70.7
Madhya Pradesh	778	14.4	8.7	5.5	777	17.4	30.3	10.4	1072	21.9	56.5	35.0
Maharashtra	945	24.7	16.7	11.0	1425	26.5	62.7	24.7	1444	25.6	79.6	59.0
Rajasthan	970	31.1	15.2	4.3	871	35.0	30.3	8.3	1090	28.4	29.4	23.2
Andhra Pradesh	1455	94.1	26.0	22.1	2038	94.1	80.9	49.6	2382	95.1	90.9	119.1
Karnataka	1762	67.1	16.1	16.3	1965	63.8	69.9	34.6	2203	64.0	79.0	70.5
Kerala	1534	57.1	31.2	22.8	1666	34.9	54.2	34.4	1985	40.6	30.8	74.7
Tamil Nadu	1966	91.6	76.6	43.7	1991	94.2	81.1	62.8	3040	90.7	96.3	124.1
India	1111	39.2	18.9	15.4	1292	41.6	47.6	34.4	1746	46.0	65.2	68.5

@: Average fertiliser consumption (nutrients) kg. per hectare of gross cropped area of all crops.

Table 12: Trends in Wheat Yield, Irrigated Area, Area under HYVs in Different States

States	1970-72 (Triennium)			1980-82 (Triennium)			1990-92 (Triennium)		
	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)
Haryana	1957	82.7	67.9	2413	93.4	91.9	3566	97.5	97.1
Himachal Pradesh	1020	18.2	38.3	1222	16.7	77.8	1584	17.7	93.4
Jammu & Kashmir	845	19.9	38.7	1038	25.7	91.5	1233	23.7	92.6
Punjab	2292	86.8	72.1	2889	91.5	98.9	3763	96.4	100.0
Uttar Pradesh	1259	67.9	40.6	1710	82.8	77.8	2249	89.7	96.4
Bihar	1331	42.9	71.5	1352	74.1	79.8*	1790	86.4	85.5
Gujarat	1548	72.7	39.5	2023	74.1	69.6	2151	83.8	73.1
Madhya Pradesh	776	17.9	9.0	998	30.2	32.7	1444	57.6	65.6
Maharashtra	456	31.8	28.2	842	50.8	76.9	1074	61.9	79.1
Rajasthan	1274	69.2	32.7	1651	56.9	89.3	2393	64.0	74.6
Karnataka	405	10.0	17.2	586	20.9	35.7	677	37.2	34.7
India	1319	54.4	45.3	1712	70.7	73.3	2333	82.6	87.9

@: Data relates to the year 1980-81 because area under HYVs has been reported higher than the total area under wheat during 1981-82 and 1982-83.

The results at disaggregate levels show that there are important differences among the different regions and also within the region. Haryana and Punjab have almost all the rice area under irrigation against less than 25 per cent in Assam, West Bengal, and Madhya Pradesh. Fertiliser consumption levels also vary widely between 8.9 kg per hectare in Assam and 163.4 kg per hectare in Punjab. Punjab ranks first in terms of yield per hectare among all the states.

All-India level average yield of wheat increased from 1319 kg. per hectare in 1970-72 to 2333 kg/ha in 1990-92 (Table 12). There has been a vast growth in the use of yield increasing inputs in case of wheat. There has been significant increase in the area under irrigation and the coverage of HYVs. The area under irrigation increased from 54.4 per cent in 1970-72 to about 83 per cent in 1990-92. Punjab again ranks first with respect to wheat yield and the coverage of HYVs. Haryana comes next to Punjab.

The above results clearly reveal that the yield performance of rice and wheat in most of the states and all-India level has been quite impressive in the recent years. There is a clear evidence that the growth in the use of these inputs has significant impact on the performance of crops, but it needs a thorough investigation. Therefore, in order to examine the impact of important factors on the crop yields, production function technique has been used. Performance of agricultural sector depends on number of controlled and uncontrolled factors ranging from weather conditions to the use and optimal al-

There is a clear evidence that the growth in the use of these inputs has significant impact on the performance of crops, but it needs a thorough investigation.

location of various inputs like irrigation, fertiliser, seeds, besides institutional support through government price policies and organised marketing and credit supply. In the present study, only important variables such as fertiliser consumption, area under irrigation and HYVs have been taken into account to ascertain the impact of these variables on the crop yields. The scope of investigation has been restricted to rice and wheat only, because these are the major foodgrain crops.

The OLS estimates of rice yield response functions for the selected states during 1970-71 to 1992-93 are presented in Table 13. It is interesting to note

Performance of agricultural sector depends on number of controlled and uncontrolled factors ranging from weather conditions to the use and optimal allocation of various inputs like irrigation, fertiliser, seeds, besides institutional support through government price policies and organised marketing and credit supply.

that application of fertiliser has normally positive and statistically significant effect on yield rates of rice all the states except Maharashtra where the coefficient was negative but non-significant. The increase in yield rate of rice due to one per cent increase in fertiliser ranges from 0.7 per cent in Karnataka to 0.44 per cent in Orissa. Fertiliser consumption in Orissa (21 kg/ha) seems to be quite low in the country. So an increase in application of fertiliser can ensure an increase in the quantum of production of rice. The HYVs variable is positive in some cases and negative in other cases; however the coefficient was positive and significant in case of Haryana and Maharashtra only. Irrigation plays an important role in determining the quantum of rice production. So far less than half of the rice area is under irrigation in the country. The irrigation variable has a positive and significant influence on rice yield in Uttar Pradesh, Karnataka and all-India level.

The OLS estimates of wheat yield response for major wheat producing states for the period under study, i.e., 1970-71 to 1992-93 are presented in Table 14. The results for all-India indicate that the fertiliser consumption and area under irrigation have significant and positive contribution towards the growth of wheat yield. The regression coefficient for fertiliser is found to be positive and statistically significant in all the states implying that there is still scope to increase the wheat yields by applying higher doses of fertilisers. The irrigation variable has positive impact on wheat yields in all the states except Punjab though it is significant in only Uttar Pradesh, Rajasthan and all-India level. It is also observed that the HYVs variable has negative regression coefficients in some cases and positive in other cases but statistically non-significant.

Summary and Conclusions

The study of growth rates of production of major foodgrain and non-foodgrain crops indicate that the overall growth in agricultural production has been faster

Table 13: Estimated Coefficients of the Yield Response Functions for Rice in India, 1970-71 to 1992-93

State	Intercept	Regression coefficients of			R ²
		Fert.	HYVs	Irri.	
Haryana	12.9063	0.2445* (0.0817)	0.1546*** (0.0825)	-1.3887 (1.4615)	0.70
Punjab	-1.6881	0.1950* (0.0617)	0.2110 (0.0937)	1.786*** (0.9690)	0.87
Uttar Pradesh	5.1585	0.1739* (0.0881)	0.1244 (0.0967)	0.3536* (0.1062)	0.94
Bihar	6.4498	0.1793* (0.0776)	-0.0429 (0.0970)	0.1117 (0.4085)	0.41
Orissa	6.4400	0.4363** (0.1986)	-0.0732 (0.1457)	0.0191 (0.5591)	0.51
Madhya Pradesh	8.2784	0.4241* (0.1861)	-0.0745 (0.1407)	-0.6980 (0.6545)	0.43
Maharashtra	7.4531	-0.0408 (0.1136)	0.3245** (0.1211)	-0.3178 (0.4645)	0.50
Andhra Pradesh	-6.8901	0.2492* (0.0428)	0.0584 (0.0530)	3.7872 (3.2693)	0.89
Karnataka	3.7848	0.0701* (0.0480)	0.0669 (0.0478)	0.8878* (0.2309)	0.69
Kerala	7.4246	0.1781* (0.0195)	-0.0128 (0.0298)	-0.0544 (0.0466)	0.82
Tamil Nadu	8.3655	0.3726* (0.0781)	0.0932 (0.2857)	-0.4949 (1.5576)	0.70
India	5.5447	0.3214* (0.1097)	-0.0972 (0.1164)	0.3525* (0.2590)	0.88

Figures in parentheses are the standard errors of regression coefficients.

*, ** and *** significant at 1 per cent, 5 per cent and 10 per cent level, respectively.

during the 1980s as compared to the 1970s. During the seventies both area and yield increases were witnessed whereas, during the eighties the major driving force behind the upward movement in the pace of growth was expansion in yield. In contrast, non-foodgrains registered accelerated expansion in both area and yield per hectare. The pace of growth in yield per hectare of foodgrains increased significantly during the eighties as compared to 1970s. There has been a shift of land from foodgrains to non-foodgrains in the recent period. It is quite clear that the non-foodgrains acquired a distinct lead over foodgrains in India's agricultural growth during the eighties.

During the 1990s, there has been a deceleration in the growth performance of Indian agriculture. Growth in output of foodgrains decelerated in the nineties reaching a level of 1.88 per cent from its earlier level of 2.92 per cent realised in the eighties. The growth rate of non-foodgrains also declined from 4.16 per cent in the eighties to 3.91 per cent in the nineties. Consequently, the growth in output of all

Table 14: Estimated Coefficients of the Yield Response Functions for Rice in India, 1970-71 to 1992-93

State	Inter-cept	Regression coefficients of			R ²
		FERT.	HYVs	IRRI.	
Haryana	2.7091	0.3152* (0.1105)	-0.6760 (0.3687)	1.5353 (1.1254)	0.90
Punjab	7.5217	0.3890* (0.0595)	-0.1665 (0.2566)	-0.1309 (0.2077)	0.86
Uttar Pradesh	1.3570	0.3147* (0.0850)	-0.3099 (0.2425)	1.4061*** (0.7495)	0.91
Bihar	6.5619	0.1859* (0.0530)	0.0799 (0.1546)	-0.0542 (0.1709)	0.57
Gujarat	6.7192	0.1821* (0.0404)	0.0096 (0.0654)	0.0313 (0.0707)	0.60
Madhya Pradesh	6.1282	0.3121* (0.1105)	0.0138 (0.0789)	0.0165 (0.2780)	0.88
Maharashtra	5.0862	0.3402* (0.1102)	0.0528 (0.1050)	0.0746 (0.2983)	0.57
Rajasthan	4.7030	0.2409* (0.0769)	0.0920 (0.1228)	0.4066** (0.2142)	0.86
India	3.6529	0.2638* (0.0791)	-0.3363 (0.2201)	1.0137** (0.4163)	0.95

Figures in parentheses are the standard errors of regression coefficients.

*, ** and *** significant at 1 per cent, 5 per cent and 10 per cent level, respectively.

commodities too decelerated in the nineties reaching the level of 2.67 per cent.

The analysis of pattern of acceleration or deceleration in output growth supported the hypothesis of significant acceleration in the production of foodgrain and non-foodgrain crops during the eighties as compared to the seventies. However during the nineties, significant deceleration in aggregate production in Indian agriculture was witnessed in comparison to the eighties. These results raise the doubt about achieving the 4.5 per cent growth rate in the agricultural sector during the Ninth Five Year Plan.

The results of instability indices show that the instability in production for the entire period 1970-71 to 1995-96 varied from 6.1 in case of wheat to as high as 16.34 in oilseeds. The estimated instability index for the three sub-periods revealed that there was a progressive but marginal decline in instability at all India level. Trends in instability for major foodgrain and non-foodgrain crops show that instability was lowest in case of wheat, followed by total foodgrains, rice and the highest in case of pulses during the seventies and oilseeds during the eighties and the nineties. The fluctuations in crop yields turned out to be the major factor responsible for this instability.

With regard to regional outlook the analysis indicate that the growth performance of Indian agriculture has varied from state to state and region to region. This has affected the overall national performance too depending upon the weightage of the states in the production of various agricultural crops. Recent trends in production growth clearly indicate that in the northern region though high growth in foodgrain production at the rate of more than 4 per cent continued in the eighties, but the large incremental increase in output of atleast traditional crops seems unlikely due to saturation in productivity of major crops. Farm level evidences indicate that in Punjab and Haryana, yields of rice are catching up to the yield frontiers and that further exploitation of yield gap is not economical, as the incremental costs of further yield gains exceed incremental returns. Therefore, major attention must be focused on increasing annual crop production and income through diversification. This may involve partially replacing rice with other crops or enterprises, or both. There may be a greater promise in non-traditional crops such as fruits and vegetables but much will depend on the availability of economically more attractive competing options to rice and wheat and the how the food processing industries come up in the region.

In the eastern zone, all the major foodgrain growing states experienced a rapid improvement in foodgrains output growth. Absolute stagnation in yield and production of foodgrains in the seventies was replaced by growth rates closer to or higher than 3 per cent in all three important foodgrain growing states of the region, namely, Bihar, Orissa and West Bengal. This indicates that the policies to promote agricultural growth should increasingly focus on the problems and prospects of the eastern region, because this region has the comparative advantage in the production of foodgrains. A large part of this agricultural production in this region is under rainfed condition, therefore, irrigation development may be a laudable long run objective.

The performance of the western region has been most unsatisfactory during the eighties. This region is also predominantly dry farming region. One of the reasons for poor performance of agricultural sector in this region could be because the resources available were put to better use in other sectors of the economy since the sectors other than agriculture enjoy a comparative advantage in most of the states of this region.

The southern zone showed a mixed picture in respect of performance of agricultural sector. Kerala recorded a downturn in foodgrain production and this was mainly caused by shift of area away from staple foodcrops to the high value plantation crops. Therefore,

the scarce resources should be allocated to the crops other than food crops.

Yield response analysis revealed that in the states where there has been a significant increase in yield of rice and wheat, fertiliser consumption played a major role in the variation of yield in all the states. In case of rice, the regression coefficients of irrigation were significant for Uttar Pradesh, Karnataka and all India level, whereas in case of wheat it was significant for Uttar Pradesh and Rajasthan. The effect of HYVs was not significant in case of wheat for all the states because the coverage of HYVs in wheat has reached almost the saturation level. Therefore an increase in application of fertiliser and irrigation facilities can ensure an increase in the quantum of crop production.

Based on the above findings one thing is clear that improvement in crop yields will have to be the main part of any growth in agricultural production in future since there is a little likelihood of any significant increase in new cultivated area. The area shifts are possible only within agricultural crops. Reclamation of wastelands, on sustainable basis, is only the way to increase the total arable area but the experiences with reclamation of wastelands for agricultural purposes have not been very encouraging. The recent trends in production growth clearly indicate that programmes and policies to promote agricultural growth should primarily focus on the problems and prospects of the eastern region of the country. Further

One thing is clear that improvement in crop yields will have to be the main part of any growth in agricultural production in future since there is a little likelihood of any significant increase in new cultivated area.

the growth performance of agriculture in the nineties indicate that the target of 4.5 per cent growth rate proposed for agriculture seems difficult to achieve unless policies and programmes for broadening the base of agricultural growth are strengthened. In this context, role of physical and infrastructure facilities such as rural roads, irrigation and other inputs, better extension services and input delivery system, better marketing facilities, watershed management etc. for the development of agriculture and rural sector needs to be strengthened.

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Cotton Farming in Andhra Pradesh: A Production Function Analysis

K. Pochanna

The present paper examines the input-output relationship and compares input efficiency across various size groups on both irrigated and unirrigated cotton farms. The findings of the study clearly demonstrated that the input significantly higher than that on the unirrigated farms which were facing the problem of low yield with uncertainty. Therefore it is suggested that emphasis should be given on a suitable technology package for unirrigated cotton farmers so as to improve their input efficiency. Appropriate technical suggestions are imperative to curtail excess use of chemical inputs which do have an adverse effect on yield of the crop in both the areas. It is also imperative to ensure a reasonable remunerative price along with assured market facilities to cotton growers.

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Introduction

Cotton is an export-oriented crop of great economic importance. India occupies the third place among the cotton growing countries of the world. The area under the cotton is estimated at 1,236 lakh hectares with annual production of 1,911 lakh tonnes in 1994-95. India tops the list in production of extra-long staple cotton in the world.

Among the principal cotton producing states in India, Andhra Pradesh stands fourth. In Andhra Pradesh, cotton cultivation has been concentrated in the districts of Guntur, Adilabad, Prakasam, Kurnool and Warangal. Cotton is having, mostly raised as a kharif crop in the State. The crop is predominantly a rainfed crop in the traditional areas like Adilabad, Kurnool and some other districts. It is also raised as an irrigated crop in the districts of Guntur, Prakasam, Warangal and other districts. There is a need to assess the relative contribution of various inputs to the production of cotton.

Among the major cotton growing districts in the State, Adilabad and Warangal have been selected for this study. These two districts come under Intensive Cotton Development Programme (ICDP) and they occupy a distinct place in the cotton map of the State on account of their significant contribution in production of superior long staple cotton.

With the advent of new strains (HYV seeds), there has been an increase in the potentiality of cotton yield in the irrigated and unirrigated cotton growing areas. But, the increase in cotton yield is not uniform across regions and farmers. The yield level of crops is affected by inputs like irrigation, use of fertilizers, pesticides, quality of seeds and quality of land.

An attempt is made in this paper (i) to estimate the relative contribution of different input to output on irrigated and unirrigated cotton farms; and (ii) to study

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the relative economic efficiency across the various farm size groups on irrigated and unirrigated farms.

Research studies in India on estimation of input-output relationship in irrigated and rainfed crops have been studied by many economists for many decades (Sen, 1963; Raj, 1964; Rao, 1965; Lau and Yotopoulos, 1973; Sidhu, 1974; Bagi, 1981; Kalirajan *et al*, 1991; Panda, 1996). These studies estimated technical and allocative efficiency for suggesting measures for improving the contribution of each input in the productivity of crop enterprise. The studies found inter-size group differentials in productivity due to variation in pattern of input combination across the farms. A few studies have also focussed on estimation of input-output relationship for cotton crop (Sain, 1978; Alshi *et al*, 1983; Subramanyam *et al*, 1987). They observed that the Cobb-Douglas type of production function gives a better fit for the cotton crop. The results of the studies show a positive production elasticity for human labour, farm yard manure and fertilizer. In most of the studies the coefficient of bullock labour turned out to be non-significant with a negative sign and they also inferred that human labour and capital appear as the most significant contributing factors to cotton output. In some studies, the elasticity of fertiliser and pesticides suggests to a reduction in the use of these inputs from the present level.

Data and Methodology

The study has utilised farm level data collected from the six villages in Andhra Pradesh covering different categories of farms and regions (irrigated and unirrigated) taking 1995-96 agricultural year as the reference year. For this study a total of 300 cotton farmers have been selected with the ratio of 150 from irrigated and unirrigated areas.

A unique¹ feature of this data is that farmers from the irrigated and unirrigated areas are selected from At-

1. The selected Mandals (blocks) were included in similar agro-climatic zones. For details refer the National Commission on Agriculture, Rainfall and Cropping Pattern, 1976 (Govt. of India, 1976).

makur Mandal which falls under Warangal district and Kubir Mandal which falls under Adilabad district. For selection of villages and cotton holdings from each mandal two stage stratified random sampling were adopted. The villages with 60 per cent or more area under cotton crop in the Mandals were enlisted; and later the top three villages were selected from each mandal. Among the three villages, one village was the nucleus and others are within the radius of 5 to 8 kilometers from the nucleus village. In each sample, village farmers were stratified into five groups according to the size of holdings: marginal, small, medium, large and very large (big) size groups. Marginal farmers consist of those cultivating less than 2.5 acres, small farmers are those cultivating land between 2.5 and 5 acres while medium farmers are those cultivating land between 10 to 20 acres are considered as large farmers and those cultivating land holdings of 20 acres and more are called big farmers.

In each stratified group the top 15 cotton holdings in the nucleus village and in other villages top 8 and 7 cotton holdings from each village were selected. The cotton holdings, distributed in different size groups, had 30 number of holdings in selected mandals such that each size group had equal number.

The present study used log-linear² Cob-Douglas Production function for cotton crop of aggregated as well as different farm categories both under irrigated and unirrigated farms.

The farm of production function is:

$$\log Y = \log A + a \log X_1 + n \log X_2 + c \log X_3 + d \log X_4 + c \log X_5 + f \log X_6 + g \log X_7 + U_1$$

where

Y = Yield per acre in kgs³.

X₁ = Per acre use of human labour in mandays

X₂ = Per acre use of bullock labour days

X₃ = Per acre use of farm yard manure in Rupees

X₄ = Per acre use of chemical fertilizers in Rupees

X₅ = Per acre use of Pesticides in Rupees

2. The regressions are based on double log function in order to absorb the element of non-linearity that generally accompanies the use of data on per acre basis.
3. Heteroskedasticity problem is defined as the large area (size of the farm) having large residual variance and small area (size of the farm) having small variance or vice-versa. This problem is minimised in the present study by measuring all the variables in terms of per acre.

X_6 = Per acre use of HYV seeds in Rupees

X_7 = Per acre use of other expenses in Rupees⁴

U_1 = Random error term with zero mean ($\sum u = 0$) and finite variance ($\sum u^2 = \sigma^2$)

The regression coefficients have been estimated for the production function with the help of the least square method. In the present study, technical efficiency and allocation efficiency, which constitute in economic efficiency are examined both for irrigated and unirrigated farms. Technical efficiency, however, is quite sensitive to the specification of the production function. Hence, a test on technical efficiency is attempted and it is proved that the assumption of linearity and homogeneity is valid in both the farms. The problem of multi-collinearity is also addressed and it is found that none of the coefficients of the explanatory variables is greater than the value of coefficients of multiple correlation.⁵

Relative Allocative Efficiency

The ordinary least square estimates are presented in Table 1. It can be observed from the table that the seven selected explanatory variables used in the model were able to explain the variation in cotton yield to the extent of 90 per cent in irrigated and 80 per cent in unirrigated farms. In both the cases the coefficient of determination (R^2) was highly statistically significant at one per cent level. The sum of elasticities of input gives an indication of return to scale. The "t" test indicated that the sum of elasticities in both the farms are significantly characterized by constant return to scale. In both the group of farms, human labour was exerting a significant influence on yield. The production elasticities of this input indicated that one per cent increase of this input, while keeping all other variables constant at their geometric mean level, would increase the yield by 0.6218 per cent in irrigated and 0.2782 per cent in unirrigated farms. The sum of production elasticities for labour, fertilizer and pesticides turn out to be 1.022 and 0.6745 for irrigated and unirrigated farms. These results show that the determinative influence on cotton yield by these inputs are much stronger in irrigated farms than unirrigated farms. The evidence also suggests that these inputs place a higher premium on investment in cotton farming. The elasticities

4. Other expenses include depreciation charges (calculated by straight line method), maintenance of machinery, hiring charges of machinery, interest on expenses (hired labour + hired bullock labour + value of seed + value of fertilizers + Value of plant protection measures + in the case of irrigated farms irrigation charges). All inputs are measured in 'flow' terms.

5. Klein seems to accept that multi-collinearity is not necessarily a problem unless it is high relative to overall degree of multiple correlation among all variables simultaneously. (Kleins, 1965).

of bullock labour and HYV seed turned out to be much on the lower side and statistically insignificant in both the farms. Some inputs show negative sign, reflecting that there is an excessive use of these inputs. It is clearly evident from Table 1 that the marginal value product and acquisition costs of all the included variables have positive impact on cotton yield except the two factors, namely, bullock labour and HYV seeds which turned out to be negative. In both the farms, labour, farm yard manure and other expenses show higher ratio of marginal value of product to factor cost on these inputs. In irrigated areas the farmers seem to be making excess use of pesticides, resulting in its marginal productivity being lower than its acquisition cost.

The ratio of marginal value product to acquisition cost is much higher in irrigated farms than unirrigated farms. This reflects that the irrigated farms are allocating fertilizer inputs more efficiently than unirrigated farms. The lack of irrigation with higher uncertainty in crop production may be partially responsible for less efficient allocation of fertilizers in unirrigated farms.

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The category-wise ratio of marginal value productivity (MVP) to factor cost for irrigated and unirrigated cotton farms are presented in Table 2. The share of labour in irrigated area is 0.60 in big farms and 2.23 in marginal farms. This indicates that the big farmers are making excess use of human labour results in its marginal productivity being lower than its acquisition cost. The productivity of labour could be increased either through cuts in its level of use or through an increase in the level of other resources or through both. In the case of medium category of farmers, the ratio (MVP/Factor cost) is less than one with a negative sign, which suggests a cut in its level of use from the present level. In the unirrigated area, the ratio of human labour productivity to its factor cost is higher than one in big, large and marginal farm size groups. This indicates the positive impact of human labour on per acre farm crop return.

In the case of bullock labour input except big (irrigated) and medium (unirrigated) farms, all other categories show the ratio (MVP factor cost) less than one and in some categories it has a negative sign. This result suggests that this input is over utilised in relation

Table 1: Estimated Marginal Products and Marginal Value Productivity to Factor Cost Irrigated and Unirrigated Cotton Farms (per acre)

Items	Irrigated				Unirrigated			
	Geometric mean	Production elasticities	Marginal Products	Ratio of marginal productivity to factor cost	Geometric mean	Production elasticities	Marginal Products	Ratio of marginal productivity to factor cost
Yield in Kgs. (Y)	715.08	-	-	-	336.46	-	-	-
Human labour (mandays) X ₁	89.03	0.6218** (5.3547)	4.9942	3.91	57.51	0.2782** (2.6292)	1.6275	2.46
Bullock Labour (days) X ₂	14.49	-0.0593 (-1.4363)	-2.9264	-0.65	17.93	0.0441 (0.4708)	0.7660	0.13
Farm Yard manure (in Rs.) X ₃	300.51	0.0141 (0.4661)	0.0335	2.68	145.18	0.1057* (2.2535)	0.2449	1.95
Fertilizer (in Rs.) X ₄	434.24	0.1498** (4.2392)	0.2468	1.97	099.49	0.60 (1.1826)	0.1021	0.80
Pesticides X ₅ (in Rs.)	1477.2	0.2502* (6.6817)	0.1211	0.96	745.08	0.2803** (5.4659)	0.1265	1.01
HYV seeds X ₆ (in Rs.)	183.27	-0.0345 (-1.0256)	-0.1346	-1.07	178.89	0.0366 (0.1946)	0.6880	5.50
Other expenses X ₇ (in Rs.)	547.3	0.1440** (3.4542)	0.1881	0.50	373.08	0.2652** (4.6023)	0.2391	1.91
R ²		0.9050				0.9094		
\bar{R}^2		0.7960				0.8063		
F-value		193.2500				84.44		
Σbi		1.0961				1.0609		

Note: # since the production function fitted in logarithmic geometric mean level have to be considered

* significant at 0.005 level.

** significant at 0.1.

Marginal products are computed at the geometric and are expressed in kgs.

Figures in parentheses are t-values

Source: Field data.

Table 2: Size-Wise Ratio of Marginal Value Productivity to Factor Cost for (per acre) Irrigated and Unirrigated Cotton Farms

Items	Irrigated					Unirrigated				
	Big	Large	Medium	Small	Marginal	Big	Large	Medium	Small	Marginal
1	2	3	4	5	6	7	8	9	10	11
Human labour (mandays)	0.60	1.62	-0.21	2.22	2.23	7.10	1.35	0.35	0.73	1.06
Bullock labour (days)	1.13	-2.69	0.81	0.66	0.09	-13.58	0.70	1.88	-0.33	-0.82
Farm Yard manure (in Rs.)	-0.11	1.84	-0.34	-3.80	2.22	0.18	0.11	4.22	-0.39	3.08
Fertilizer (in Rs.)	6.40	2.01	-3.34	-2.13	1.49	-2.13	1.49	-2.70	2.48	2.00
Pesticides (in Rs.)	-0.26	0.72	0.28	0.10	0.47	2.01	1.10	0.79	1.06	1.33
HYV seeds (in Rs.)	-5.40	-10.67	-0.42	-11.59	-5.92	-20.36	-5.23	-0.82	-1.93	3.04
Other expenses (in Rs.)	1.13	0.03	5.26	4.31	0.23	2.47	3.15	2.25	2.45	1.42

Source: Field Data.

to its cost. The productivity of bullock labour could be increased by reducing its level of use. The results strongly suggest that for optimising cotton yield, the magnitude of human labour should be increased and bullock labour should be curtailed.

The ratio of MVP to factor cost of fertiliser input shows highest return per unit of cost on big and large size group of farms in irrigated area. In the other categories of farms, the ratios were less than one with negative sign which suggests the need to reduce its level of use. In the unirrigated area except big category of farms, all other category show high return per unit of cost resulting in their ratio (MVP/factor cost) being higher than its acquisition cost.

In the irrigated areas, except small farms all other categories of farmers are making excess use of pesticides, resulting in its marginal productivity being lower than its acquisition cost. This indicates that in this region the farmers are making excess use of this input to avoid the risk and uncertainty of damage by diseases like White-fly and Bole worm which appear in cotton crop. The farmers in unirrigated area, except medium category of farms, all other category of farmers have marginal productivity of pesticides higher than its acquisition cost. The results indicate that in unirrigated areas, the farmers are allocating pesticides relatively more efficiently. The main reason for this is the higher uncertainty of crop production, due to which the farmers have to be more cautious in spending money.

Conclusions

There are a few conclusions that follow from our analysis. Our analysis provides strong evidence that the availability of irrigation is one of the important factors for potential increase of cotton yield. We find that irrigated cotton farms are better off in terms of their economic performance, particularly in use of fertilizer inputs. There is very little difference in the economic efficiency of various classes of farms. However, the small irrigated farms make relatively more efficient use of most of the variables inputs compared to the large ones particularly, the big farms makes relatively less efficient use of pes-

There is very little difference in the economic efficiency of various classes of farms. However, the small irrigated farms make relatively more efficient in most of the variables inputs compared to the large ones.

ticides input. The main reason for this is that although in commercial farming, this category of farms make excessive use of this input to avoid risk and uncertainty. Therefore, the results suggests that in this category, the use of pesticides should be reduced from the present level.

On the whole, the study clearly demonstrates that in the technical and allocative efficiencies, there are not much significant differences among the categories of farms. This shows that the policy for curtailing farm size may be based only on social and political considerations rather than in economic consideration. This inference is subject to the constraint that we have studied only the cotton crop in North Telangana farms. The picture may be different if we study the production relationship between output and input using aggregate data including all crops.

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Changing Structure of Milk Production in Maharashtra: A Macro Level Analysis

Deepak Shah & Alok Shah

Milk production of Maharashtra has undergone considerable transformation mainly due to the application of scientific production technique and greater importance being given to the development of dairy co-operative infrastructure that has contributed in no small measure towards substantial growth in milk production since the early eighties. Nevertheless, the period gone by has also been marked with very slow expansion in milk production figures for some of the districts and regions of Maharashtra. The slowing down in milk production increases has caused a great deal of regional imbalances in production growth. In order to overcome regional imbalances, a medium term strategy is suggested in this paper that will not only increase the resource base of the farmers in the long run but will also help in tapping the unutilised production potential of milch animals and, thereby, lead to increased milk production for this State.

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Introduction

The dairy sector of India has witnessed some major changes over the last two decades. As a result of concerted efforts towards total dairy development, our milk production has nearly tripled¹ and milk has now become our largest single agricultural commodity with dairy industry's turnover estimated at more than Rs. 52,000 crores, a figure which is expected to reach Rs. 88,000 crores per annum by the turn of the century (A. Banerjee, 1995). It is needless to mention that the country's dairy sector needs to be encouraged, but not at the cost of cereal production but of course by fully utilising and exploiting the complementary, supplementary, synergistic and even symbiotic relationship of raising animals with crop production.

As a matter of fact, encompassing a wide geographical area and reflecting different political systems, differing levels of economic development, social systems and changes in tastes, preferences and traditions, the approach to dairy development has varied widely from region to region in India. Viewing our dairy spectrum in the light of these variabilities, it becomes pertinent to ask whether the future of our co-operative will remain as bright as in the past if we were to follow the principles and practices of the past (Shah, 1997).

There is no iota of doubt that since the inception of Operation Flood programme launched in 1970 by National Dairy Development Board the total milk production has been increasing in all the states of the country. The credit for this healthy scenario should also go to various development projects which have been simul-

1. This is evident from the fact that the milk production of India, which had stagnated at around 20 million tonnes for 20 years between 1950 and 1970, began rising from 1970 onwards and crossed the 50 million tonnes mark in 1989. In 1991-92, the milk output was around 59 million tonnes. Milk production is poised to reach the 76 million tonnes mark by 2000 A.D.

taneously undertaken to give a fillip to agriculture and dairy production. As a result of these programme initiatives, the productivity levels of animals have increased to a considerable extent. Nevertheless, still there are wide variations in terms of number of bovines (in-milk) and the productivity of milch animals across states. And, as a result of this the milk production is seen to vary considerably for different states of the country.

Maharashtra, which falls in the western region of the country, started showing quantum leaps in milk production only from 1987-88 onwards when its milk production was 2.66 million tonnes. This State occupied 11th position in the country's total milk production as early as 1986-87. The State currently occupies a much higher position in total milk production owing to sustained and concerted efforts towards total dairy development. During 1990-91, it had even crossed the milk production figures of Gujarat.² In fact, over the last 6-7 years the State has progressed by leaps and bounds in its milk production. Despite these facts there are vast regional imbalances in milk production in the State. Surprisingly, only a couple of regions in the State are contributing to more than 50 per cent of the total milk produced in the State.³ Notwithstanding the regional imbalances in milk production visualised in the State of Maharashtra, the crucial questions that may merit considerations are: What prospects do the study of Maharashtra hold in milk production enterprise? With the passage of time, what structural changes have taken place in different regions of the State vis-a-vis productivity of milch animals, number of animals in milk and total production of milk. What is the extent of instability in the production growth of milk in different districts and regions of the State? No discussion on dairy sector development may be complete without going into these very many questions.

The present study, therefore, was an attempt to examine the above mentioned aspects with a view to evaluate comprehensively the structural changes in milk production and also to identify the factors that are responsible for imbalances in milk production across different districts and regions of this State. This exercise was attempted with a view to formulate strategies for increased milk production in the State of Maharashtra.

2. During 1990-91, while Maharashtra occupied fifth position in the country's total milk production, the position of Gujarat was sixth. The milk production figures for Maharashtra and Gujarat states during 1990-91 were 3.74 and 3.53 million tonnes, respectively.

3. The contribution of Nasik and Pune regions put together to state's total milk production was 54 per cent during the early nineties.

Data Base and Methodology

The study is based on the secondary data collected from various secondary sources and offices. The district-wise time series data on milk production for various species of milch animals as well as total milk production were collected for the period 1985-86 - 1993-94 from the Directorate of Animal Husbandry, Government of Maharashtra, Pune. In addition to this, district-wise data on cattle, buffalo and goat population, their milk productivity, etc. were also collected using Livestock Census reports of 1982 and 1992 for the State of Maharashtra. Exponential trend equations have been fitted to the time series data obtained from various sources in order to compute compound rates of growth that were also tested for their significance by the student 't' statistics.⁴

With a view to understand growth performance of various parameters better and in order to capture year to year fluctuation in the same over the given period of time, an index of instability as suggested by Coppock and subsequently used by Mitra and Shah (1998) was also incorporated in the analysis, which appeared to have taken care of the trend component in the time series data.⁵

The study is divided into three sections. The first section examines the productivity indices of bovines for different districts of Maharashtra and thereby identifies the districts that are instrumental for higher milk production in the State. This section also deals with

4. The equation fitted to analyse the trend is semi-log exponential form

$$Y = e^{A+Bt}$$

$$\text{Log } Y = A + B^*t$$

The compound growth rates (r) = $(e^{B^*}-1) \times 100$ were tested for their significance by the student 't' statistics given by

$$t = \frac{r}{S.E.(r)} \text{ where,}$$

$$S.E.(r) = \left(\frac{100b}{\log e} \right) S.E.(b)$$

5. According to Coppock, the annual instability index equals the anti-log of the square root of the logarithmic variance. The series is given in algebraic form as follows:

$$V \log = \frac{1}{N-1} \sum \left[\log X_{t+1} - \log X_t - \frac{1}{N-1} \right]$$

$$\sum (\log X_{t+1} - \log X_t)^2$$

or

$$V \log = \frac{\left[\log \frac{X_{t+1}}{X_t} - m \right]^2}{N-1}$$

Where, N = number of years; X = Quantity of Production
M = Mean value of the logarithmic first difference.

the changes that have taken place over time in respect of milk productivity of different species of milch animals. Section II places an onerous task on analysing the changing structure of milk production in different districts and regions of Maharashtra. The main foci of attention of Section III are to provide an insight of growth and instability in milk production for different districts and regions of Maharashtra, aside from providing policy suggestion for increased milk production in the State.

Productivity Indices of Bovines⁶

Many workers have reported considerable differences in respect of relative share of different districts in the State's total milk production and in relation to relative share of different districts in the State's total bovine population (in-milk). In more recent times this argument was put forward by Gupta and Jain (1994). There is, therefore, a need to go into the details of these shares and thereby examine inter-district variations in the index of productivity of bovines in the State of Maharashtra.

Many workers have reported considerable differences in respect of relative share of different districts in the State's total milk production and in relation to relative share of different districts in the State's total bovine population (in-milk).

A close scrutiny of results presented in Table 1 revealed considerable variations in the productivity indices of bovines across various districts of Maharashtra. The districts like Greater Bombay, Ratnagiri, Ahmednagar, Pune, Satara and Sangli showed much higher contribution to the State's total milk production compared to their contributions to the State's total bovine population (in-milk). The bovine productivity indices for these districts, therefore, stood at more than 100. There were also spectrum of districts like Raigad, Sindhudurg, Nasik, Aurangabad, Jalna, Parbhani, Nanded, Akola, Amravati, Yavatmal, Wardha, Nagpur and Bhandara which showed much lower contributions to the State's total milk production compared to their contributions to the State's total bovine population (in-milk). The bovine productivity indices for these districts, thus, turned out to be much below 100. In the case of districts, like Chandrapur and Gadchiroli, these indices was found to

6. It is the ratio of share of each district in the State's total milk production to the share of each district in the State's total bovine population (in-milk).

be even below 50. Apart from the districts like Greater Bombay, Ratnagiri, Ahmednagar, Pune, Satara and Sangli, the other districts which showed their bovine productivity indices a little higher than 100 were Thane, Dhule, Jalgaon, Solapur, Kolhapur, Beed and Osmanabad, whereas the bovine productivity indices of Latur and Buldhana worked out at 97 and 99, respectively, indicated that the contributions of these districts to the State's total milk production had fallen little short of their contributions to the State's total bovine population (in-milk).

Thus, based on bovine productivity indices, three categories of districts were identified in this State viz., districts with bovine productivity indices below 50 (category I), districts with bovine productivity indices between 50 and 100 (category II) and districts with productivity indices above 100 (category III). It could be observed that in respect of productivity indices of bovines majority of the districts in the State had fallen under category I and II. However, it is to be noted that the total contribution of districts under category III put together to State's total milk production stood at about 65 per cent. This observation clearly brings us closer to the conclusion that even though there are only 13 districts in the State whose productivity indices of bovines are above 100, by and large their contribution is very high to the State's total milk production. These are the most progressive districts of the State if milk production alone is considered as an indicator for development and growth.

In this context, an earlier study conducted by Gupta and Jain (1994) for 17 major states of the country revealed that *the overall productivity index per bovine (in-milk) was 73 for Maharashtra which turned out to be higher than the bovine productivity indices of Madhya Pradesh, Karnataka, Jammu and Kashmir, Assam and Orrisa, but, at the same time, stood at much below the bovine productivity indices of other major states of the country.* Thus, concerted efforts are still required to be launched in order to boost the productivity of bovines and thereby total milk production in the State.

The overall productivity index per bovine was 73 for Maharashtra which turned out to be higher than the bovine productivity indices of Madhya Pradesh, Karnataka, Jammu and Kashmir, Assam and Orrisa, but much below the bovine productivity indices of other major states of the country.

Table 1: Inter-district Variation in Milk Productivity Indices of Bovine (in-milk) in Maharashtra

District	Total Bovine* Population (in-milk)	Total Milk** Production (in lakh kgs)	Share of District in State's total Bovine population (%)	Share of District in State's total milk Production (%)	Productivity Index of Bovine [(4)/(3) × 100]	Category
	(1)	(2)	(3)	(4)		
Greater Bombay	81268	2115	1.87	4.98	266	III
Thane	111531	1242	2.57	2.92	114	III
Raigad	117832	794	2.71	1.87	69	II
Ratnagiri	67544	582	1.55	1.37	127	III
Sindhudurg	50871	381	1.17	0.90	77	II
Nasik	214254	1846	4.93	4.34	88	II
Dhule	128264	1406	2.95	3.31	112	III
Jalgaon	221265	2434	5.09	5.73	113	III
Ahmednagar	282639	3533	6.50	8.31	128	III
Pune	273478	3446	6.29	8.11	129	III
Satara	221742	2796	5.10	6.58	129	III
Sangli	216402	2573	4.98	6.05	121	III
Solapur	209386	2112	4.82	4.97	103	III
Kolhapur	316790	3121	7.29	7.34	101	III
Aurangabad	118557	980	2.73	2.31	85	II
Jalna	76659	643	1.76	1.51	86	II
Parbhani	164953	1344	3.80	3.16	83	II
Beed	130193	1338	3.00	3.15	105	III
Nanded	195032	1603	4.49	3.77	84	II
Osmanabad	110965	1130	2.55	2.66	104	III
Latur	124960	1183	2.88	2.78	97	II
Buldhana	109792	1067	2.53	2.51	99	II
Akola	131952	760	3.04	1.79	59	II
Amravati	116710	700	2.69	1.65	61	II
Yavatmal	112847	755	2.60	1.78	68	II
Wardha	70800	426	1.63	1.00	61	II
Nagpur	101284	782	2.33	1.84	79	II
Bhandara	125425	826	2.89	1.94	67	II
Chandrapur	92385	382	2.13	0.90	42	I
Gadchiroli	49830	206	1.15	0.48	42	I
Maharashtra State	4345610	42506	100.00	100.00	100.00	

Note: * According to 1992 Livestock Census of Maharashtra.

** Total Milk Production during 1993-94.

Table 2: Inter-district Variation in Milk Productivity of Cows, Buffaloes and Goats in Maharashtra: 1985-86 - 1993-94

District	Cows*		Buffaloes		Goats	
	1985-86	1993-94	1985-86	1993-94	1985-86	1993-94
Greater Bombay	4.94	5.00	4.18	4.99	0.02	0.02
Thane	1.05	1.54	3.13	4.86	0.03	0.04
Raigad	0.90	1.34	3.10	2.62	0.03	0.04
Ratnagiri	0.92	2.13	1.22	2.86	0.03	0.03
Sindhudurg	0.91	1.67	1.21	2.37	0.03	0.04
Nasik	1.49	1.80	2.57	3.26	0.06	0.06
Dhule	1.41	2.31	2.63	3.73	0.06	0.07
Jalgaon	1.43	2.26	2.61	3.48	0.06	0.07
Ahmednagar	2.04	3.32	2.26	2.88	0.05	0.06
Pune	2.39	3.61	2.23	3.08	0.05	0.07
Satara	2.44	3.96	2.71	2.80	0.07	0.09
Sangli	2.83	5.00	2.72	2.37	0.08	0.09
Solapur	1.65	2.61	2.75	2.33	0.08	0.10
Kolhapur	3.02	3.86	2.68	2.42	0.08	0.10
Aurangabad	1.35	2.06	2.85	2.11	0.06	0.06
Jalna	1.17	1.90	2.83	2.64	0.05	0.06
Parbhani	1.14	1.81	1.89	2.81	0.06	0.05
Beed	1.56	2.42	2.73	2.87	0.07	0.08
Nanded	1.12	1.81	1.90	2.71	0.06	0.05
Osmanabad	1.56	2.69	2.80	2.50	0.05	0.09
Latur	1.44	2.36	2.70	2.60	0.10	0.08
Buldhana	1.23	2.25	2.84	3.00	0.06	0.06
Akola	0.91	1.00	2.62	2.54	0.04	0.04
Amravati	0.94	1.14	2.65	2.52	0.03	0.03
Yavatmal	0.88	1.27	2.69	2.76	0.03	0.03
Wardha	0.88	1.32	3.14	2.41	0.03	0.03
Nagpur	0.86	1.68	3.22	2.87	0.03	0.03
Bhandara	0.81	1.26	3.15	2.66	0.04	0.03
Chandrapur	0.56	0.65	0.56	2.04	0.03	0.03
Gadchiroli	0.56	0.73	2.24	2.43	0.03	0.03
Maharashtra State	1.38	2.27	2.73	2.95	0.05	0.06
Coefficient of Variation (C.V.) %	51.41	47.07	26.34	23.16	40.34	43.69

Note: * Cows include indigenous cows and crossbred cows.

Milk Productivity⁷ Variations

An examination of inter-district variations in produc-

7. The milk productivities for the reference year 1985-86 are estimated using the population figures (in-milk) of cows, buffaloes and goats reported in Livestock census report of 1982 for the Maharashtra State and the actual quantity of milk produced by the respective breed of milch animal during 1985-86. On the other hand, the estimation of milk productivities for the reference year 1993-94 was done using the population figures (in-milk) of the above breed of milch animals reported in 1992 Livestock census report of Maharashtra and the actual quantity of milk produced by the respective breed of milch animals during 1993-94.

tivity indices of bovines is one end of the problem, the other end being an evaluation into the changes that have taken place over time in terms of actual milk yield of different species of milch animals in different districts of Maharashtra. In the light of this fact, district-wise milk productivity estimates for different species of milch animals for the reference years 1985-86 and 1993-94 are brought out in Table 2.

It could be discerned from Table 2 that during 1985-86 - 1993-94 period there has been significant increase in average daily milk productivity of cows in all the districts of Maharashtra. As for buffalo milk productivity,

many districts showed a decline in the same during the same period. The districts that showed a decline in their buffalo milk productivity during the period between 1985-86 and 1993-94 were Raigad, Sangli, Solapur, Kolhapur, Aurangabad, Osmanabad, Latur, Akola, Amravati, Wardha, Nagpur and Bhandara. Despite this decline in milk productivity of buffalo that was visualised for the above districts, the overall scenario for the State as a whole presented to us with an increase in the same during the same period. On the other hand, goat milk productivity remained by and large the same in most of the districts during 1985-86 - 1993-94 period, though a marginal increase was noticed in goat milk productivity for the State as a whole during the same period.

Although both cows and buffaloes have shown increases in their milk productivities over time, the increase in cow milk productivity was seen to be much faster than buffalo milk productivity. During the period between 1985-86 and 1993-94, the increase in cow milk productivity for the State as a whole was found to be 64 per cent and in the case of buffalo, this increase stood at only 8 per cent. Most of the increase in buffalo milk productivity for the State was seen to be due to the increased/productivity contributions of districts like Ratnagiri, Sindhudurg, Nasik, Dhule, Jalgaon, Pune, Parbhani and Chandrapur as in the case of other districts either there was slow growth in buffalo milk productivity or there was decline in the same over time.

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The higher milk productivity of cow was noticed due mainly to higher concentration of cross breed cows compared to indigenous cows in the above districts which, without an iota of doubt, were high yielders. Generally, the milk yield of cross bred cow is seen to be 2-3 times higher than indigenous cows. This argument has been put forward by many research workers (Sardiwal and Kalla, 1975; Singh, 1980; Singh *et al* 1986; Shah and Sharma, 1994).

During 1985-86, the per day cow milk yield varied from 0.56 kg in Chandrapur and Gadchiroli districts to 4.94 kg in Greater Bombay with coefficient of variation (C.V.) at 51 per cent. The inter-district fluctuation in cow milk yield was seen to be less during 1993-94 compared to 1985-86. This held true in the case of buffalo milk yield also. It is noteworthy to mention that in due course

of time Chandrapur district has shown substantial increase in its buffalo milk yield. While during 1985-86 buffalo milk yield varied from 0.56 kg in Chandrapur district to 4.18 kg in Greater Bombay with C.V. at 26 per cent, this variation in the same during 1993-94 was found to be from 2.04 kg in the case of Chandrapur district to 4.99 kg in Greater Bombay with C.V. at 23 per cent. Nonetheless, in the case of Goat, the inter-district variation in milk productivity was seen to increase from 1985-86 (C.V. = 40.34 per cent) to 1993-94 (C.V. = 43.69 per cent).

Thus, *The cow milk yield was seen to be generally higher in those districts where the buffalo milk yield was also high. The factors that were responsible for higher milk yield of buffalo in a particular district could also be considered as instrumental for higher milk yield of cow in that district.*

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Structural Changes in Milk Production

An attempt is now made to evaluate the changes that have taken place over time in milk production figures of various breeds of milch animals in different districts and regions⁸ of Maharashtra. The estimates of milk production for different breeds of milch animals for various districts and regions of Maharashtra in respect of the reference periods mid-eighties and the early nineteen are brought in Table 3.

The scenario obtaining over the past one decade reveals dramatic transformation in milk production figures for the State of Maharashtra. Although majority of the districts of this State have shown perceptible increases in their milk production levels during the period between mid-eighties and the early nineties, the period gone by has also been marked with very slow expan-

8. There are six major economic regions in Maharashtra. The districts under each region are as follows: (i) Konkan region—Greater Bombay, Thane, Raigad, Ratnagiri and Sindhudurg, (ii) Nasik region—Nasik, Dhule, Jalgaon and Ahmednagar, (iii) Pune region—Pune, Satara, Sangli, Solapur and Kolhapur, (iv) Aurangabad region—Aurangabad, Jalna, Parbhani, Beed, Nanded, Osmanabad and Latur, (v) Amravati region—Buldhana, Akola, Amravati and Yavatmal and (vi) Nagpur region—Wardha, Nagpur, Bhandara, Chandrapur and Gadchiroli.

Table 3: Changing Milk Production Pattern in Maharashtra (1985-86 - 1993-94)

(Milk Production in lakh litres)

District/ Region	Milk Production												Total Production		
	Indigenous Cow			Crossbred Cow			Buffalo			Goat					
	P-I	P-II	% chg.	P-I	P-II	% chg.	P-I	P-II	% chg.	P-I	P-II	% chg.	P-I	P-II	% chg.
Greater Bombay	34	70	106	7	7	0	1052	1998	90	2	2	0	1095	2077	90
Thane	185	271	46	57	52	26	570	836	47	19	28	47	831	1207	45
Raigad	178	306	70	16	54	238	281	394	40	12	19	58	487	773	59
Ratnagiri	124	236	90	69	143	107	82	172	110	8	10	25	283	561	98
Sindhudurg	51	111	118	26	54	108	73	188	158	4	12	200	154	365	137
Nasik	482	636	32	141	364	158	394	656	66	84	121	44	1101	1777	61
Dhule	306	473	55	62	222	258	363	553	52	66	94	42	797	1342	68
Jalgaon	388	522	35	82	359	338	757	1309	73	77	111	44	1304	2301	76
Ahmednagar	464	662	43	569	2090	267	328	466	42	127	179	41	1488	3397	128
Pune	336	520	55	592	1722	191	667	1033	55	96	129	34	1691	3404	101
Satara	224	332	48	355	1076	203	887	1146	29	71	99	39	1537	2653	73
Sangli	181	217	20	412	895	117	1064	1231	16	75	87	16	1732	2430	40
Solapur	400	479	20	114	630	453	568	733	29	170	197	16	1252	2039	63
Kolhapur	128	173	35	322	498	55	1596	2199	38	52	62	19	2098	2932	40
Aurangabad	209	323	55	70	306	337	169	255	51	57	79	39	505	963	91
Jalna	188	303	61	20	69	245	136	202	49	39	53	36	383	627	64
Parbhani	384	655	71	35	93	166	237	489	106	55	71	29	711	1308	84
Beed	387	463	20	76	255	236	347	477	37	80	105	31	890	1300	46
Nanded	369	655	78	29	106	266	344	736	114	50	63	26	792	1560	97
Osmanabad	225	303	35	45	334	642	332	389	17	44	67	52	646	1093	69
Latur	237	351	48	40	182	355	332	558	68	39	51	31	648	1142	76
Buldhana	300	384	28	69	198	187	344	398	16	59	65	10	772	1045	35
Akola	250	264	6	27	69	156	350	376	7	37	42	14	664	751	13
Amravati	234	240	3	29	100	245	278	313	13	31	36	16	572	689	20
Yavatmal	272	296	9	21	78	271	269	323	20	40	50	25	602	747	24
Wardha	103	132	28	29	124	328	118	139	18	16	20	25	266	415	56
Nagpur	187	240	28	48	201	319	210	290	38	31	36	16	476	767	61
Bhandara	202	258	28	35	120	243	327	396	21	27	35	30	197	809	311
Chandrapur	125	157	26	9	22	144	136	186	37	23	26	13	293	391	33
Gadchiroli	106	101	-5	5	2	-60	36	69	92	16	23	44	163	195	20
Regions															
Konkan	572	994	74	175	330	89	2058	3588	74	45	71	58	2850	4983	75
Nasik	1640	2293	40	854	3035	255	1842	2984	62	354	505	43	4690	8817	88
Pune	1269	1721	36	1795	4821	169	4782	6342	33	464	574	24	8310	13458	62
Aurangabad	1999	3053	53	315	1345	327	1897	3106	64	364	551	51	4575	8055	76
Amravati	1056	1184	12	146	445	205	1241	1410	14	167	193	16	2610	3232	24
Nagpur	723	888	23	126	469	27	827	1080	31	113	140	24	1789	2577	44
Maharashtra State	7529	10133	40	3411	10445	206	12647	18510	46	1507	2034	35	24834	41122	66

Note: Period-I = 1985-86 - 1987-88 (Triennium Average)

Period-II = 1991-92 - 1993-94 (Triennium Average)

sion in some districts, these are: Sangli, Kolhapur, Beed, Buldhana, Akola, Amravati, Yavatmal, Chandrapur and Gadchiroli. All these districts have shown only 13-40 per cent increase in their milk production levels during the period between mid-eighties and the early nineties compared to 66 per cent overall increase in milk production for the State as a whole during the same period. On the other hand, the districts that have shown perceptible rise in their milk production levels during the given period of time were Greater Bombay, Ratnagiri, Sindhudurg, Ahmednagar, Pune, Aurangabad, Parbhani, Nanded and Bhandara. The total increase in milk production figures for these districts was found to be above 80 per cent during the period between mid-eighties and the early nineties. It might appear from this observation that the onus of technological efforts have been more favourably inclined and concentrated in these districts of the State.

The scenario obtaining over the past one decade reveals dramatic transformation in milk production figures for the state of Maharashtra.

Among various districts, Ahmednagar district, in particular, has shown tremendous increase in its milk production figures during the given period of time. In fact, during the mid-eighties, the total milk production figures of Ahmednagar district stood at much lower compared to the total milk production figures of Satara, Sangli and Kolhapur districts. However, by the early nineties, the scenario was been to be completely changed as during this period Ahmednagar district had crossed the milk production figures of all the above three districts. Similarly, Pune district has also shown quantum leap in its milk production figures over the past one decade. During the mid-eighties, the milk production figures of Pune district rose sharply so much so that by the early nineties it had crossed the milk production figures of Sangli and Kolhapur districts. The districts that have shown the least expansions in their milk production levels during the given period of time were Akola, Amravati and Gadchiroli.

In the State of Maharashtra, the milk production figures of crossbred cows have grown generally much faster than the milk production figures of indigenous cows and buffaloes during the period between mid-eighties and the early nineties. The exceptions are: Greater Bombay, Thane, Ratnagiri, Sindhudurg and Gadchiroli districts; furthermore these being the only aberration in this scenario that have shown much faster growth in their buffalo milk compared to crossbred cow

milk production during the same period. In fact, in the case of Gadchiroli district, the milk production figures of both crossbred cows and indigenous cows have rather declined during the period between mid-eighties and the early nineties; the decline in milk production during this period being much sharper for crossbred compared to indigenous cows. As a matter of fact, majority of the districts showed their indigenous cow milk production to increase in tune with the increase in their buffalo milk production, not much of a variation was noticed in the milk production increases across various districts during the period between mid-eighties and the early nineties. The milk production increases in the case of goat hovered in the range of 20-50 per cent for majority of the districts during the same period.

The milk production data for various districts were further analysed to get an overall insight about the imbalances prevailing in different regions of Maharashtra. These results are also brought out in Table 3.

An overall analysis drawn from Table 3 revealed that during the period between mid-eighties and the early nineties the increases in milk production figures were much sharper for Nasik, Aurangabad and Konkan regions compared to other regions of the State. However, as for the total contribution, Pune region showed the highest contribution to the State's total milk production. The contribution of Pune region to the State's total milk production stood at 33 per cent during the period between mid-eighties and the early nineties. The other major contributors to the State's total milk production were Nasik and Aurangabad regions – each contributing 20 per cent to the State's total milk production. As regards milk production expansions for various breeds of milch animals, while Aurangabad region showed the maximum expansion in milk production of cross bred cows during 1985-86 - 1993-94 period, the increase during the same period for indigenous cow, buffalo and goat milk production was found to be the highest in the case of Konkan region. In general, *the past one decade showed 66 per cent increase in total milk production for the State of Maharashtra which has been due mainly to the production increases of crossbred cow milk as the increases in the case of indigenous cow, buffalo and goat milk production have been very slow during this period.*

Pattern of Growth and Instability in Rates of Growth

The pattern of milk output growth along with instability in rates of growth for different districts and regions of Maharashtra in respect of various breeds of milch animals over the last one decade is presented in Table 4.

Wide variations in rates of growth of milk production were noticed for different breeds of milch animals across different districts. During 1985-86 - 1993-94 period, districts falling under Konkan region showed 8-15 per cent annual growth in their milk production figures with Sindhudurg district showing the maximum growth (15.1 per cent) followed by Greater Bombay (11.7 per cent), Ratnagiri (11.4 per cent), Thane (8.2 per cent) and Raigad district (8.0 per cent). The milk production figures of the districts of Nasik region are also estimated to have grown in the range of 8 to 15 per cent during the same period with Ahmednagar district showing the highest growth (14.6 per cent) and Nasik district showing the least growth (8.2 per cent) in the same. The annual growth in milk production for the districts of Pune region was found to be in the range of 6 to 12 per cent with Pune district showing the highest rate of growth (12.1 per cent) followed by Satara and Solapur districts (8-9 per cent) and Sangli and Kolhapur districts (5-6 per cent). As for Aurangabad region, while districts like Parbhani, Aurangabad and Nanded recorded 10-12 per cent annual growth in their milk production during the period 1985-86 and 1993-94, the annual growth in the same for other districts of this region like Jalna, Beed, Latur and Osmanabad was found to be 6-9 per cent during the same period. The districts that have shown the least growth in their milk production figures during the given period of time are seen to be falling under Amravati and Nagpur regions. The districts falling under Amravati region showed 2-5 per cent annual growth in their milk production figures between 1985-86 and 1993-94. On the other hand, the districts falling under Nagpur region showed 5-8 per cent annual growth in their milk production figures during the same period with Gadchiroli district being an aberration in this scenario as this district showed negligible growth in its milk production figures during the given period of time.

The bulk of the increase in total milk production in the State of Maharashtra is seen to be accounted for by the increase in crossbred cow milk production that has grown substantially over the past one decade. During 1985-86 - 1993-94 period, the milk production through crossbred cows is seen to have grown at the rate of 20 per cent per annum. Except Greater Bombay and Gadchiroli districts, all the districts of this State have shown significant and very high rate of growth in their crossbred cow milk production during the given period of time. However, the cross bred cow milk production of Gadchiroli district is estimated to have declined significantly during this period; a marginal decline in the same is also seen for Greater Bombay during the same period. The rates of growth in milk production for indigenous cows, buffaloes and goats are estimated to have been in the range of 5 to 7 per cent per annum for

the State as a whole with buffalo showing relatively higher growth in its milk production compared to the growth in milk production for indigenous cows and goats.

In general, the milk production in the State of Maharashtra is estimated to have grown at the rate of 8.68 per cent per annum over the past one decade. However, this growth in milk production is achieved in the face of wide year to year fluctuations in the same. Very high degree of instability in milk production noticed in the case of districts like Greater Bombay, Raigad, Ratnagiri, Sindhudurg, Ahmednagar, Aurangabad, Parbhani, Nanded and Latur is seen to be associated with moderate as well as high growth rates in the case of districts like Thane, Raigad, Satara, Sangli, Solapur, Kolhapur, Jalna, Wardha and Nagpur. Districts showing high growth rates associated with very low degree of instability are noticed to be Nasik, Dhule, Jalgaon, Pune and also to some extent Beed. However, districts, like Buldhana, Akola, Amravati and Yavatmal are seen to show very slow growth in their total milk production which are also seen to be associated with very low instability in rates of growth. Nevertheless, the overall instability of the State's milk production is seen to be less compared to the annual rate of growth in milk production during the period between 1985-86 and 1993-94.

As regards instability in rates of growth of milk production for various breeds of milch animals, crossbred cows showed much higher fluctuations in their milk production growth rates compared to indigenous cow, buffalo and goat. However, the higher instability in crossbred cow milk production was found to be associated with higher growth rate. On the other hand, lower instability noticed in the case of indigenous cow, buffalo and goat milk production was seen to be associated with lower growth rates. However, high degree of instability associated with low or declining rate of growth, as noticed in the case of cross bred cow milk production in Greater Bombay and Gadchiroli districts, is a matter of concern. Therefore, *in order to correct the inter-district imbalances in milk production, more emphasis should be given by the policy makers to the districts that have shown low growth rates and high instability in milk production.*

In order to correct the inter-district imbalances in milk production, more emphasis should be given by the policy makers to the districts that have shown low growth rates and high instability in milk production.

Table 4: Growth and Instability in Milk Production for Different Districts and Region of Maharashtra: (1985-86 - 1993-94)

Districts/ Regions	Indigenous Cow		Crossbred Cow		Buffalo		Goat		Total Production	
	CGR	II	CGR	II	CGR	II	CGR	II	CGR	II
Greater Bombay	12.88	15.03	-0.77 ^{NS}	17.06	11.30	12.59	3.61	2.51	11.65	12.09
Thane	6.87	7.90	3.56 ^{NS}	12.96	6.38	11.40	6.54	4.09	8.19	6.68
Raigad	9.76	9.81	22.24	13.97	5.63	10.04	8.67	5.15	7.99	8.28
Ratnagiri	12.07	13.28	12.46	6.47	12.75	8.25	3.47 ^{NS}	8.49	11.36	9.35
Sindhudurg	19.61 ^{NS}	27.23	12.58	5.84	16.68	11.51	18.87	15.49	15.06	11.54
Nasik	4.66	6.05	19.04	16.64	8.82	2.24	6.43	6.22	8.17	4.22
Dhule	7.48	9.09	23.13	14.62	7.22	3.20	6.39	6.57	9.01	4.94
Jalgaon	5.00	6.49	27.42	18.02	9.52	2.92	6.38	6.11	9.87	4.82
Ahmednagar	6.00	2.71	23.78	15.17	6.20	6.04	5.88	4.26	14.55	7.49
Pune	7.45	3.34	19.06	11.04	7.77	4.89	5.17	3.92	12.10	5.83
Satara	6.60	7.21	19.90	11.79	4.46	6.28	5.92	6.27	9.42	6.75
Sangli	2.83 ^{NS}	7.34	13.40	6.73	2.56 ^{NS}	7.14	2.59	5.68	5.71	5.76
Solapur	2.97	4.72	32.59	21.75	4.36	6.51	2.56 ^{NS}	6.53	8.38	5.66
Kolhapur	5.00	6.77	7.19	8.44	5.59	6.41	3.11	4.83	5.74	5.45
Aurangabad	7.29	7.29	27.46	18.11	6.74	5.94	5.51	5.56	11.05	8.63
Jalna	8.02	7.95	21.90	13.50	6.51	5.81	5.23	5.40	8.26	7.06
Parbhani	9.29	7.71	17.37	9.50	12.58	9.36	4.21	6.01	10.56	7.82
Beed	2.93	4.95	21.99	13.63	5.44	6.93	4.76	6.45	6.42	4.95
Nanded	10.03	8.11	23.57	15.00	14.18	10.76	3.53	5.64	12.17	9.01
Osmanabad	5.02	5.47	48.39	33.87	2.71 ^{NS}	6.90	8.17	8.02	9.13	6.08
Latur	6.66	7.07	28.41	18.80	9.09	8.85	4.33 ^{NS}	15.18	9.82	8.59
Buldhana	3.98	4.21	18.76	10.79	2.20	3.77	1.62	3.79	4.92	3.50
Akola	0.69 ^{NS}	5.34	16.68	8.85	1.17 ^{NS}	5.07	2.22	4.46	1.96	1.61
Amravati	0.14 ^{NS}	5.16	22.77	14.88	1.98 ^{NS}	4.40	2.16	4.34	2.94	1.95
Yavatmal	1.15 ^{NS}	5.56	24.32	15.64	3.05	3.77	3.62	5.73	3.50	2.67
Wardha	4.27	5.81	26.75	17.57	2.72	4.26	3.18	6.73	7.56	6.37
Nagpur	4.27	5.84	26.44	17.45	5.49	5.73	2.75 ^{NS}	6.43	8.19	7.00
Bhandara	4.27	5.78	22.11	13.68	3.18	3.95	3.91 ^{NS}	7.61	5.29	4.74
Chandrapur	2.11	24.15	15.08	7.56	1.92	29.36	1.47 ^{NS}	10.09	5.85 ^{NS}	15.57
Gadchiroli	-0.72 ^{NS}	9.36	-12.54 ^{NS}	34.78	5.47 ^{NS}	55.25	6.60 ^{NS}	16.99	0.33 ^{NS}	23.69
Regions										
Konkan	10.34	10.62	10.70	6.41	9.59	10.79	8.05	5.09	10.30	8.13
Nasik	5.67	5.29	23.45	14.61	8.37	2.33	6.20	4.69	10.96	5.58
Pune	5.06	2.77	17.50	9.67	4.90	4.44	3.70	1.91	8.24	4.69
Aurangabad	7.22	5.82	27.64	18.23	8.60	6.30	4.98	5.10	9.66	6.79
Amravati	1.68 ^{NS}	4.19	20.10	11.97	2.06	3.59	2.34	3.69	3.43	1.98
Nagpur	3.25	6.74	23.90	15.30	4.49	4.60	3.45	6.27	5.95	5.69
Maharashtra State	5.64	4.63	20.25	11.99	6.55	3.95	4.59	3.08	8.68	5.11

Note: NS = Not significant at 1 per cent level of probability.

CGR = Compound Growth Rate II = Coppock Instability Index.

Table 5: Changing Shares of Different Regions in Total Milk Production of Maharashtra

Region	(in per cent)									
	Indigenous Cow		Crossbred Cow		Buffalo		Goat		Total Production	
	P-I	P-II	P-I	P-II	P-I	P-II	P-I	P-II	P-I	P-II
Konkan	7.88	9.81	5.13	3.16	16.27	19.38	2.99	3.49	11.48	12.12
Nasik	22.59	22.63	25.04	29.05	14.57	16.12	23.49	24.83	18.89	21.44
Pune	17.48	16.98	52.62	46.16	37.81	34.26	30.79	28.22	33.48	32.72
Aurangabad	27.54	30.13	9.24	12.88	15.00	16.78	24.15	27.09	18.43	19.59
Amravati	14.55	11.69	4.28	4.26	9.81	7.62	11.08	9.49	10.51	7.86
Nagpur	9.96	8.76	3.69	4.49	6.54	5.84	7.50	6.88	7.21	6.27

Note: Period I = 1985-86 - 1987-88

Period II = 1991-92 - 1993-94.

Regional Imbalances in Growth

An overall analysis in relation to comparative position of different regions discloses that Amravati and Nagpur regions lag far behind other regions of the State in terms of growth performance of milk production (Table 4). The rate of growth of milk production of Amravati and Nagpur regions over the past decade is seen to be 3-6 per cent per annum which turns out to be much below the State's average rate of growth in the same. And, as a result of this, the share of these two regions in total milk production of Maharashtra is estimated to have declined during the period between mid-eighties and the early nineties (Table 5). In fact, all the districts of Amravati and Nagpur regions have shown their milk production to have growth rates less than the State's average growth rate. Despite one-third contribution to the State's total milk production, Pune region has also shown its milk production to increase below the State's average rate of growth in the same during the given period of time (Tables 4 and 5). This consequently has resulted in declining share of Pune region in the State's total milk production during the given period of time. On the other hand, Konkan, Nasik and Aurangabad regions have shown much faster rate of growth in milk production compared to State's average growth rate.

Although Konkan region showed maximum growth and relatively higher degree of instability in rates of growth of indigenous cow, buffalo and goat milk production, in respect of production expansions of crossbred cow milk this region was seen to lag far behind all other regions of the State. In the case of crossbred cow, Aurangabad region recorded maximum growth that was also seen to be associated with very high degree of instability. As a matter of fact, Amravati is noticed to be the only region that has shown poor rate of growth in milk production. Even the overall average

growth rate of milk production of Amravati region estimated at 3.43 per cent is largely contributed by higher rate of growth of crossbred cow milk production since the rates of growth in milk production through other breeds of milch animals are estimated to have been very low for this region.

As for milk production growth rates, a study conducted by Patel (1993) showed much lower rate of growth in milk production for the State of Maharashtra during the decades 1970-71 - 1979-80 and 1989-90 as compared to the rate of growth in the same witnessed for the period 1985-86 and 1993-94 in this study. According to the estimates reported by Patel (1993), the total milk production of Maharashtra grew at the rate of 7.57 per cent a year during the period 1980-81 - 1989-90 as against only 4.15 per cent annual growth in the same during the period between 1970-71 and 1979-80. The present study shows a much higher rate of growth in milk production for this State which is estimated to have grown at the rate of 8.68 per cent per annum during the period between 1985-86 and 1993-94. Thus, it may well be inferred that there has been acceleration in rate of growth of milk production for the State of Maharashtra with every passing decade. *The State's current pace in the rate of growth of milk production amply demonstrates that it may even overtake States like Rajasthan and Madhya Pradesh⁹ in the years to come.*

Concluding Remarks

Two differing points of view emerged about the status of dairying in the State of Maharashtra. While the State showed remarkable progress in terms of overall

9. During the early nineties, while the positions of Rajasthan and Madhya Pradesh in the country's total milk production stood at 4th and 3rd, respectively, the ranking of Maharashtra in the same was 5th during this period.

growth in milk production over the last one decade, there were also wide inter-and intra-regional variations in growth rates during this period. The factors underlying regional imbalances in the growth of milk production could be many. Imbalances might be associated with (a) difference in the distribution of breedable bovine population in different regions of the State, (b) differences in resource base with respect to feeds and fodder and animal health cover, (c) differences in terms of number of insemination in the field areas for breed improvement and thereby causing differences in genetic architecture of milch animals, and (d) differences in the productivity of animals.

The higher potentiality of milk production in the case of some of the districts and regions of Maharashtra was assessed through significant and higher rate of growth associated with higher index of instability of milk production. *The ready acceptability of modern technology by the milk producers, intensive efforts by the dairy co-operatives in providing balanced cattle feed, veterinary services and the availability of other infrastructure facilities could be considered as the other underlying forces that have transformed the status of dairying in most of the districts and regions of Maharashtra.* In fact, dairy co-operative movement in this State has contributed in no small measure towards this substantial growth in milk production and, there cannot be two opinions about it.

The ready acceptability of modern technology by the milk producers, intensive efforts by the dairy co-operatives in providing balanced cattle feed, veterinary services and the availability of other infrastructure facilities could be considered as the other underlying forces that have transformed the status of dairying in most of the districts and regions of Maharashtra.

Future Strategy and Prospects

What kind of future strategy would be appropriate for the State of Maharashtra in order to sustain the growth of milk production, at least at the current level, is the crucial question that could strike one. In this context, it deserves mention that a medium term strategy that can realise the unutilised/underutilised production potential of animals will be more conducive than a strategy based on capital intensive and high production technology. *This in turn will lead to formulation of a long term strategy for increasing the resources base of the*

A medium term strategy that can realise the unutilised/underutilised production potential of animals will be more conducive than a strategy based on capital intensive and high production technology.

farmers. There still exists vast scope for increasing milch animal productivity by following improved animal husbandry practices. However, this warrants an effective machinery for imparting extension services to the farmers through co-operatives. Many of the prevailing notions among the farmers need to be changed in view of higher milch animal productivity. Even with all this, *the prospects for increased milk production in the State in the years to come will also depend on the extend to which farmers undertake fodder cultivation as an integral part of milk production.* These measures will surely provide rich dividends for increased milk production in the State.

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Book Reviews

Information Technology in Agriculture and Rural Development by Asian Productivity Organisation, Tokyo (Japan), 1997, unpriced.

Information technology (IT) has a fundamental role in rural development, particularly in the context of market-friendly approach under the new regime of globalisation and liberalisation. Augmenting productivity in agriculture and allied activities is the only way to the sustainable development of rural areas. To be competitive and efficient, information is required at various levels of economic as well as social activity. For example, a local government may be interested in getting socio-economic details of the local area while a farmer, even in a remotest village, has to take care of the trends in prices, the latest technological advancements in cultivation, marketing facilities, climatic changes, soil conditions, rainfall, pest control measures, etc. In all these activities, information technology has a pivotal role to play.

In the context, IT for rural development, this report of the Asian Productivity Organisation's Study Mission is pioneering and deserves recognition. The book elucidates recent developments in IT and their applications in agriculture and rural development in Asia-Pacific Region. It has been observed that information systems for agriculture and rural development have been set up in various forms and varying degrees of specialisation in countries in this region. Japan has a highly sophisticated and comprehensive system of information for agriculture and rural development. In countries like Republic of China and Republic of Korea, computer based information networks have elaborately been established to facilitate information generation and dissemination at national and regional levels. In Southeast Asian countries like Thailand, Malaysia and Philippines, IT is fast gaining ground as a result of their realisation of its importance in maintaining international competitiveness. By contrast, in rest of Asia, the application of IT is in its nascent stage.

The report has four parts and a foreword. Part one

gives a summary of the Mission findings. Three resource papers, focusing on IT and its applications in agriculture and rural development in Japan, are presented in part two. Part three contains twelve country papers—Bangladesh, Republic of China, Fiji, India (two papers), Islamic Republic of Iran, Republic of Korea, Malaysia, Mongolia, Nepal, Philippines and Thailand. Part four consists of list of participants, resource speakers and programme activities. The organisation of the study is commendable. The resource papers provide a systematic overview of the state of the art in IT and its applications in agriculture and rural development. The country papers provide the details regarding rural development activities and the status of information system prevailing in the respective countries. And the field studies are wonderfully reported in such a manner as to give the reader the feeling of having travelled to these countries.

Basically, there are three elements in the development of an information system: (1) creation of data base and information sources; (2) creation of networks and their improved speed; and (3) extension of information terminals. The efficiency of an information system depends, mainly on two aspects: one, the speed and two, the user-friendliness of the system. In the case of the information systems for agriculture and rural development, the second aspect is particularly important. As a result of the easiness in operation, the facsimile media communication is going to be expanded in a big way compared to other media such as Cable T.V., Off-talk communications, etc. From the point of view of agriculture and rural development, Geographic Information System (GIS) is very important. The GIS envelops various types of information (such as data on the owners of land, crops being cultivated, soil information, etc.) on a map and display them.

An observation of the trends in development of various media for agriculture and rural villages shows that most of them have been developed since the liberalisation of telecommunication industry in 1985. In the development of information systems, the ap-

pearance of multi-media and high speed networks seem to be a major turning point.

Japan has been applying IT, in a big way, in its agriculture and rural development activities at the grass roots level and its impact has been quite remarkable. In Japan, the application of information technology in rural development dates back to 1950s. Personal Computer (PC) based management of agriculture—book-keeping, tax estimations, office management, etc.—has come of age. At present, there are six categories of information systems in Local Governments: (1) rural community Multipurpose Information System (MPIS)—for information relating to agricultural production and status of life in rural communities; (2) Radio Information System—for disaster relief administration and land development information; (3) Computer Systems—farmland usage management systems, labour adjustment systems, local agricultural meteorological information systems, soil analysis systems, health and welfare information systems, etc. (Among the computer systems, Agricultural Strategy Information System (ASIS) is very important in the sense that it is able to cater to the consumer needs even in rural communities by using information communication networks); (4) Communication Satellite Systems (Green Channel)—for weather information, market information, newspaper news, etc.; and (6) Agricultural Meteorological Information System. These information systems in Japan provide details required for administration, and of management activities in agriculture and rural development. Interestingly, it is observed that IT, to a certain extent, is progressing as an antidote to the general apathy towards agriculture.

In the case of Republic of China and Republic of Korea, information systems have been developed at the national and subnational levels. In China, the Agricultural Information System provides data relating to rains, forestry, fisheries, livestock and veterinary, farmer's guidance, etc. Similarly, in Korea, the Agriculture and Fisheries Statistics Information Bureau (AFSIB)—an on-line information retrieval system—provides information on numerous subjects such as agricultural commodity prices, statistics, government policies, and agricultural inputs. In countries like Thailand, Malaysia and Philippines, the application of IT is gaining ground, though its application is rather limited in rural development. In other countries like India, Fiji, Bangladesh, Bhutan, etc., the application of IT is limited and confined to the national level and regional level management of rural development activities.

The study team has identified a host of debilitating factors in application of IT: lack of financial resources; shortage of IT-trained personnel; inadequate infrastructural facilities; proliferation of agencies/institutions in-

involved in data generation processing and dissemination; low literacy level; and lack of strong government support for the promotion of information technology.

The book on the will definitely help augmenting the pace of application of information technology in agriculture and rural development and there is no doubt that it will be of interest to various quarters of knowledge including academicians, administrators, students, and those who are interested in agriculture and rural development.

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India's Software Industry: State Policy, Liberalisation and Industrial Development by Heeks, Richard, Thousand Oaks and London, Sage Publications Inc., 1996, p. 428, (tables, figures) US \$ 39.95.

The 421-page book under review with nine chapters, a select bibliography, appendix and an index, gives an intensive and extensive analysis on India's one of the most export potential industries. It touches upon some of the vital segments namely—historical perspective, growth pattern, the impact of liberalisation, Government interventions and foreign collaborations in India's software industry.

The central theme of the book is to highlight how the development of Indian software industry has been affected by the initiation of liberalisation regime by the state in July 1991. Hence, the book covers a far and considerable span of 9 years to give a critical insight into the central theme. Chapter I gives a detailed and comprehensive discussion in regard to hardware and software policies initiated by Indian Government. However, it is observed that despite most liberalised industry state interventions have been of continuous and pervasive nature affecting export potential of the industry. Chapter II gives a synoptic view with regard to steps taken for speedy growth and development of Indian software industry. Besides, an excellent analysis in terms of export earnings, employment generation and productivity has been provided. The most significant finding is that India's software industry has changed its focus from domestic orientation to export orientation. Chapter III concentrates on export performance and potentialities of Indian software industry. It suggests that there is a greater need to bring integration and balance between export and domestic production as it is an undisputed fact that without developing domestic market export performance could not be ensured.

Chapters IV and V evaluate the impact of liberalisation regime on India's software industry in the context of consumers and producers. The book rightly opines that "import liberalisation has probably worsened India's balance of trade—not unexpected given the direct link between liberalisation and imports, and the indirect uncertain link between liberalisation and exports". This in turn brings out a number of long-term dangers which threaten Indian software export.

The nature, causes and consequences of collaborations between Indian software industry and foreign companies have been analysed in chapter VI. Collaborations have been made in order to remove existing deficiencies of Indian firms in respect of skill, capital, technology and marketing. The study confirms that such collaborations have helped much in supplying the said inputs and hence have emerged as a vital facet of growth and development of Indian software industry. The chapter also discusses software packages, technological capability and costs and benefits which are having far reaching effect on India's exports of software. The next two chapters are concerned with the degree of government interventions and policy making processes in India. Much emphasis has been given in the chapter VIII on non-political factors and political pressures affecting India's software policy. Hence, it is high time to take intelligent, selective and discriminating measures. Chapter IX is a comprehensive resume of findings of the timely study which is of light bearing and fruit bearing nature.

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Strategic Management of Public Enterprises in Developing Countries by *S. Ramnarayan and I.M. Pandey*, Vikas Publishing House, New Delhi, 1997, p. 326, Rs. 495 (Hb).

In the name of liberalisation and integration with the global economy, it has become fashionable to decry the public sector which once occupied a position as the leader of industrial development and as the most important instrument to implement social objectives and bring about socio-economic transformation. Serious doubts have been expressed about its efficacy, efficiency and its capability to withstand competition. In the last ten years, a number of solutions have been proposed to improve the performance of PE's. These proposals include: exit (closure), privatisation, partial disinvestment, greater autonomy, more accountability, non interference by government, withdrawal of government support, restructuring etc. Most of these suggested solutions

imply that a private sector company is more efficient and better performing. In the process, the entire gamut of real issues as to the relevancy of a PE, what constitutes its performance, validity of comparing the performance of a PE with a private company and obligations of a PE to carry out social responsibilities have been brushed aside.

As the compiling editors explain, the book under review presents experiences and insights of leading academicians and practitioners on issues and challenges faced by PE's. The publication is the outcome of a series of programmes organised for top managers of PE's in commonwealth countries. The different papers included in the book have been presented at these programmes. The book comprises of three sections.

Section I presents key issues and emerging environment in public sector corporations. The first chapter 'Organisational Change in Public Sector Enterprises: An Overview' by S. Ramnarayan focuses on strengthening three types of processes in PE's: processes that create a shared sense of purpose; processes that generate supportive environment; and processes that influence people's perceptions of the situation and elevate their expectations. It is a well reasoned and an analytical paper and brings out the case that organisational change has to be carefully nurtured and managed as a process.

While sharing experiences to improve PE's, the chief executives recognise the need for clear goals, objectives, performance criteria, and the need for greater autonomy and restructuring of organisation. Dr. Samuel Paul in his paper 'Global Trends and Issues in Public Enterprises Management: A Macro Economic Perspective' has carried out an analysis of several issues which confront a PE. Dr. Paul very rightly questions the constraints imposed on a PE in areas such as product pricing, labour policies, staffing, retrenchment etc. Dr. Paul opines that PE efficiency can be enhanced by reforming the policy frame work and the management system.

Prajapati Trivedi's paper 'Privatisation, Performance contract and Performance Evaluation of Public Sector Enterprises' and Nasir Islam's paper 'Performance Contracts in India, Pakistan and Senegal' provide excellent studies on such issues as controls, accountability and autonomy of PE's. Both the authors have highlighted several misconceptions about the working of PE's. Islam for example, mentions that 'the relationship between performance and autonomy is neither clear nor conclusive; we are not sure whether autonomy leads to performance, or efficiency and performance are the preconditions for autonomy'.

Pradip Khandwalla's long paper 'Regeneration of Strategic Organisations' examines and analyses public enterprises which underwent regeneration. The author found that regeneration converted most PE's from 'deep sickness to healthy profitability'. Khandwalla questions the belief that privatisation or closure could be the only remedies for rescuing sick PE's. In a related paper 'How Managers Deal with Strategic Complexities' authors, Harold Schaub and Stefan Strohschneider bring out the characteristics of working environment with features as complexity, novelty, dynamism, unclear goals and risky measures. Human mind has shortcomings and limited capacity. The authors recommend computer simulations and training using different kinds of complex, dynamic and concealed problems.

Section II of the book includes papers from four of the highly successful and much acclaimed chief executives from PE's. These are first person accounts detailing personal experiences of positions held.

The case study on National Paper Corporation of Sri Lanka by M.G. Kargaonker and B.H. Dholalia is highly detailed, full of statistics, data and analysis. Like many parallels in India, this corporation was called upon to serve social objectives of supplying paper for exercise books for school children at subsidised rates. The corporation grew up to become a market leader with 80 per cent market share. The case study presents a detailed account of several issues such as marketing, raw materials, quality management, HRD, etc. Change of agenda in the new environment is the focus of case study on Agricultural Finance Corporation, Zimbabwe by I.M. Pandey and S. Ramnaryan. The new environment a resultant of independence of Zimbabwe, increased the clients to be serviced to 50,000 in place of earlier figure of 3000. The company introduced the concept of group lending to deal with the problem of very small loans.

'The Malta Dry-docks Corporation' by I.M. Pandey is the case study of a sinking corporation and its struggle for survival. The chairman of the corporation is a trade unionist himself. It is an interesting case study wherein even after a decade of self management practices, there is no worthwhile improvement in performance.

The case study 'National Machinery Corporation of India', by Ravi Ramamurti is a disguised case, partly based on a PE operating in India. The case is meant for class discussion and describes as to how a CEO struggles to transform a loss making company with demoralised workforce to a profitable concern which can be a model for other PE's.

Case studies included in Section III provide an excellent reading and no pains have been spared to furnish

detailed data and statistics. In-depth analysis of performance and how a public sector corporation changes its agenda in the new environment arising out of competition and new expectations are presented. It is however very paradoxical to note that not a single case study could be included from the Indian context. One would have longed to see an in-depth study of performance of a Navratna PE or a consistently losing PE such as NTC. Perhaps a case study on such a giant as HMT or Central Electronics Ltd. now on down the hill slide would have been more appropriate. First-hand accounts included in Section II no doubt carry prestigious and high profile signatures from India, but in the absence of data and statistics as in case studies, they lack an in-depth critique and an analytical performance evaluation. Many passages in these accounts are only nostalgic references to events and discussions with bureaucrats.

One would have also wished to go through a case study on comparative performance of a PE in pre-reform and post-reform periods in order to understand and appreciate the impact of reforms, as practiced in India for the past ten years.

The focus of the book is to find methods and means to improve the working of the PE's. To this extent the book is a highly useful addition to the existing literature. The book presents a wealth of experience, unfolding several issues faced by PE's. The publication should prove to be a useful guide in the hands of executives and managers working for a PE. The book is recommended to students and research scholars of business management studies who plan to make a career in industry in general and PE's in particular. The book should be equally valuable to such categories of readers who are keen to find remedies to improve the performance of PE's. This book should provide right directions to the policy makers of PE's.

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Tom Lambert: Key Management Solutions, Macmillan India Ltd., 1997.

In this fast paced and everchanging environment, managers are faced with a variety of problems. This book can be of great help to working managers in solving their problems. Most of the solutions presented in this book are based on the author's experience with the corporate world as a consultant. The author has offered models given by different management gurus or modifications of those models as solutions. They are

meant to provide a framework to working managers for gathering data, analysing it and applying the information generated therefrom for making timely, economical and effective decisions.

The book has been divided into eleven chapters each of which deals with different aspects of business administration like strategic and operational planning, people management, leadership, team building, decision making, financial management, marketing and sales management, managing culture and training & development.

In the first chapter, the author has discussed the relevance and importance of using management models. According to him, instead of blindly copying successful firms, it would be better for firms to adapt the models given by management gurus to solve their unique problems.

In the chapter dealing with strategic and operational planning, the author has provided a seven step model for evolving a tactical plan and another model called RAISE for increasing the acceptability of the tactical plan. In the next chapter on managing people, the author has given a modified version of Maslow's need hierarchy theory, a model for handling redundancies and a model for job performance management. Bottom up appraisal has been suggested for proper appraisal of individuals.

In the case of problem solving and decision making, the author has discussed the appropriate use of participative decision making and has suggested two models for problem solving namely—Synectics and the KT model. As for financial management, the author has restricted himself to the definitions of important financial terms. This chapter will be useful for managers with no financial background but for people in finance, it will not be of much use. The author could rather have excluded this chapter. In case of marketing management, the he has thrown light on evolving a comprehensive marketing plan, doing competitive analysis, market planning and how to advertise effectively. For bringing about cultural changes, the author has suggested the conducting of a cultural audit and he has also given a model for implementing cultural changes.

The book is exhaustive touching upon all the major issues of business. It has been written to suit all types of managers with or without a management background. The author has not only provided ways and methods of solving problems but has also given a checklist at the end of each topic enumerating all the common mistakes managers make while dealing with problems related to that topic. This book is based on years of research and

experience and hence the solutions are bound to work, if applied properly. This book will be highly useful to working managers, students of management, professional trainers and management teachers in gaining insights into problems and applying the right solutions.

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Meeting the Challenge of the European Union: Prospects of Indian Exports by Atul Sarma, Gerrit Faber, Pradeep Kumar Mehta, Sage Publications New Delhi, 1997, pp. 346, Rs. 425.

The study being an outcome of collaborative effort of Indian and Dutch scholars, has been sponsored under the Indo-Dutch Programme on Alternatives in Development (IDPAD). The background for the study accrued from changing trading environment due to the introduction of structural reforms in India since mid 1991. These changes were introduced in trade, monetary and fiscal policies. At the same time, in the rest of the world, the concept of liberalisation and globalisation was also gaining momentum.

The study is well conceived and is based on primary and secondary data. It is divided into three parts and a separate chapter discussing the conclusions and policy implications. The first part deals with historical perspective and policy changes accruing from structural reforms followed by performance and prospects of exports to Europe. This was through reduction of protection given to indigenous industry and making them competitive. In second part, the authors examine the performance and prospects of Indian exports to Europe after it becomes a single European market. In this part of the book, the inter-temporal behaviour of Indian exports in different product categories have been analysed along with prospects of growth in Indian exports. The last part of the book discusses the barriers to export growth and talks about the perception of Indian exporters and European importers in respect of future prospects of export growth and the impact of changing environment on exports from India.

First part contains two chapters. In the first chapter, the authors try to identify the structural reforms having relevance for Indian trade. The authors indicate that the recent policy changes of reduction in protection of domestic industry are intended to create a competitive environment so that the competitive strength of Indian

industry is enhanced. At the same time, a friendly atmosphere for increasing exports is created by improving the incentive structure. Authors expect that these changes would have positive impact on Indian export performance and conclude that the liberalisation when accompanied by harmonisation of markets leads to better access to markets, more competition, both at the domestic and global levels. Consequently, this would bring in more opportunities to expand and diversify.

The second part of the book comprises three chapters. In the beginning of this part, the authors analyse the growth and composition of exports to European Union (EU). The period chosen is 1976-93. To analyse and compare, the period has been divided in to two spans, 1976-82 and 1983-93. The measures used for comparison required the selection of four time points therefore the authors focused on four time points 1976, 1983, 1991 and 1993. The authors use commodity and geographical concentration indices for comparison. Apart from the estimation of complementarity and similarity indices, the authors have also estimated income and price elasticities of imports to European Union. The empirical exposition in this chapter is very comprehensive and illustrating. The chapter is a valuable reference for future studies. In the following chapter, the performance and prospects of dominant exports have been analysed.

In the beginning of the third part, the authors analyse and discuss present and prospective commercial policy of EU and how the policy changes would influence the Indian exports. In this chapter the present and prospective barriers to trade have been highlighted. The chapter is informative and revealing. In the next two chapters, the authors discuss the perception of Indian exporters and EU importers separately. This makes the study distinctive because the perceptions of the exporters from India are reconciled with the perceptions of the importers from EU.

The last chapter of the study, dealing with conclusions and policy directions, is most relevant for both academia and policy makers. The authors assert that India has comparative advantage for several commodity groups. The recent inter-temporal growth of large number of commodity groups indicate increasing competitive strength of the products. The authors suggest that the exporters stand to gains if they target non-traditional markets. The authors also opine that the recent policy changes have created optimism among exporters from India and importers in EU.

The study handles most of the important issues relating to exports to EU and pleads for further diversification of product categories. The study is logically

sequenced, empirically strong and simple in exposition. The book is an unavoidable reference for research in export-growth studies and is important for exporters to make them understand the future dynamics of the exports to EU.

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Stuart Crainer, Key Management Ideas, Macmillan India Ltd., New Delhi 1997, p. 252.

In nine Chapters, the history of management concepts and practices, evolved from the time of Frederick W. Taylor (1856-1917) till date has been traced in this book.

The author, in his first chapter on the New World of Management, states that the management concepts are beset by fads and fashions, which have their own life cycle, yet there has never been before such grand scale new approaches to management. Tracing the history of management, he uses Alvin Toffler's phrase that we have already moved from "brute force economy" to "brain force economy" or put differently the "machine age" has been replaced by "information age".

Taylorism is said to have dehumanised the work by insisting on the workers to follow the "best way" of doing a job as prescribed by the management and he should be rewarded and punished according to his performance. The author quotes Peter Drucker and very rightly in support of Taylor's contribution-he was the first person to really begin to think about the "actual act of work" rather than taking it for granted. Looking at Taylor's "Scientific Management" and Champy and Hammer's "Process Re-engineering", both the approaches have some basic ingredients, i.e., nothing is taken for granted, wasteful activities which do not contribute to the objectives must be ruthlessly eliminated.

Henry Fayol (1841-1925), brought to focus the importance of people when in one of his principles, Fayol stated that efforts must be made to promote harmony within the organisation and prevent dissension and divisiveness. People focus was also highlighted by Hawthorne experiments (1927-32) which lead to the broad conclusion (not without controversy) that workers' productivity increased when the management was concerned about their well being. From here onwards, management thinkers, one after another, emphasised the pivotal role of the people.

Whatever form of an economic activity it may be, people count the most.

The author herein also discusses an important concept: Management of Change, which has to be radical, transformational and not merely incremental. He quotes substantially from Pascal's works on this theme, and takes out a number of most absorbing observations, for example "change can be brought about only by those who relentlessly commit themselves to self-questioning and reinvention". Smartest companies must use conflict to stay ahead; companies with internal coherence become ill equipped to deal with radical shifts in the ever increasing uncertain environment, as happened to the companies referred to in "In Search of Excellence"; talk about quality management only after worrying about the quality of beings; with change becoming inevitable, no company can guarantee progressive career within the organisation; only those will survive who become a strong change agents etc. The book talks eloquently about the skills required to manage change and the organisational conditions conducive to change.

In the second chapter, "New World of Organisations", the author starts with a reference to Henry Ford (1863-1947), a genius for mass production and creating functional type organisation. Ted Levitt, Marketing Expert, had, however, argued that Ford's genius lay in marketing than in mass production techniques. Ford set the affordable price for the car and challenged the organisation to meet it. Though Ford, like Taylor, is also seen as having dehumanised work, provided wealth for workers and products for customers which were not previously available.

The functional organisation concept, leading to workers' alienation, lack of coordination between different departments and absence of flexibility, was dismantled by Alfred P. Sloan (1875-1966), CEO of General Motors, who replaced it with multi-divisional form of organisation-wherein senior managers were required to oversee decentralised divisions with entrepreneurial decisions centralised at their level.

Jack Welch, GE Chairman and Percy Barnevik, CEO of ABB, found multi-divisional form organisation as inflexible and cumbersome in the fast moving 1990s. Various new organisation models started emerging, focussing on delayering and utilising IT as a key resource. In GE where 5 to 6 people were earlier reporting to a manager, this number has already gone upto 14 and in some cases upto 25. Chrysler is working to take this number to 100. ABB management practices matrix model based on three foundational aspects (1) identifying the skills required in executives and identifying a small number of key executives; (2) practicing open

communication and (3) eliminating head office bureaucracy. ABB matrix organisation seeks to resolve three contradictions: (1) being global and local, (2) being big and small (3) radically decentralised with centralised reporting and control.

The author discusses the important characteristics of a new organisation: (1) flexible and free flowing, (2) non-hierarchical, (3) based on participation and empowerment, (4) practicing creativity and entrepreneurship, (5) driven by corporate goals and not narrowly defined functional ones, (6) utilising IT as a key resource. He also quotes Charles Handy elaborately on shaping the new organisation. Some of the thought-provoking observations of Handy referred to by Crainer are: you cannot solve others' problems, you can only help them to solve their problems; human brains must become the core of the organisations, other activities can be contracted out; in this age of discontinuity, status quo should be rigorously shaken off; today's language is of cultures and networks, teams and coalitions, influence rather than control, leadership and not management; companies must work continuously on value addition derived by utilising intelligence, information and ideas; principal objective of any company is not to make only profits but how to utilise it to do things better and more abundantly etc. The organisations of the future will appear almost edgeless, continuously changing interfaces among company, suppliers and customers. From within, the traditional offices, departments and operating divisions will constantly reform according to the needs and net result will be "virtual organisations".

Crainer has extensively researched on three themes-the New World of Management, Organisations and New Ways of Managing People. Very many theories were experimented to comprehend people's behaviour and attitudes towards work. Most prominent among them were theory X (workers are inherently lazy, they need both carrot and stick to motivate them). Theory Y (workers want to work, what is needed is to enhance their commitment to the organisation) and Theory Z based on Japanese work culture which focuses on concern for employees including their social life, decision thru consensus, information sharing, commitment to firm and concern for quality.

Theorizing on the Concept of Empowerment, the author brings out the fine distinction between delegation and empowerment by quoting Dr. Ian Cunningham, author of *Wisdom of Strategic Learning*—delegation is process of shedding manager's job to his subordinates; empowerment on the other hand requires removing constraints which prevent employees doing their job effectively, or getting involved in enlarging and enriching

their jobs. The role of managers is thus changing from planning, directing, and control to coaching, leading and acting as a resource.

Commenting on teamworking, the author says that teams occur when members have a common goal and they realise that their personal success is others' too. But more than that, the author says that behaviour of the team members must mesh together in order to achieve objectives. In a team there has to be a fine mix of Doers, Solvers, Checkers, Carers and Knowers. Further, the success of a team lies not merely in the selection of its members but more so in genuinely granting power and responsibility to teams in solving their own problems.

The chapter on Leadership, starts with two pertinent statements—(1) everyone wants to change his/her organisation, which requires change in people and that is possible when you change yourself first; (2) learning to lead oneself is the only way to lead others better. In the military model of leadership, morale is considered a state of mind, founded on spiritualism, intellectualism and materialism. The new model leader realises that he cannot ignore the foot soldier who fights on the ground. Vice Chairman of Pepsi Co. says that he spends half his time with the employees. The author, among various approaches refers to Transformational leadership which creates vision and Tao of Leadership which reckons enlightened leadership as service and not selfishness. The concepts contained in Tao of Leadership (not referred to by the author) are very close to Indian thoughts.

Finally, the author discusses the key drivers behind Globalisation—technology, cost saving, and rise of homogeneous markets, and states that globalisation focuses on speed, flexibility and cost saving. The transnational organisations face a number of challenges,—delivering benefits to consumers by producing customised products; being responsive to customer service; making its presence felt everywhere; continually evaluating and monitoring market information; constantly utilising global cost efficiency; avoidance of repetition and duplication; dynamic, flexible and lean management structure with excellent system of communication.

Global companies have to be world class players and refers to ten point agenda of the London Business School. Some of the agenda items are: role of chief executive as change pushers; focus on customer satisfaction; employees' morale and quality rather than only worrying about financial health; ambitious goals because survival alone is not enough and combining efficiency with effectiveness, strive for continuous improvements through effective participation and upgrading continuously the capabilities of employees; benchmarking on internationally documented best prac-

tices in all fields and everywhere; and finally a bias for action, allowing people to take risks, make mistakes and learn from failures. On the whole this is a good reference book worth keeping in one's library shelf.

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Financial Management of Co-operative Spinning Mills by S. Mohan, Chaitanya Publishing House, Allahabad, 1997, p. 176, Price Rs. 350.

The present book is a commendable addition to the already existing literature in the textile area. The first chapter of the book is devoted to developing a conceptual structure prior to the body of the analysis that follows. With a justified stress on the importance of finance in the sustenance and survival of an enterprise, the author emphasises on the management of scarce finance. Different forms of financial management embedded in decision making regarding capital investment, capital structure, dividend and working capital are clearly delineated. With an allusion to the concept of pure spinning mills as distinguished from the composite mills which house both spinning and weaving, the author puts stress on the importance of spinning mills which supply most of the yarn requirement of the decentralised sector. In this context the financial management of co-operative spinning mills (CSM) in Tamil Nadu, having close nexus with the agro processing and handloom industries, is sought to be analysed. The author rightly observes that the management executives in CSMS have to blend the objective of profitability with the twin social objective of provision of quality yarn to weavers' societies at reasonable prices and creation of employment.

A profile of the sample mills in terms of size, origin, growth, capacity utilisation and production per spindle has been outlined in chapter 2. All the mills except one had been set up before 1966 and have almost outlived their machinery. The odd one is one of the five newer mills established in 1982. The sample would have been more meaningful had the newer mills been given a somewhat greater representation.

The next chapter deals with the importance of fixed assets in production and its operational management. Among the several aspects of fixed asset management are discussed adequacy of fixed assets, efficiency in the use of fixed assets, financing of fixed assets, analysis of depreciation policy and capital investment decision.

Various ratios representative of each of these categories have been formed and indepth mill-wise tabular analysis extremely important for maintaining the right cash balance of a company. Despite Tandon and Core Committee recommendations, the author noted that most of the mills excepting one made excessive use of bank borrowing, held inadequate cash and suffered from inventory mismanagement.

Acid test for the managerial performance of any enterprise lies in its profitability. This aspect has been elaborately dwelt on in chapter six. Various ratio analysis of profitability suggest that the mills on the average have suffered from losses. Insufficient value added coupled with the objective of employment creation have eroded the resources generated internally. Better capacity utilisation, modernisation of machinery, better planning, avoidance of diversion of working capital, extension of equity by allowing individual participation are some of the important development oriented concluding suggestions. With extensive bibliography and set of tables, the book is supposed to be extremely useful to those engaged in related field of research.

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Bargaining Power, Wages and Employment: An Analysis of Agricultural Labour Markets in India by Gaurav Datt, Sage Publication Pvt. Ltd., New Delhi, 1996, p. 224, Price Rs. 295.

Amidst the voluminous literature on agricultural labour markets and wage determination process in India, the present book "Bargaining Power, Wages and Employment: An Analysis of Agricultural Labour Markets in India stands out for its useful and comprehensive analysis of rural wage determination. The study herein is based on ICRISAT data for four districts from Andhra Pradesh, Gujarat and Madhya Pradesh. In the first two chapters of the book, the issue of agricultural labour market is introduced and the standard theories on labour market are schematically reviewed. Quite convincingly, the review demonstrates the extent to which the standard theories fail to explain the regional, seasonal and gender variations in agricultural wage rate. Since competitive models, in general and collective bargaining approaches in particular are yet to be meaningfully incorporated into the analysis of the agricultural labour markets in the Indian context the present study is a significant contribution.

The author notes that competitive models of wage determination have not received due attention in the Indian context. This, according to him, could be because of the conspicuous absence of any formal wage bargaining mechanism. Despite the fact that a major part of the labourers in the rural labour market are not unionised, the agricultural wage rate is observed to be uniform within a village. This intra-village wage uniformity is attributed to the tendency prevalent on both sides of the labour market to abide by the going wage rate, which is made possible by the tacit understanding between the employer and the labourer—the two major players in the market. In this context, the author invokes the concept of 'social sanction' to explain the observed tendency on the part of the labourers to undercut the wage rate and attain more days of employment in a situation of involuntary unemployment. Such behaviour of the two players is analysed using 'Assurance Game', a modified version of the 'Prisoners' Dilemma'.

Agricultural labour faces a binary choice of whether or not to undercut the wage rate. The choice of 'Assurance Game' to analyse the behaviour of the two players is justified as Prisoners' Dilemma allows no room to invoke the concept of 'social sanction'. 'Social sanction' enforces every labour not to undercut the prevailing wage rate and, in turn, to help the rural labour market to attain equilibrium. The collective bargaining model developed in the study takes village as the spatial domain of labour market and the wage determination process is perceived as a bargaining game between the groups of village employers and labourers. The literature on bargaining theory proposes a number of bargaining solutions which can be broadly categorised as axiomatic, (the co-operative), and strategic, (the non-cooperative). The solution to the 'two person bargain problem' is proposed in the axiomatic framework. The Nash bargaining solution of the game theoretic approach is applied to set up the village wage bargaining model. The basic model includes a simultaneous system involving a profit function, labour demand function and the bargained wage function. The wage function is determined by the Nash bargaining solution and the profit and demand functions are specified using the dual approach to production economics. The estimation of the model is presented in chapter 5. Chapter 6 provides an extension of the basic model incorporating the wage determination process for male and female labourers. The basic model is further modified to analyse the operation of the agricultural labour market with respect to wage variation across regions, between main and lean seasons, the impact of changes in cropping and irrigation intensities on wages and profits, and finally the effect of the changes in output prices on nominal and normalised wages and profits.

The regional wage variation is analysed using the basic model by introducing district binary variables to capture the regional effects which interact with the parameters such as the employers bargaining power, demand elasticity of labourers with respect to wage rate and the disagreement pay off of labourers, defined as the income that could have been earned from alternative non-farm employment. Wage rates across regions vary and all the three parameters incorporated into the basic model are found contributing to regional variations in the wage rate. In one of the villages surveyed by the author, the wage rate is found to be lower than in the neighbouring villages and the variation is attributed to the 'own system and custom' prevailing in the village. Though oblique reference is made to mark the influence of sociological and anthropological factors in shaping the agricultural wage rate, none of these factors is incorporated into the model. The point which assumes importance in this context is that agricultural wage rate determination is an evolutionary process which involves interaction of several factors, and that these factors can not be empirically specified in the model. In other words, wage rates need to be viewed in their totality. For instance, the studies on agricultural wage rate in Kerala have shown that the wage hike experienced for the paddy labourers in the 1980s was contributed by the boom in the construction sector.

In the ICRISAT villages, chosen for the study, worker characteristics such as age, years of schooling, main occupation and area under possession are reported to have negligible influence on agricultural wage rate in the case of 80 per cent of the sample households. The rest 20 per cent is left unexamined as they are statistically insignificant. It is possible that the left out 20 per cent would represent a different segment of the labour market and that their characteristics are significantly different from those of the majority.

Chapter 7 of the book can be read with much profit. Issues such as the impact of the changes in the price of agricultural output and variations in cropping and irrigation intensities, on labour market outcomes are addressed in this chapter. The analysis of the distributional effects of cropping and irrigation intensities show that increase in profits of employers due to area expansion would be higher than rise in wage earnings. Another interesting finding of the study is that 10 per cent increase in the prices of agricultural output is associated with 3.4 per cent increase in employment and 2.6 per cent and 8 per cent increase in nominal wage rate and earnings respectively, whereas normalised wage rate will be reduced by 7 per cent and normalized wage earnings by 2 per cent. On the other hand, the normalised profits of employers would record a rise by 6 per cent.

The major lacuna in the study is that it has totally skipped the other side of the labour market, i.e., labour contracts, interlinkages between different sub-markets, different forms of employers-employee relations which has already been shown to be influencing final outcomes of the labour markets. The present study does not take account of any of the non-competitive forms of operations of the labour market as it focusses only on the bargaining part. For a realistic analysis of the agricultural labour market both the competitive and non-competitive including the institutional aspects need to be addressed. Despite such limitations, the study constitutes the first attempt towards constructing an agricultural wage model in the Indian context in a Nash bargaining framework taking village as the unit of analysis. Moreover, analysis of the distributional outcomes of the different changes lends further relevance. It supplies important material for researchers specialising on the dynamics of the agricultural labour market.

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Perspectives on Forestry Resources Management by Cruz D.A., Asian Productivity Organisation, Tokyo, 1997, p. 275.

The publication is an outcome of a seminar organised by Asian Productivity Organisation, during October 17 to 27, 1995. The objectives of the seminar were to assess the current status of forestry resource management in Asia and the Pacific, discuss policy measures and programmes for effective implementation of forestry resource management and exchange information and share experience on the subject among the participants. The publication has been divided into four parts. Part I of the publication contains type of participants, objective of the seminar and regional overview, highlights of country and resource papers and field studies.

While presenting the regional overview, Masakazu Kashio expressed that the annual deforestation rate, has increased from 2.0 million ha during 1976-80 to 3.9 million ha during 1981-90 confining mostly to south and south east Asia. Countries in the temperate zone such as People's Republic of China, Japan and Republic of Korea on the other hand maintained or increased their forest cover. Factors responsible for deforestation were considered as horizontal expansion of the agricultural frontier in the form of subsistence farming/shifting cultivation, livestock ranching, cultivation of cash crops,

colonization, transmigration, infrastructural development programmes, exploitation for fuel wood, repeated brush fires etc. The consequences of the depletion of forest resources have been frequent floods, droughts and landslides, soil erosion and siltation, loss of biodiversity, changing climatic patterns, shortage of water, timber, fuel wood and fodder and extinction of plant and animal species.

Part II of the publication contains seven resource papers presented by experts on various topics like current status of forestry resource management in Asia and the Pacific, recent policy initiatives in forestry resource management, potential for community forestry and agro forestry development in the Asia–Pacific region, technologies on afforestation and reforestation, forest planning system in Japan and policies and programme for maintaining and increasing public functions of forestry resources.

These papers present the status of degradation and deforestation of natural forests in tropical countries, their direct and indirect cause and consequences, and concept of forest management. The details of forest resources management like national forest policy, forest acts etc. in India and Thailand, are also included. The Taungya method of reforestation in which tree seedlings and agricultural crops are grown has also been explained in detail which includes mechanics of growing field crops and planting trees relationship between tree and crops, negative interactions, conflict between land-owners and growers etc. The last paper dealt with the system for the preservation of forest including the protection forest system and the forestland development permission system based on the forestlaw in Japan.

Part III of the report contains the country papers presented by the delegates of twelve countries. The country papers in general contain the informations regarding current situation of forestry, forest resources and their utilization, problems in forestry resource management, reforestation and afforestation programmes, forest policies, role of forest sector on economy of these countries, forestry research and future planning for forestry development.

Government of Bangladesh has taken up a massive afforestation programme through various local/foreign aided projects for implementation in government owned forestland and marginal land or in privately owned homestead, with an objective to bring 20 per cent of the country's land under tree cover by the year 2015. The forestry section of Bhutan contributes directly about 11 per cent to GDP and generates about 3 per cent of government revenues. Protection and conservation

have been pursued by means of an intensive control and penalty system on the unauthorised use of forest products. The country paper also highlights the objectives, strategy and targets of forest management plans. Government of India has set aside about 75 million ha or about 21 per cent land area for forestry resource management. The natural forests are mostly owned by the state governments and they are regulated and managed by a central legislation called India Forest Act as well as a scientific management document known as working plans.

The Republic of China plans to use agricultural automation system in agro forestry in future to reduce costs and improve production both in quality and quantity. Reforestation projects on the cutover areas have always been a top priority of the National Forest Policy and strongly supported by the Government of China since 1945.

The objective of the Forest Resources Enhancement Plan of Republic of Korea is designed to maximize forestland benefits through the creation of forest income sources and promotion of public benefits of the forests. One of the tasks of Republic of Korea is to modernize the forest management foundation through the expansion of forest road and mechanization of forest works. The forestry sector has contributed significantly towards the overall economic development of Mongolia and the sector has great potential for further development in future. Agricultural sector is the mainstay of the national economy of Myanmar. Forest policy has laid down a guideline concerning the protection and management to constitute the reserved forest upto 30 per cent and protected area system upto 5 per cent of the total land area of the country.

Nepal is full of rugged hills and mountains which cover more than 80 per cent of the land. Despite continuous degradation. The forest resources of the Terai are considerable and offer excellent basis for sustainable silvicultural management. The present natural forest management approach is more or less protection oriented. The future approach may be focussed on increasing production in sustainable, economic and ecological balance way through the development and implementation of appropriate plans, participatory and technical approaches.

Nearly all the forest lands in Sri Lanka are state-owned. Government has made a national forest policy for the management of state forest resources, private forest and tree resources, wood and non-wood forest products, industries, marketing, institutional support for forestry development, inter-sectoral linkages and international forest related conventions.

Deforestation in Kingdom of Thailand has damaged agriculture, energy production, transportation, industry and human settlements. The paper highlights the utilization of forest resources specially wood, forest use planning and management, socio-economic and environmental aspects and development of reforestation. The development of forestry is mainly through land tenure system in Tonga. Forestry contribution to Tonga's economy is very small compared to other. Tonga does not have a formal national forest policy. Much of the investment in forestry over the next 10 years will be to manage and develop forest resources on sustainable basis. The economy of Western Samoa is dominated by subsistence agriculture and related activities which support around 75 per cent of the total population. High rate of deforestation and unpredicted order of cyclones, have reduced the potential of the forest resource quite drastically.

The contents of the most of the country papers have sufficient information to fulfil the objectives of the seminar. The publication may provide useful reference material to policy makers, research workers, progressive farmers, forest officers and teachers and students of forestry management.

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Agricultural Finance and Management by Reddy S.S. and Raghu Ram P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1996, p. 256.

Agricultural finance and its related management decisions are matters of critical importance in the overall agricultural development. Because of its current importance, graduate and post-graduate courses in this field have been offered in agricultural universities.

The book has been designed as a comprehensive text covering all aspects related to agricultural finance and management. Though the book is primarily meant for under graduate students, the economic principles and econometric models dealt in the book would help the post graduate students and teachers to acquire analytical skills.

The book is spread over nine chapters, supported with analytical tools and numerical examples. Chapter 1 outlines the concepts and scope of agricultural finance. Chapter 2 provides a comprehensive picture of functions, objectives and role of financial organisations. The economic principles like law of diminishing return, mar-

ginalism, factor-factor relationship, product-product relationship, equi-marginal return, comparative advantage, opportunity cost and cost concepts are discussed elaborately with numerical and graphical illustrations in chapter 3.

In chapter 4, various farm credit proposals including the details of repayment plans are focussed, which provides basic information for preparing credit proposals and benefits the students, teachers and researchers to acquire this skill.

A brief discussion on tools of financial analysis, viz., farm planning and budgeting, balance sheet, income statement, cash flow statement, financial ratios and break-even analysis are furnished with hypothetical examples in chapter 5.

A theoretical background of production functions, cost functions, linear discriminant function, probability models with dependent variable of binary nature and growth curves are presented in chapter 6. Similarly, the optimisation models, such as, linear programming and its extension like MOTAD are dealt with numerical examples in chapter 7.

Chapter 8 provides useful insights into the techniques of evaluation of agricultural projects. The capital budgeting techniques viz., undiscounted and discounted measures are described. A brief outline of the important financial schemes related to crop and animal husbandary is given in chapter 9.

Though some of the mathematical models are dealt with appropriate numerical examples and estimation procedure, there is undue use of mathematical and statistical techniques in explaining the issues related to the subject. For instance, growth curves and probability models are discussed with much less significance of their applications. Moreover, the book has much less significance in dealing with the theoretical and empirical understanding of the economic principles and mathematical models in the context of well exposed books on these aspects are available to researchers, teachers and students.

Overall, the book is a welcome addition to the literature on the subject and some parts of the book are dealt beyond a conventional text of agricultural finance and management.

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Pollution Control in the South and North by Kuik, O.J. et al, Sage Publications India Private Ltd., 1997, p. 253, Price Rs. 350.

For years industrialisation has influenced lifestyles and for years it has impacted the environment throughout the world. Interestingly at one moment of time (in one round the Globe trip) we can view its manifestations—what with the South and the North depicting succinctly the link from the past to the future. The question of answers is—why is man bent upon defacing the pristine revolving planet? Has the myopic haze begun to lift and fuzzy logic finally overcome by sane enterprise?

Pollution is indeed a mockery of Development and Growth and mankind has declared a battle for Pollution control. One can only say that the quest for controlling has begun. The book under review presents the reader the evolutionary trends in the Development of Environmental Policy. It then focuses on the constraints and strengths of pollution control instruments. By adopting a comparative approach, the authors wish to enlighten the readers on differences and similarities that exist in the application of Environmental Policies in the developed and developing countries. They have chosen India and Netherlands to aptly represent the developing and developed economies. It remains to be seen whether the Environmental scientists, activists, policy makers, economists and Industrialists of these countries learn from the contrasting experiences.

The book has been divided into three parts:

Part I delves on the variety of tools and instruments that could make Environmental policies work.

Part II is a discussion of case studies and is studded with facts and figures (in comparing the unequals).

Part III summarises the milestones in Indian and Dutch Environmental Policy and draws conclusions on the comparative study with a discussion on opportunities for improvement in Pollution control policies.

The current Environmental Policy instruments are:

- (i) Communicative Instruments—have a voluntary basis
- (ii) Regulatory Instruments—have a command and control basis
- (iii) Economic Instruments—they are market based.

The communicative instruments seek to popularise cleaner production alternatives through moral

suasion/and institutionalisation of environmental Management.

The Regulatory instruments—by far the most commonly used—impose restrictions or obligations by introducing emission and design standards (also known as Source oriented/effect oriented standards). In most situations however, these have not produced the least cost solution. They have always been a burden on the administrator especially because of monitoring and enforcement problems.

The economic instruments are of recent origin and are effected through a gamut of techniques like, charges and taxes, subsidies and sops, tradable permits, deposit-refund systems, liability legislations etc. It is advocated that these instruments have higher efficiency and administrative feasibility.

The author in elaborating the concepts and benefits of above instruments has however cautioned about their indiscriminate use. No single instrument is a panacea and the applicability of each or a combination thereof has to be tried in a studied environment. Infact to judge the performance of Environmental policy instruments many criteria have been suggested.

To achieve environmental harmony all countries have placed environmental problems on the top of their agenda. Environmental concerns may rest on aesthetic and health grounds in some countries and on survival and livelihood issues in others. It is important to realise that the benefactors of economic growth and the sufferers of its fall-out are seldom the same people—infact mostly they belong to different eras.

In the Indian context it is observed that the Environmental policy like the Motor Vehicles Act (1939), Water Cess Act (1977) and Hazardous Waste Management Rules (1989), laid emphasis mostly on administrative action only. This has been the theme of the various Acts since 1853 till date. Various institutions have also been created such as the Ministry of Environment and Forests and the Central and State Pollution Control Boards which are empowered to implement the provisions of these policy Acts. The authors claim that the emergence of Public Interest Litigation (PIL) has pulled the judiciary into actively participating in the shaping of environmental policies today.

In the Netherlands, following the Industrial Revolution and after the post war reconstruction (early 1960s) the concern for Environmental protection grew with the emergence of NGOs. The 1972 Emergency Memorandum on Environmental Hygiene followed by Waste Act (1976), the Noise Nuisance Act (1979), National En-

Environmental Policy Plan 1989 and the integrative Environmental Protection Act, 1993 etc. were important policy responses to the Environmental problem. From the compartment-oriented approach to the present day integrative approach the book elaborates about the paradigm shift in the policies. The book also provides evidence on successes scored (in terms of costs of enforcement and compliance) by various policy instruments including permits and covenants (besides regulatory instruments), and delves on the various themes such as climate change, Acidification, Eutrophication, Diffusion of Hazardous substances and Waste Disposal etc., that were applied in the Dutch context. It is observed that cooperation has become a key-stone of environmental policy in this part of the world.

The case studies are a comparative appraisal of the working of pollution control measures in three branches of industry—namely Textiles, Cement and Fertilisers (in the Netherlands and India). The Bovenberg Framework on situation and characteristic Indicators was used in the analysis. It was observed that economic instruments relatively play a modest role in environmental policy. However, their role may become important since:

- (a) Marginal abatement costs rise when standards are tightened
- (b) More experience is gained in implementing economic instruments and
- (c) When monitoring costs fall.

The case studies have thus revealed ample scope and potential for adoption of Market based policy instruments.

On the whole the book (which is the 21st volume in the series of studies sponsored by the Indo-Dutch Programme on Alternatives in Development IDPAD) is an excellent treatise on Environmental policy. The authors deserve commendation for producing a book of immense value to policy makers and a handy reference to all who are concerned about the Environment.

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Implementing Quality Management in Asian and Pacific Firms, Basic research report by Asian Productivity Organisation, APO, Tokyo, 1998, p. 423.

There will not be any economic progress without

change in management function, today the only constant thing is change. It has become necessary for organisations to be prepared for change or otherwise become reconciled to extinction at worst and fossilization at best. The organisations have to move from a simple supply and buy relationships to the technical and operational complexities of an intimate customer relationship. They have to develop a new mind-set, a new way of doing business—with new structures, new strategies, new values and a new vision.

Total Quality Management (TQM) is now widely accepted as a strategic approach to enhance competitiveness and business performance. It is in this context that APO adopted TQM as a thrust area of activities in 1991. The present book focuses on quality management practices and implementation aspects. During 1993-94, APO conducted a study on TQM practices, which pointed out a number of findings and recommendations that firms should consider for the improvement of TQM performance. They include for example, the need for top management leadership and commitment, importance of continuous education and training and sharing of information among workers. These recommendations, although useful but were not so specific to translate them into practical actions. This book is the result of second Basic Research conducted as a follow-up to the previous survey to establish linkages between the two studies and focus on implementation aspects.

The book provides a synopsis of historical development of TQM in Japan and the prevailing factors of quality and productivity promotion. The book gives a brief resurrection of competitiveness in US and comparisons between behaviour of US and Japanese firms. The basic managerial behaviour of US firms lies in profit maximization. To achieve this paramount mission, they raise prices to increase profits during business booms and reduce production to prevent falling prices and carry out worker retrenchments for cost reduction during business recessions. However, Japanese firms maintain their production levels and expand by increasing their sales and thus market share. When business is good, they expand production and production facilities and ask workers to do overtime work. During recessions, however, they try to maintain production and sales even at the expense of profits because worker retrenchments are difficult to carry out. Thus economic friction between US and Japanese firms is the natural course of events because the business behaviour of the two remains poles apart.

Furthermore, an overall view is provided on the basis of a survey (43 case studies) conducted in Bangladesh, China, Fiji, Hongkong, India, Indonesia, Islamic Republic of Iran, Republic of Korea, Pakistan, The

Phillipines, Singapore and Thailand. For the survey the countries were divided into three groups (A-C). The level of TQM implementation in the 12 participating countries varied significantly due to different socioeconomic backgrounds and economic development. Group A covers Hongkong, Singapore, the Republic of Korea and the Republic of China; Group B includes such ASEAN members as Thailand, The Phillipines and Indonesia. These were previously agriculture oriented but have recently promoted industrialization through foreign direct investment. Group C refers to such South Asian countries as India, Iran, Pakistan and Bangladesh as well as Fiji in South Pacific. TQM is now in the mature stage and firms in these countries are required not only to achieve ISO 9000 and ISO 14000 certification but also to develop human resources with a creative mind set.

Similarly, challenges to Group B countries, does not mention TQM word even once says that major challenge is to develop middle managers, engineers and workers. For Group C, it emphasizes quality, SQC techniques and TQM. Under Common Challenges Ahead, the book says that education and training of workers are crucial in strengthening quality management. The role of middle managers is important in upgrading the quality of rank-and-file workers and the leadership of top management is indispensable in TQM implementation. A bottom-up approach through QCC's is effective, but more often a top-down approach in devising policies and strategies for TQM is desirable. Workers morale

should be raised not only through monetary incentives but also through participation for example, information sharing.

The book highlights the adoption of ISO 9000 standards in Asian Countries. ISO 9000 implementation achieves customer satisfaction and improves the overall business performance. India is among the top bracket along with Japan and China in adopting quality system standards ISO 9000.

Although the book does not give anything new other than what has been covered in many TQM books. It does bring out some practices in various Asian Pacific countries but falls short of meeting its objective to provide down-to-earth practices and TQM implementation process.

On the whole the book is a welcome addition to existing TQM literature. It will serve a good cause for the persons in this field.

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New Books Received for Review

Joseph J. and Singh K. (Eds), *Organisational Effectiveness Through HRD*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1998, p. 163, Price Rs. 350.

The relationship between organisational effectiveness and the development of human resources in organisations is not necessarily a settled question. The committed believer may think that the positive relationship between the two phenomena is so obvious that any attempt at closer scrutiny would be considered almost blasphemous and that any attempt to articulate the all so obvious relationship is both tautological as well as redundant. The thirteen experiences in experimentations and explorations in developing people in organisations reconstructed in this volume are samples of organisational initiatives in this important sphere of corporate life. The sample represents public sector, private sector, family business sector, the cooperative sector and the multinational sector spread across the length and breadth of this country and also represents both the manufacturing as well as services sectors.

Harper M., *Profit for the Poor: Cases in Micro-Finance*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1998, p. 199, Price Rs. 195.

Micro-credit is the latest development fashion, and it has even received the ultimate accolade of "World Summit". It is not generally appreciated, however, that there is a wide variety of quite approaches to the profitable delivery of financial services to the poor, and that such services are being and indeed have for many years been provided by many different type of institutions, including traditional commercial banks as well as NGOs and the much publicised "new generation" institutions. The book is about profitable micro-finance. The case studies describe a variety of different ways by which it is possible to provide financial services to poor people at a price they can afford, and which also covers the costs of the institutions.

Chattopadhyay S. and Sharma H.S. (Eds), *Sustainable Development: Issues and Case studies*. Concept Publishing Co., New Delhi, 1998, p. 307, Price Rs. 450.

Considering overriding importance of sustainable development and its societal implication, the National Association of Geographer's India (NAGI) constituted a Commission on Sustainable Development. It was decided that one of the activities of the Commission will be to highlight the various issues involved in this matter from multi-disciplinary angle with a view to create a knowledge base. This book is an outcome of that venture. Apart from the concepts and issues, articles in the first section also deals with methodological problems citing definite examples. The issues dealt are ecological, ethical, problem of conception, problem of quantification green politics, political economy, and operational problems.

Kanungo R.N. (Ed), *Entrepreneurship and Innovation: Models for Development*. Sage Publications, New Delhi, 1998, p. 366, Price Rs. 395.00 (cloth).

The book is divided into four parts, the first of which presents conceptual models which explain the phenomenon of entrepreneurship, provide a typology for theory development, and discuss the relationship among the various elements that describe the process of entrepreneurship. The critical roles of both the cultural and the business environment are emphasized, and ways of building sound theories in this area are suggested. The essays in the second part focus on the entrepreneur as a person. Among the aspects discussed are the role of enterprises, the problems encountered by woman entrepreneurs, and the largely neglected issue of ethical conduct. In part three, the focus of analysis shifts from the entrepreneur as a person to small scale and rural enterprises exhibiting entrepreneurial and innovative processes. The final part of the book identifies several management skills that are needed for starting and sustaining small enterprises.

Guha B.P. (Ed), *Challenges of Economic Reforms: Impact of Labour and Industrial Relations*. B.R. Publishing Corporation, Delhi, 1997, p. 300, Price Rs. 350.

This is an attempt to analyze the varying view points of important functionaries representing Trade Unions, Management, Government and Academics on the reform measures initiated in 1991. Based on the deliberations in a National Seminar organized in April, 1993, an Executive Summary was brought out a month later. There were suggestions for undertaking a review of the impact of the corrective actions recommended by the seminar after allowing 3-4 years time for the new procedural changes to go into the system. This will enhance the usefulness of the study.

Herman B. and Sharma K., *International Finance and Developing Countries in a Year of Crisis: 1997 Discussions at the United Nations*. Vistaar Publications, New Delhi, 1998, p. 143, Price Rs. 165.00.

The book begins with an incisive analysis of the financial crisis in some of the emerging market economies of Asia, with a special focus on Thailand, and its implications for policy makers. The following chapters emphasize the importance of the UN's contribution to international policy for development; the need for improving current account positions and strengthening the financial sector rather than merely boosting growth in developing nations; the necessity to manage the volatility of capital flows to emerging markets; the benefits of capital-market liberalizations accompanied by proper infrastructural development; and the techniques of attracting external financial resources and their effective absorption. The final chapter advocates an inter-governmental conference on finance and development and argues that the current system of global economic governance does not adequately represent developing economies.

Ramanujam M.S., Awaathi I.C. and Pandey, Gayatri, *Employment Promotion in the Urban Informal Sector*, New Age International (P) Ltd., Publishers, New Delhi, 1998, p. 308, Price Rs. 395.00.

Urban planners are often confronted with a variety of issues in evolving policies to promote employment in the urban informal sector. The issues range from conceptual aspects; to data related problems; to macro-economic environmental issues; and to approaches, strategies and policy formulation. There are many controversies surrounding these issues. This volume presents some scholarly contributions by some development economists, policy planners and professional experts on these controversial issues. These con-

tributions were discussed and relevant issues were deliberated upon threadbare at the National seminar on Employment Promotion in the Urban Informal Sector held to arrive a consensus on the recommendations to tackle major controversial issues.

Asian Productivity Organisation, *Productivity and Quality Improvement in Civil Service*. APO, Tokyo, 1998, p. 380.

In the last two decades a marked shift could be observed towards a reduced role for government all over the World. Simultaneously, globalization and rising aspirations of people are forcing governments to improve the quality of public services. The civil service must adapt to the new environment and play a leading role in accomplishing needed changes. Civil Servants are under increasing pressure to provide productive, lean, and clean administration. To respond positively to these challenges, many member governments have initiated reform programmes to improve the productivity and quality of civil service. The measures launched by various governments include deregulation, privatization, decentralization and improvements in human resource management and public services through the extensive use of Information Technology. This publication is a compilation of presentations of the resource persons, country papers, and the report of the study meeting including the finding and the recommendations.

Asian Productivity Organisation, *Top Management Forum Green Productivity and Role of Top Management in Search of Sustainable Asia Through Green Products and Services*. APO, Tokyo, 1998, p. 134.

The concept of green productivity has been developed based upon the shared conviction among stake holders that the relationship between productivity improvement and environmental preservation should not be treated as trade off but as a harmonious one for a better quality life for all people. Keeping the background in view, a forum was organised as one of the major projects in the APO's concerted efforts of promoting green productivity, so that the experiences of Japanese business leaders in their efforts to design and develop green products and services could be shared among member countries.

Asian Productivity Organisation, *Irrigation Association for Participatory Management in Asia*, APO Tokyo, p. 182.

Institutional development has an important role in making further improvement in irrigation management by providing an organisational response to the need for better operations of irrigation schemes. This volume is a

compilation of proceedings and papers presented at the seminar which aimed to review the present situation to discuss the future course of action to be taken by irrigation associations in promoting participatory irrigation management in member countries.

Mehta P.V. and Bhardwaj S.K., *Managing Quality in the Apparel Industry*. New Age International (P) Ltd., Publishers, New Delhi, 1998, p. 327, Price Rs. 550.00.

This easy-to-follow reference book explores all aspects of quality for the clothing and apparel industry—detailing the fundamental principles as well as the latest topics in the quality profession. Presenting quality as an overall business strategy and management function, this book explains what is quality, why quality is important and describes how to build quality into products, show how to evaluate quality of all the components that go into making garments, explains how to measure the cost of quality or rather poor quality and shows how to begin to manage quality.

AIMA, *Business-led HR Strategies*. Excel Books, New Delhi, 1998, p. 175, Price Rs. 125.00.

The major thrust of this publication is to focus on challenges encountered by organisation in their strategy

business concerns and the initiatives taken by them in their HR practices. The experiences in the book are thought provoking and highlight the best practices that have contributed to the success of these organisations. Various trends and issues emerge out of the book. Pace setting organisations from the private and public sector like HLL, IOC, Indian Airlines, Escorts, ONGC, L&T, Power Finance Corporation, and TISCO share their experiences in the book.

Singer H. (Sir), Hatti N. and Tandon R. (Eds), *New World Order Series: Export Led Versus Balanced Growth in the 1990s*. Vol. 13, B.R. Publishing Corporation, Delhi, 1998.

The Prebisch-Singer hypothesis has been extremely influential in policy making during the the 1980s as well as 1990s. In spite of subsequent broadening of the Prebisch-Singer thesis, away from barter terms of trade and into questions of international hierarchy, technology and other areas of dominance and dependence, the empirical basis has continued to be debated. This book in the New World Order series is dedicated to Raul Prebisch who underlined the dynamics of the World economy and the interdependence between the industrial countries of the North and the LDC's of the South.

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